Chasing Parity

Gender Pay Gaps in the Twin Cities and in Greater Minnesota

Minnesota ranks third in the nation for its female labor force participation rate and 12th for the percent of women with a Bachelor's Degree or higher. Despite these accomplishments, female workers in Minnesota experience lower earnings compared to their male peers. This study analyzes the extent and sources of gender pay gaps in Minnesota using the following research questions: 1) Can we observe gender wage gaps even when taking into account productivity-related factors? 2) Is there a difference between the Twin Cities and Greater Minnesota in the size of the gender wage gap and in the mix of factors that drive it? Understanding the mechanisms through which gaps develop and which components account for most of the gap can help craft policy responses that address the underlying sources of the disparities.

The dataset consists of 255,519 individuals who enrolled in a Minnesota post-secondary institution, exited between July 2009 and June 2014, and were employed in Minnesota five years after school exit. This cohort-based approach ensures that all individuals had approximately the same amount of job search time since exiting school. The analysis is restricted to students who reported being of white race and were 40 years or younger at the time of exit in order to control for the role that race and age play in wage gaps and thus to simplify the analysis.[1]

About the data

This research relies on two data sources, both found in the Statewide Longitudinal Education Data System (SLEDS): (1) post-secondary enrollment and graduation records, which cover all for-credit public and private programs in Minnesota; merged with (2) wage record data from the Unemployment Insurance program. The panel nature of wage data allows us to follow students longitudinally through education into the workforce. All numbers and graphic displays of numbers are the work of the author.

The dataset has 255,519 enrollees who exited post-secondary school between July 2009 and June 2014, reported being of white race, were between 19 and 40 years of age at the time of exit, and were employed in Minnesota five years after school exit. Graduates who earned more than one degree in the same academic year were classified according to the highest degree obtained. Excluded from the dataset are individuals who went to work for the federal government, were self-employed, or left the state. These workers are not covered by Minnesota's Unemployment Insurance program.

[1]See article by A. Leibert, Racial Disparities in Wage and Employment After Graduation mn.gov/deed/newscenter/publications/trends/december-2015/disparities-wage-employment.jsp

Gender pay gaps widen with age

To set the stage for our analysis Figure 1 plots the earnings of the youngest cohorts of male and female students from two years before to six years after exiting post-secondary school, distinguishing between credential completers and non-completers. The left panel shows earnings in the Twin Cities, while the right panel represents Greater Minnesota.

Two results stand out. First, among individuals age 21 to 26, wage gaps are non-existent at the time of school exit but emerge right after, increasing gradually with age. By the sixth year after exit women in the Twin Cities with a credential earned 12.2 percent less than men, while the corresponding gap in Greater Minnesota was 8.7 percent less. Second, in Greater Minnesota the earnings trajectory differs significantly between completers and non-completers. Women who did not complete a credential earned wages 17.6 percent lower than their male peers, while women who completed a credential faced a discrepancy half that size (8.7 percent). This result suggests that in the low-skilled labor market in Greater Minnesota men have more opportunities for career advancement than women.

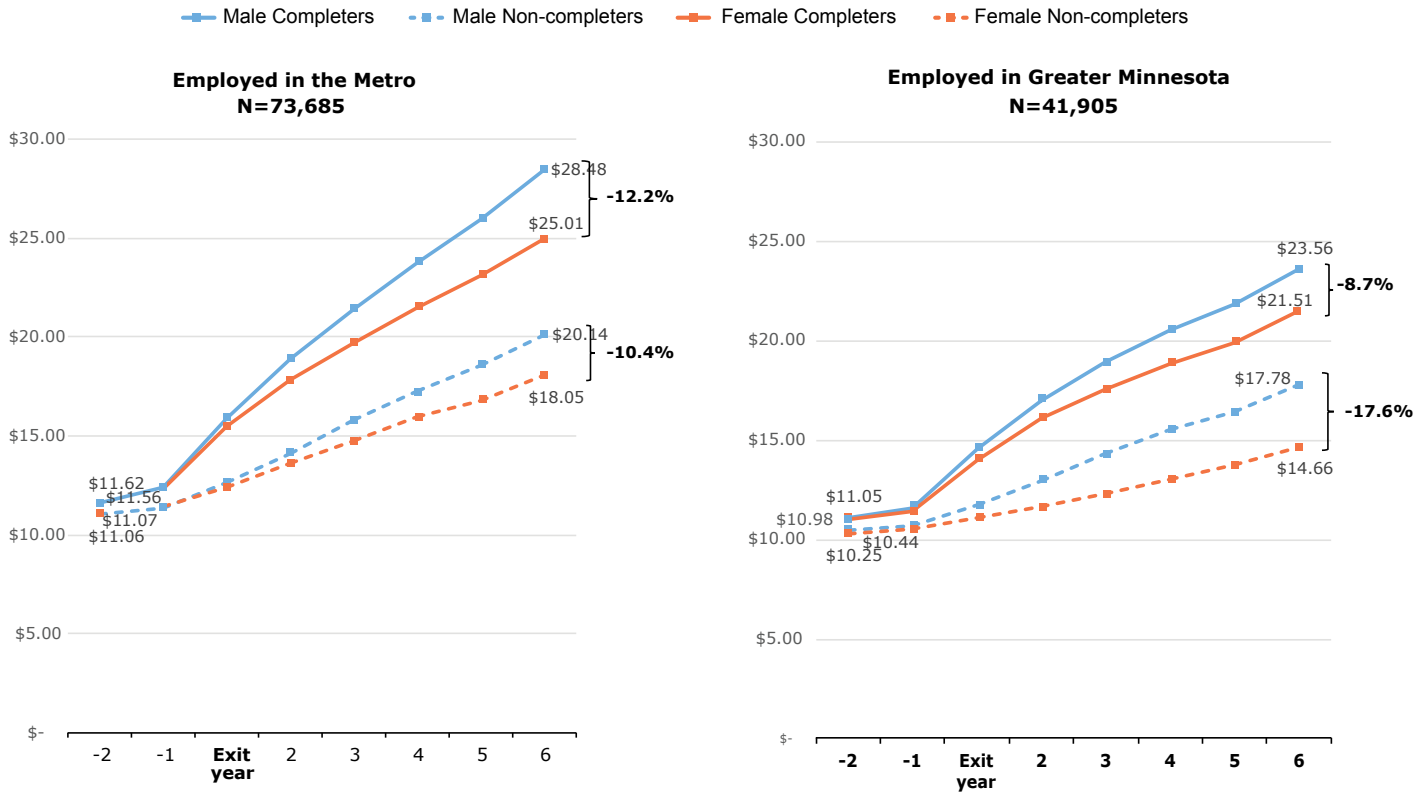
Among older students, those who left school after age 30, gender wage gaps exist even before school exit. In Greater Minnesota we see the same pattern of larger gender wage gaps among non-completers regardless of age.[2]

Do Men and Women Have the Same Productivity Characteristics?

Could the gaps illustrated in Figure 1 and 2 stem from differences in what men and women study in college? Or might they stem from differences in how men and women participate in the labor market? To answer these questions this analysis uses individual-level data on some of the most important factors known to influence job productivity and, therefore, earnings. The analysis distinguishes between factors that are fixed such as age or that emerge before entering the labor market (Table 1) and factors that develop through participation in the labor market (Tables 2 and 3).

While certain characteristics are fairly equally distributed among employed men and women in the dataset, others are not. For instance, women have more

Figure 1. Wage Trends from 2 Years Before to 5 Years After School Exit by Gender



Note: All wages reported in constant 2017 dollars. Wage outliers are being excluded from the median calculation. To allow for six years of wage data we excluded the 2014 cohort from this particular chart. Ph.D. graduates, who represent a small minority, were also excluded.

[2]One potential explanation for the more rapid widening of the gender gap among young women who are non-completers is the fact that they tend to have children earlier than college-educated women so the wage penalty would start earlier. If, however, this effect were predominant, we would have found wider gaps among non-completer young women in the Twin Cities.

formal schooling than men: only 26.4 percent of women did not complete a credential versus 36.1 percent of men, and 16 percent of women completed a credential above Bachelor's compared to 11.5 percent of men.

Stark gender disparities are also evident in fields of study,[3] which reflect differences in occupational goals. Men are over-represented in high-paying fields, including STEM (16.5 percent versus 5.2 percent among women), skilled trades (15.7 percent versus 0.6 percent among women), and business majors such as Finance and Business Administration (13.5 percent versus 7.7 percent among women). Women are over-represented in Healthcare (26.5 percent) and in some of the lowest-paid majors (Cosmetology and Culinary Services, Psychology, Early Childhood Education). Registered Nursing is an exception, with high wages and high female representation.

Another factor associated with earnings is college readiness, which can be indirectly measured through enrollment in post-secondary programs such as Remedial Education, Adult Basic Education, or GED preparatory courses. As shown in Table 1, men and women are equally distributed across these indicators. Another proxy for college readiness is the type of post-secondary institution of first enrollment. High performing students are more likely to enroll in four-year institutions, especially those with selective admissions criteria, while less academically prepared students are more likely to enroll in two-year, open enrollment institutions. These characteristics are likely to affect earnings among individuals but are fairly equally distributed by gender.

Table 2 presents firm characteristics, starting with an indicator for employment in the private sector, broken down into for-profit and non-profit, or in the public

Table 1: Demographics and Educational Characteristics by Gender

Characteristics	Men	Women
Total	118,445	137,074
Percent	46.4%	53.6%
Average Age At School Exit	25.3	26.0
Highest Education Level Completed		
Left School Without a Credential	36.1%	26.4%
Sub-baccalaureate Certificate or AAS Degree	22.4%	25.3%
Bachelor's Degree	29.9%	31.8%
Graduate Certificate of Master's Degree	9.0%	13.7%
Above Master's	2.5%	2.8%
College Readiness Indicators		
High School Dropout or GED Completer	4.8%	4.1%
Enrolled In Adult Basic Education During Post-secondary	2.8%	2.7%
Enrolled in Remedial Education During Post-secondary	21.4%	21.4%
Post-secondary Institution of Initial Enrollment		
Two-year Minnesota State	46.1%	38.4%
Four-year Minnesota State	15.0%	16.2%
Private For-profit Career School	8.5%	12.7%
Four-year Public, Private, and Professional School	29.5%	32.7%
Fields of Study of Highest Degree Completed (Excluding Non-completers)		
IT	5.3%	0.6%
Engineering	4.9%	0.5%
Other STEM (Math, Biology, Physical Science, Architecture)	6.4%	4.1%
Skilled Trades	15.7%	0.6%
Finance, Business Administration, Management Information Systems, Taxation, Project Management	13.5%	7.7%
Health Care	5.1%	26.5%
Education, Family Science, and Early Childhood-related	6.0%	13.1%
Cosmetology and Culinary Services	0.8%	4.0%
Psychology and Social Work	1.9%	6.9%

[3]Non-completers were assigned field of study based on number of credits taken.

sector. These characteristics are important to include in an analysis of wages because public sector wages are typically determined through centralized bargaining and do not offer bonuses. Women are over-represented in the non-profit and public sectors (21.3 percent and 15.5 percent respectively), probably reflecting their preference for part-time/flexible work arrangements or for careers in Education and Healthcare that have a higher share of jobs with part-time schedules.

By far the biggest gender differences in workplace characteristics are in industry of employment, also shown in Table 2. The starkest differences are in Healthcare (26 percent women versus 6.2 percent men), Education (12.7 percent women, more than twice the share of men), Construction/Mining/Utilities (1.4 percent women versus 10.3 percent men), and Manufacturing (4.7 percent women versus 13.2 percent men). Industry distribution partially mirrors choice of major, but one of the main sources of gender pay disparities is that industry can differ by gender even within the same major, as we shall see later.

Finally, we take advantage of the panel nature of wage data to create measures of work experience accumulated from approximately 10 years before to five years after school exit. Each work experience variable displayed in Table 3 captures a different dimension known to influence the rate of skills accumulation in the labor market. We expect wages to rise with each quarter of work experience, industry tenure, and firm tenure because these represent the main mechanisms through which workers acquire general skills, industry-specific skills, and firm-specific skills, respectively. Since accumulated work experience is partially a function of age, each metric is displayed by age group.

The number of years of employment in Minnesota, a measure of workforce attachment, is actually slightly higher for women (8.4) but their experience is more in part-time work than men's. The likelihood of working full-time in a dominant job is slightly higher for men than for women (3.4 years versus 3.2 years in the young age group and 8.2 years versus 7.1 years in the older age group). The average 35 year old woman in the dataset has accumulated 12 years of general work experience, of which 6.1 years were full-time work, versus 11.4 years among men of the same age, of which 6.7 years were full-time work. Although young women accumulated nearly the same average work hours as their male peers (8,693 versus 8,798) their hours were more likely to be distributed across multiple jobs rather than being concentrated in one dominant job. Among workers who exited between age 20 and 29, women worked on average 1.19 jobs each quarter versus 1.13 for men. Finally, women have a slightly higher average firm and industry tenure than men.

Overall, women and men in our dataset have very similar labor force participation patterns. Much more significant gender differences exist in major and industries of employment. We expect these forms of segregation by gender to explain a large share of the gender wage gap.

Table 2: Gender Distribution by Characteristic of Firm of Employment

Characteristics	Men	Women
Sector of employment		
Private For Profit	82.6%	63.2%
Non-profit	6.4%	21.3%
Public (Including State and Local Government)	11.0%	15.5%
Location		
Twin Cities Metro	63.0%	60.4%
Greater Minnesota	35.1%	38.2%
No Fixed Location in Minnesota	1.9%	1.4%
Industry		
Healthcare	6.2%	26.0%
Social Assistance	1.0%	4.7%
Education	6.3%	12.7%
Government	5.0%	5.7%
Retail	9.9%	8.0%
Construction, Mining, Utilities	10.3%	1.4%
Manufacturing	13.2%	4.7%
Professional and Technical Services	8.0%	6.7%
Job Was Obtained Through a Temporary Staffing Agency	2.3%	1.6%

Estimation results

This section quantifies the association between earnings outcomes and each of the factors introduced in Tables 1 through 3 in order to answer the first research question: How much of the pay gap still remains net of productivity-related factors? The analysis uses a linear regression technique of the form suggested by Mincer[4] to measure the combined effect of all characteristics. Table 4 summarizes the results from seven regression models, each adding a new group of explanatory variables, in order to observe how the starting gender wage gap varies with the addition of more factors. Before interpreting these results we need to mention that regression is a correlational analysis method and thus does not prove causal effects. In other words, finding that one characteristic is related to an "outcome" variable (e.g., that education level is related to earnings) does not mean that the characteristic is the cause of the outcome.

In Model 1, which serves as our baseline, the coefficient for gender (-0.066 log points or -6.4 percent) represents the overall male-female wage gap in the dataset.

Model 2 adjusts the baseline estimate of the wage gap by taking into account the variation in wages associated with differences in age,[5] permanent residence,[6] year of school exit,[7] education level, type of post-secondary institution of first enrollment[8] and proxies for college readiness. Using Bachelor's Degree completers as the reference category, the coefficients reveal that

Table 3: Gender Differences in Prior Work Experience and Work Participation Patterns*

Characteristics	Men	Women
Average Accumulated Years of Work Experience in Minnesota	7.6	8.4
Average Years Out of Work Since First Employed in Minnesota	1.6	1.5
Average Accumulated Years of Part-time Work		
-by age 25 to 34 (20-29 at exit)	3.1	3.8
-by age 35 to 45 (30-40 at exit)	4.5	5.9
Average Accumulated Years of Full-time Work in Dominant Job		
-by age 25 to 34 (20-29 at exit)	3.4	3.2
-by age 35 to 45 (30-40 at exit)	8.2	7.1
Average Years Current Job Seniority (Tenure) With the Same Firm		
-by age 25 to 34 (20-29 at exit)	3.0	3.1
-by age 35 to 45 (30-40 at exit)	4.7	4.8
Average Years of Industry Tenure From Two Years Before to Five Years After Exit		
-by age 25 to 34 (20-29 at exit)	3.5	3.9
-by age 35 to 45 (30-40 at exit)	4.5	4.8
Average Jobs Held Per Quarter From Two Years Before to Five Years After Exit		
-by age 25 to 34 (20-29 at exit)	1.11	1.19
-by age 35 to 45 (30-40 at exit)	1.10	1.13
Average Number of Hours Worked From Two Years Before to Five Years After Exit		
-by age 25 to 34 (20-29 at exit)	8,798	8,693
-by age 35 to 45 (30-40 at exit)	10,741	9,921

*These work experience metrics are based on quarterly reports of employment in Minnesota and do not represent work experience accumulated out of state. They span from 10 years before school exit (or an individual's 20th birthday) to five years after school exit..

[4]See Jacob Mincer, Schooling, Experience, and Earnings, Columbia University Press, 1974.
[5]Since this effect fades away after a certain age, we included a quadratic term in the model. Controlling for age in the model is also needed to correct for the fact that we don't have full work histories for individuals who were older or worked partially out of state.
[6]Residence is measured at the time of first enrollment and is categorized into four groups: students with permanent residence outside Minnesota except those resident abroad, who were excluded; residents in the Twin Cities; resident in metropolitan areas excluding the Twin Cities; and resident in micropolitan or rural areas. Out of state residents, educated and working in Minnesota, had higher earnings on average than Minnesota residents, probably because students who cross state lines for higher education typically have higher ability or more financial resources to relocate than others.
[7]Year of exit controls for differences in the business cycle. For example, students who left school in academic year 2009 at the peak of the Great Recession had significantly lower earnings five years out than students who left in 2014 because they faced a much more challenging labor market at the onset of their careers.
[8]These variables partially capture unmeasured characteristics such as institutional selectiveness, quality, and price.

completing a sub-baccalaureate credential of more than one year in length leads to higher earnings than dropping out, but lower earnings than a baccalaureate award. Furthermore, completing education beyond a Bachelor's Degree increases earnings by 0.248 log points (28.2 percent) for a Master's Degree and by 0.505 log points (65.7 percent) for above the Master's Degree level. Adding educational attainment widens the gender disparity, increasing the female coefficient from 0.066 (unadjusted) to 0.111 log points. That is, if men had the same educational attainment as females the gender pay gap would actually be higher. The R squared of the model is .366, meaning that these variables combined explain 36 percent of the variation in wages.

Model 3 expands the analysis by adding 73 fields of study, not fully listed for reasons of space. The R squared of the model increases to .470, representing an 11 percentage point increase in explanatory power. The coefficient for female falls by 3 log points, from -0.11 to -0.08. This important result implies that a key source of the pay gap is represented by women's choice of major. Although in this study we cannot directly control for occupation, major is a good proxy for career goals and occupation-related skills, especially among credential completers. Table 4 also displays a few examples of fields of study with large size effects. The coefficients represent the distance (i.e., percent difference) in expected wage for each major relative to the reference category, which in our case is Accounting. For example, a coefficient of 0.221 log points for individuals who pursue a program in Plumbers and Electrical/Power Installers means that these students earned 24.7 percent more to each dollar earned by individuals who pursued a program in Accounting, holding other characteristics constant.

By far the major that gives the highest boost in earnings is Medical Residency Programs, with a stellar return of more than 189 percent to the dollar compared to Accounting. Another highly marketable program is Registered Nursing at 0.313 log points or 36.7 percent. At the other end of the spectrum, majors with low returns are Cosmetology and Culinary Arts, Early Childhood Education, and Social Work. In general, college majors and jobs that emphasize service to others are undervalued in labor markets, and they tend to be female-dominated.[9]

Model 4 adds industry of employment, raising the R squared from 0.470 to 0.537. Table 3 shows regression coefficients for selected industries, using Banking as the reference category. Management of Companies (i.e., working at firm headquarters) boosts earnings by 8.8 percent because job types in this industry are predominantly managerial or white collar. In contrast, working in Child Day Care Centers starkly reduces earnings (-0.409 log points) relative to working in Banks. Interestingly, the addition of industry controls significantly reduces the female coefficient from -0.078 to -0.061 percent, making industry of employment the largest explanatory component of the gender pay gap together with major.

It should be pointed out that industry has two effects on the gender wage gap. The first is that women work in lower paid industries than men (see Table 2). If we had controlled for industry before controlling for major we would have seen a 15 percent point decrease in the gender wage gap.

The second is that the gender gap decreases further when industry controls are added *after controlling for degree level, school selectivity, and 73 detailed majors*, suggesting that there is a difference between the education-to-industry matches that prevail among men and those that prevail among women, and the job sorting mechanisms that produce those differential matches favor men over women. Working in an industry related to one's major represents a good match, while working in an unrelated industry represents a mismatch. If women are less successful than men at finding work in industries where their field of study is most rewarded, this alone would cause a gender gap. This finding supports the hypothesis that women suffer wage penalties associated with education-to-industry mismatch.

The distinction between major selection and industry selection is an important one. While major is typically a voluntary choice, industry of employment is the result of job sorting mechanisms in the labor market that individual job seekers have much less control over. Finding an association between industry distribution and gender pay gaps *while simultaneously holding major constant* signals a problem of equal opportunities.

Model 5 adds sector of employment, firm size, and employment in selected large firms. Working in the non-profit sector and state government is associated with lower pay relative to for-profit firms. Despite the fact that women are more likely to work in the for-profit sector (see Table 2), this characteristic is offset by the fact that women are more likely to work in large non-profit firms in the Healthcare industry where wages are higher. So, the combined effect on gender gaps is neutral.

Model 6 adds work experience characteristics. Since one of the main arguments made for lower pay is that women have less professional experience than men, controlling for various dimensions of work experience is essential to validate the hypothesis that women are paid lower wages even at the same levels of experience.

[9]Effects measured five years after school exit may not hold 10 or 15 years out. Some majors have a more immediate return on investment while others take longer to yield a return.

Table 4: OLS Regressions Controlling for Different Sets of Explanatory Variables
Dependent Variable: Log of Real Hourly Wages Five Years After School Exit

*** indicates statistical significance at the 1% level or better. Standard errors given in parentheses.

N= 215,248		Model 1	Model 2 Educ.	Model 3 Major	Model 4 Industry	Model 5 Firm Size	Model 6 Work Exp.	Model 7 Interaction
Gender	**Female**	-0.066***	-0.111***	-0.078***	-0.061***	-0.061***	-0.055***	-0.0207***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.025)
Education (Reference: Bachelor's)	Did Not Complete a Credential		-.274***	-0.233	-0.18***	-0.173***	-0.184***	-0.18***
			(0.003)	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)
	Sub-baccalaureate Credential		-.127***	-0.148	-0.124***	-0.118***	-0.124***	-0.124***
			(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
	Master's		.248***	.247***	0.240***	0.234***	0.194***	0.196***
			(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
	Above Master's		.505***	.370***	0.373***	0.377***	0.366	0.367***
			(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Field of study (Reference: Accounting)	Registered Nursing			0.313***	0.285***	0.287***	0.311***	0.306***
				(0.005)	(0.006)	(0.006)	(0.005)	(0.005)
	Plumbers and Electrical Installers			0.221***	0.121***	0.122***	0.122***	0.127***
				(0.008)	(0.008)	(0.008)	(0.007)	(0.008)
	Social Work			-0.209***	-0.122***	-0.115***	-0.083***	-0.081***
				(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
	Cosmetology			-0.193***	-0.100***	-0.098***	-0.047***	-0.042***
				(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
Industry (Reference: Banking)	Staffing Agencies				-0.269***	-0.260***	-0.166***	-0.162***
					(0.006)	(0.008)	(0.006)	(0.006)
	Child Care Centers				-0.409***	-0.376***	-0.382***	-0.383***
					(0.009)	(0.009)	(0.008)	(0.008)
	Nursing and Residential Care Facilities				-0.205***	-0.175***	-0.182***	-0.185***
					(0.005)	(0.005)	(0.005)	(0.005)
	Heavy/Civil Engineering Construction				0.127***	0.099***	0.109***	0.107***
					(0.009)	(0.009)	(0.008)	(0.008)
	Management of Companies				0.088***	0.060***	0.085***	0.078***
					(0.005)	(0.006)	(0.005)	(0.005)
Accumulated Work Experience (1)	Total Quarters of FT Work						0.0061***	0.011***
							0.000	0.000
	Total Quarters of PT Work						-0.0054***	--0.0066***
							0.000	0.000
	Quarters of Industry Tenure						0.0085***	0.0075***
							0.000	0.000
	Average Jobs Held Per Quarter						-0.048***	-0.048***
							(0.003)	(0.002)
	Female*FT Experience							-0.00777***
								0.000
	Female* PT Experience							0.00311***
								0.000
	Female* Industry Tenure							0.0015***
								0.000
Fixed Effects	Demographics, Educational, and Cohort Fixed Effects (2)	No	Yes	Yes	Yes	Yes	Yes	Yes
	Firm Sector, Firm Size, and Selected Large Employers	No	No	No	No	Yes	Yes	Yes
	Constant Term	3.176	2.292	2.468	2.563	2.456	2.722	2.720
	R squared	**0.005**	**0.366**	**0.470**	**0.537**	**0.550**	**0.591**	**0.593**

(1) All work experience metrics represent only Minnesota employment. To correct for the fact that we don't have full work histories for individuals who were older or worked out of state we controlled for age in the model.
(2) This includes age, residence, geography of employment, school cohort, institutional selectivity, and college-readiness proxies.

Although these factors add considerable explanatory power to the model (from 0.550 to 0.591), they reduce the gender pay gap by only 0.6 log points, demonstrating that something else is at play besides differences in the way women and men participate in the labor market.

The strongest positive effects on earnings are represented by full-time experience (0.6 percent on each dollar for each quarter or 2.4 cents a year) and tenure in the same industry. Each additional year in the current industry translates into another 3.3 percent in expected wages. In contrast, the effects of part-time experience on earnings are weaker and negative (-0.005 log points) once full-time experience is controlled for, and the effect of job tenure does not reach statistical significance so we excluded it from the model.

The factor with the strongest effect on the gender pay gap besides full-time work experience is average jobs held in each quarter of previous employment. This variable has a significant negative effect on earnings (-0.0484 or -4.7 percent) because having multiple jobs or switching between part-time jobs hurts earnings growth by delaying career advancement. Women are more likely than men to be in this type of work arrangement probably because of the need to balance work and family. Including this variable decreases the gender gap by 3 percentage points, suggesting that the female wage penalty would be mitigated if women were able to put more hours into one dominant job.

In sum, while all of the variables listed in Table 4 have a statistically significant effect on wages, very few of them play a role in driving the gender wage gap. Net of all characteristics accounted for in Model 6, the gender pay gap remains at -.055 log points, meaning that on average women are paid 5.3 percent less than men when all other characteristics in the model are held constant. This gap is already established as early as five years after school exit in a dataset of young workers. This finding raises concerns because gaps that appear early in a career can widen substantially over the course of one's work life.

The final estimate, Model 7, completes the analysis by adding the interaction between the number of quarters worked and being female. This allows us to analyze the gender gap both in terms of differences in quantity of experience and in the returns to that experience. The rise in R squared as well as the sign and significance of the interaction coefficients confirm the hypothesis of lower returns to full-time experience for females. Once the term "Female*FT Experience" is added to the model, the coefficient for full-time experience doubles in size (from 0.006 to 0.011) because it now measures the returns to full-time experience for males only. This means that an additional quarter of full-time work experience increases males' earnings by 0.011 log points (1.1 percent a quarter[10]) while for females the effect is much smaller, 0.0032 log points (0.011-0.0077). Women have less negative returns than men on part-time work and more positive returns than men on years of tenure in the same industry, but these advantages are too small to offset the male premium for full-time experience. We can now ignore the coefficient on female because the effect of being female is mostly captured by the coefficient of the interactions.[11]

The significance of the interaction indicates that the effect of being female on earnings is different at different values of full-time work experience. With each passing year the gender gap widens until a point where it stabilizes. An important consequence of these widening disparities is the *cumulative effect* that results, whereby females are increasingly disadvantaged over time.

Regional Differences in Gender Wage Gaps

We now turn to our second research question: Is there a difference between the Twin Cities and Greater Minnesota in the size of the gender wage gap and in the mix of factors that drive it? Applying Model 6 separately to the two geographies results in the same overall patterns of wage determination. The effects of each variable, measured by the sign and size of each coefficient, are very similar. The next step is to identify differences in how each factor contributes to gender pay gaps in the Twin Cities relative to Greater Minnesota.

Figure 2 reports the results from 12 regression models which replicate those in Table 4 separately by region. The purpose of this analysis is to observe how the coefficient for being a female varies as more information is added to the model, in order to isolate the contribution of each factor net of the characteristics controlled for in the previous steps. Each bar represents the coefficient for female (the wage gap) net of other variables. This time the coefficients are measured in percentages rather than logs.

We find almost no difference in the raw gender pay gap by region, which is -5.6 percent in the Twin Cities and -6 percent in Greater Minnesota. That is, women were paid around 6 percent less on average than men in both regions. The first step consists of adding demographic, education, and college-readiness characteristics exactly as in Model 1. Not surprisingly, accounting for these variables widens the gender wage gap in both regions (see blue bars), meaning that if males had the same

[10]The square term of full-time experience is highly statistically significant but extremely small because only very few individuals in the dataset are old enough to experience the declining effect of work experience. Therefore, for the sake of simplifying the display, we did not include the quadratic terms for full-time and part-time experience in Table 4, but we used it to calculate the effect on females.
[11]The coefficient now means that women with a Bachelor's Degree and zero quarters of full-time and part-time experience earn 2 log points less than their male counterparts. Since this value does not exist in our dataset, we should not try to interpret this coefficient.

education level as females, gaps would be higher. Gaps of 10 percent and 11 percent are similar to those shown in Figure 1 where age, education, and region are controlled for.

Adding controls for 73 fields of study provides a surprise. These characteristics greatly improve the fit of the model in both regions, meaning that choice of major drives earnings for both men and women, but have a different effect on the gender pay gap. The female coefficient in the Twin Cities drops by half, from -10 percent to -5.3 percent, but remains virtually unchanged in Greater Minnesota. What seems to be driving gender wage gaps in the Metro is primarily the fact that males disproportionately earn degrees in fields that are well compensated, while in Greater Minnesota it is more common for females to earn less than men *even within the same major.* This finding suggests that the rewards for specific majors are very high in the Twin Cities, and if women were to equalize their choice of major to that of men, the wage gap would shrink to half. But the same is not true in Greater Minnesota. Something else is preventing women from finding jobs that pay as well as those of their male peers with equivalent educational attainment and field of study.

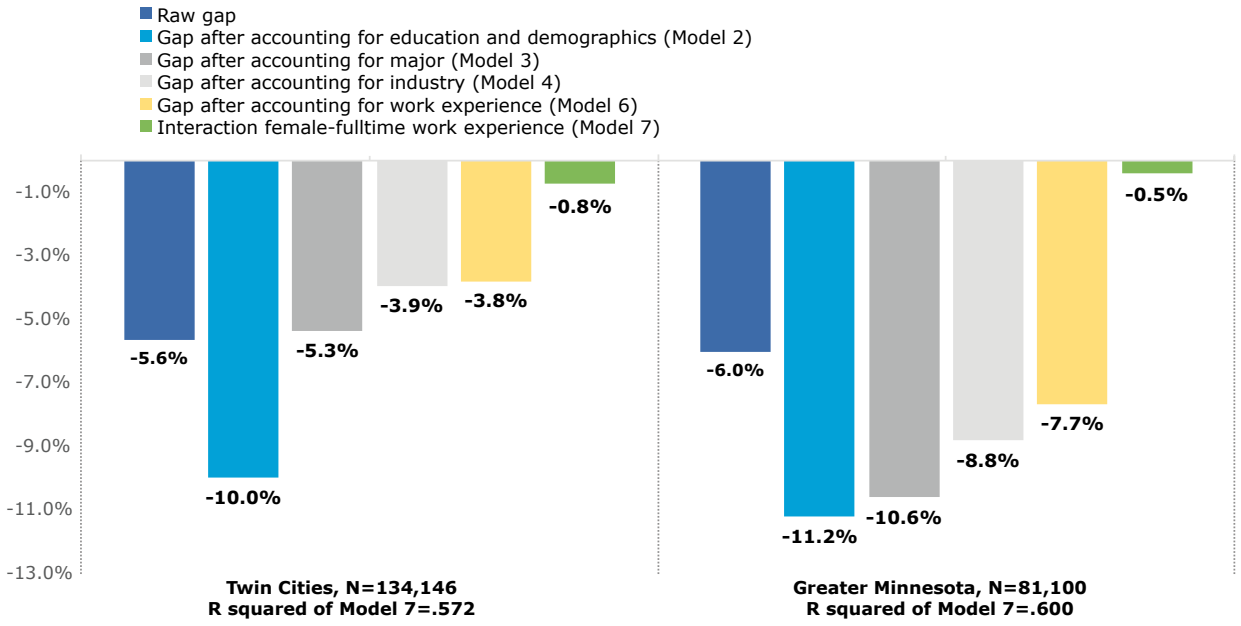
Model 4 adds information on industries of employment, which produces a reduction in the gap in both geographies, from -5.3 percent to -3.9 percent in the Metro and from -10.6 percent to -8.8 percent in Greater Minnesota. Specifically, the concentration of males in specific industries where productivity is higher, in the form of more full-time employment, more career growth opportunities, or higher technological intensity, accounts for a significant portion of the gender wage gap **net of choice of major**. This effect signals a problem of employment mismatch, meaning that women are less successful than men at entering jobs where their educational investments are fully rewarded.

Model 6 adds all remaining variables except interactions. In both regions we observe a reduction in the gap, especially in Greater Minnesota, indicating that part of men's wage premium is driven by their better work experience characteristics. This finding is consistent with job sorting effects, because if men are more likely to enter well-matched jobs or higher quality jobs than women, their work experience will also be more valuable. Five years after school exit their productivity will be higher, so wages will be higher.

When interactions for full-time and part-time work are added, as in Model 7, we test the hypothesis that accumulated work experience is differently rewarded by gender. We find, again, that the effect of an additional year of full-time work experience is *not equal by gender.* The coefficient of the interaction (green bars) is -0.8 percent in the Metro and -0.5 percent in Greater Minnesota, indicating that in both regions women get less out of another year of full-time experience than men. Women have higher returns than men on part-time work in both regions, as shown in Table 3, but the female premium from part-time experience is half the male premium on full-time experience. Therefore, the net effect is a female disadvantage.

The addition of these interactions raises the R squared to .572 in the Metro and to .600 in Greater Minnesota,

Figure 2. Gender Wage Gaps in the Twin Cities versus Greater Minnesota, Model Estimations Adding Increasingly More Controls



Note: Each bar represents a different regression. All coefficients are significantly different from zero at the p < 0.01 level.

meaning that observed characteristics were able to explain 57 percent of wage variation in the Metro and 60 percent of wage variation in Greater Minnesota.

It is important to note that being able to explain the variation in wages and being able to account for gender wage gaps are two very different research questions. Despite the fact that the model performs better in Greater Minnesota, the gap that remains when we compare men and women with identical observable productivity characteristics is *higher than the initial gap*. In contrast, in the Twin Cities accounting for measurable productivity characteristics results in a lower gap than what we started with, -3.8 percent versus -5.6 percent. This indicates that some important productivity characteristics related to gender and specific to Greater Minnesota were omitted from the model, or that females in Greater Minnesota differ from females in the Twin Cities on other dimensions omitted from the model, or that gender bias in the Greater Minnesota labor market is driving up the wage gap.

Job Sorting As a Main Source of Gender Pay Gaps

Our quantitative analysis revealed that job sorting in the form of industry allocation is a significant source of gender wage gaps in Minnesota. In the Twin Cities, however, choice of major has the strongest impact, more than job sorting by industry, while in Greater Minnesota larger gender gaps remain even after comparing males and females with an identical academic background. What could be the reasons for this divergence?

Wage gaps typically develop from differences in opportunities for skills acquisition either through schooling or through work-based training and promotions on the job. Gender wage gaps emerge if gender is a factor in how people access opportunities for skills-enhancement. Gaps are going to be larger in regions where being a female precludes access to some paths for skills acquisition. For instance, if women in Greater Minnesota struggle more than their male peers to access training opportunities or to enter certain occupations, their work experience will be less valuable and inequalities will emerge even when other productivity characteristics are held constant.

In the absence of data on occupation we cannot directly test the hypothesis that men and women get sorted into different occupations or job roles. The point can be illustrated, however, by comparing majors and industry allocation by gender in Greater Minnesota. Figures 3 and 4 present results for males and females respectively, showing major on the left side and industry of employment on the right side. The display also includes hourly wages earned in the fifth year after graduation by the subset of workers who exited school between age 22 and 27. This analysis is limited to non-completers because they have the biggest gender differences in the state. They also represent a much larger share of workers in Greater Minnesota than in the Metro, making up 40 percent of males and 30 percent of females in our dataset.

Although these students did not earn a credential, their major at enrollment reveals a great deal about their career goals and aptitudes. The strong gender segregation in fields of study combined with the industry mix in Greater Minnesota inevitably favors men over women. One out of five (20 percent) males took coursework in the skilled trades versus 1 percent of females, and 6 percent of males enrolled in IT versus 1 percent of females. In contrast, female non-completers are over-represented in Healthcare majors (26.6 versus 4 percent).

Female non-completers are significantly less likely to find employment in high-pay industry sectors. This is partially due to choice of major, but also to gender itself. While industries such as Manufacturing and Mining/Utilities/Construction drew low-educated males from every major and paid fairly good wages, about half of females ended up in Healthcare and Retail, Accommodation, and Food Services where they earned low wages. Other women ended up in Social Assistance, where wages are abysmally low. The highest wages were earned by the 8 percent of women in Manufacturing ($15.29 per hour).

An even more concerning finding is that women non-completers in Greater Minnesota earned less than men within the same industry, which can only mean that males entered higher paid occupations. Women non-completers were more likely to take jobs as Nursing Assistants, Cashiers, Waitresses, and Personal Care Aides/Home Health Aides while men were more likely to find work as Construction Laborers and Production Workers, including Machinists.

Perhaps the clearest example of gender effects in job sorting is offered by those who enrolled in liberal arts or did not declare a major. In this large group, 29 percent of the total for each gender, students did not receive any occupation-specific preparation. The fact that a sizeable portion of males from this group were able to enter high paying industries such as Manufacturing and Mining/Utilities/Construction despite having no educational background in the field points to a phenomenon of job sorting that favors males over females. Wage differentials also suggest that males have had more opportunities for skills acquisition in the same five-year span than women. This might stem from the fact that the workforce pipeline in the trades is built mainly through on-the-job training or apprenticeships[12] rather

[12]For this reason it is conceivable that relatively more males than females voluntarily dropped out of college because they could get living-wage jobs in their field without a credential.

Figure 3. Male Non-Completers Employed in Greater Minnesota Five Years After School Exit

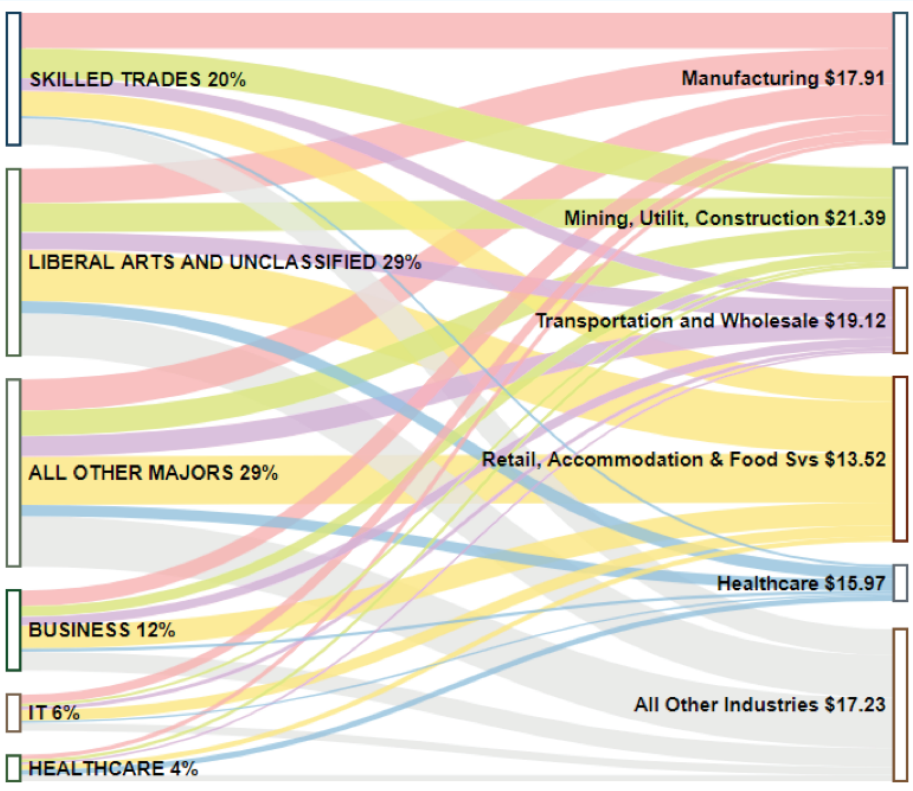
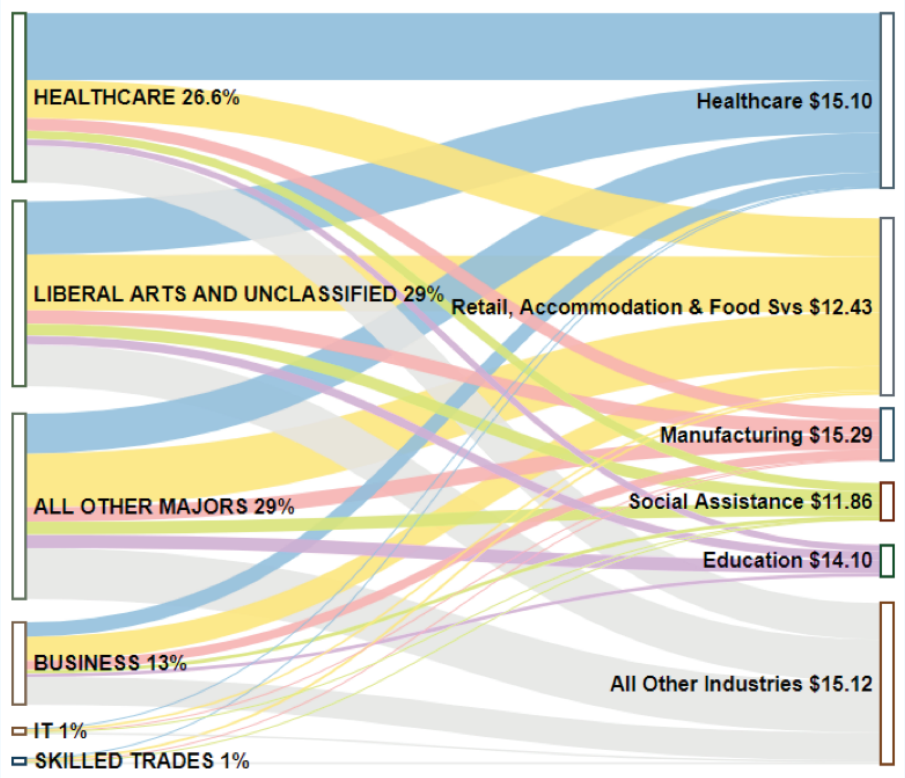
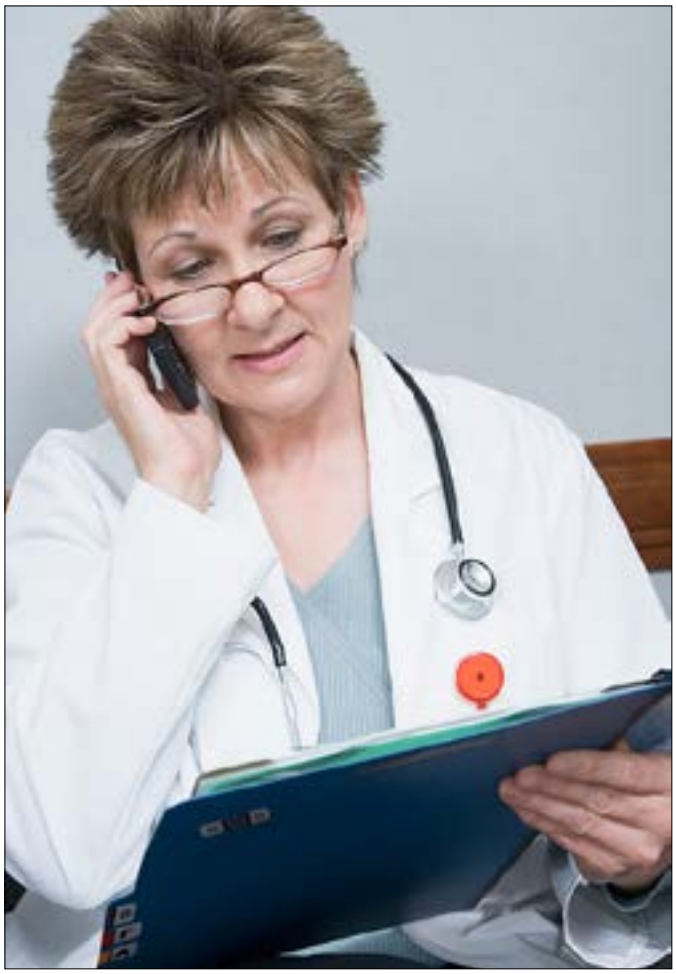


Figure 4. Female Non-Completers Employed in Greater Minnesota Five Years After School Exit





than through higher education. These opportunities might be out of reach for women, either because they have an inherent productivity disadvantage in jobs that require physical strength or stamina or because they have few role models in non-traditional careers. These industries, Manufacturing, Mining, Construction, Utilities, Transportation, and Wholesale, are the most male-dominated in the state, with males representing from 70 to 85.8 percent of the workforce.[13] The take-away from this example is that differences in productivity are reflected in gender wage gaps, but they likely stem from structural inequalities in access to productivity enhancing opportunities.

The charts also illustrate another factor further contributing to the poor outcomes of women non-completers in Greater Minnesota. Their high concentration in majors such as Education and Healthcare, which typically pay off only after obtaining a post-secondary credential required for licensure, makes them more vulnerable to education-to-job mismatches. Someone who enrolls in an RN program and falls short of graduating cannot enter the occupation of Registered Nursing or LPN, while someone who does not finish a Machining or Computer Support Specialist program may still be hired into entry-level positions and learn the trade on the job. Since traditional male occupations offer more paths toward occupational competencies outside higher education than traditional female occupations, women without credentials are more at risk of education-to-employment mismatch especially if the regional industry mix is not diversified and not gender-balanced.

The Twin Cities labor market differs from Greater Minnesota in important respects. First, in highly educated labor markets, credentials and field of specialization matter more than other productivity characteristics. As long as women acquire credentials in high demand, they'll have more chances at a direct path towards their career of choice. Second, the Twin Cities offers a more diversified set of industries with a strong service sector where gender is less likely to be a hidden criteria for recruiting and promoting. Therefore, low-skilled women in the Twin Cities might have greater opportunities for finding well-matched jobs in occupations similar to their male peers.

All of these hypotheses offer plausible explanations as to why the effect of major is weaker in Greater Minnesota than in the Twin Cities. If occupational competencies in the low-skilled labor market are developed outside higher education, and women are inherently at a disadvantage in accessing these opportunities and therefore settle for lower-level jobs, their earnings will

[13]Source: U.S. Census Bureau, Local Employment Dynamics https://qwiexplorer.ces.census.gov/

be lower than males even when major and industry are the same. This leads to a larger portion of the gap remaining unaccounted for. If we could control for occupation, we would be able to test just how much of the inequalities in Greater Minnesota are attributable to occupational sorting. But because the analysis performs multiple regressions and controls for a comprehensive set of productivity-related characteristics and still finds a wage gap, the conclusion is that the differential cannot be explained by different average levels of these characteristics between men and women. Instead the differential is almost surely caused by gender or factors associated with gender that are not controlled for in the regression but which affect the way workers are placed into jobs. These effects are stronger in Greater Minnesota than in the Metro.

The Case of Completers

As shown in Figure 1, women in Greater Minnesota face a smaller wage gap when they manage to complete a credential. Still, job sorting mechanisms hurt women even when they earn a credential. Table 5 gives an example of a female-dominated program, Registered Nursing, and a male-dominated program, Engineering.

Accounting for age, major, education level, and industry slightly reduces gender gaps in Greater Minnesota, but women still face disparities of 8 percent in Registered Nursing as a result of their distribution into different industries. The very few men with an RN degree were more likely to find work in Hospitals and Clinics, where productivity and wages are higher, while a larger share of women ended up in Nursing and Residential Care Facilities or industries that pay even less. Furthermore, the -6.9 percent wage gap in Hospitals and Clinics suggests that women and men were not similarly allocated across job roles. If women's work experience is in lower paid roles than men, after five years their earnings will be lower even if they have had the same number of years of work experience. This is precisely the implication of the interaction effects between work experience and being a female that we saw in the regression analysis.

Women who pursued a male-dominated field, in this case Engineering, and found work in Greater Minnesota faced similar challenges. They were not equally represented in the industries that fit their educational background, especially not in Manufacturing where women's representation was half that of males (28.6 percent versus 56.2 percent). Even within Manufacturing they faced a wage discrepancy of almost 5 percent. Women with Engineering degrees were slightly more likely to be employed in Professional and Technical Services where wages were aligned with those of males, but unfortunately that was not enough to offset the higher penalty that women suffer from working outside of their field or in Manufacturing. Twice as many women as men (33 percent) were employed in industries that provided a poor match with their education (other than those listed in the table), and their wages were 30 percent lower than those of males. This is a case of female talent in an important STEM field being diverted away from its most productive uses.

Table 5: Industries of Employment and Gender Wage Gaps for Graduates Working in Greater Minnesota

	Share, All Ages		Wages Earned By Workers Who Exited School at Age 23-30		
	Men	Women	Men	Women	Gap
REGISTERED NURSING, ASSOCIATE'S DEGREE					
Hospitals and Clinics	76.8%	68.8%	$35.66	$33.20	-6.9%
Nursing and Residential Care Facilities	17.8%	22.8%	$28.40	$28.81	1.5%
All Other Industries (Government, Schools)	5.4%	8.4%	NA	$26.06	NA
Total	185	2332	$33.68	$30.98	-8.0%
ENGINEERING, BACHELOR'S AND MASTER'S DEGREE					
Manufacturing	56.2%	28.6%	$34.01	$32.43	-4.7%
Professional and Technical Services	17.5%	23.8%	$31.00	$30.68	-1.0%
Mining, Utilities, Construction	10.6%	11.9%	$37.59	$41.03	9.1%
All Other Industries	15.7%	33.3%	$29.89	$20.71	-30.7%
Total	530	42	$33.57	$31.34	-6.6%

Table 6 shows results for the same programs in the Twin Cities. The comparison reveals that women with RN degrees fare better in the Metro, thanks to an almost perfect gender balance in the industry distribution. The raw gender gap for women with an RN degree is -4 percent, which almost disappears once we control for industry. Women even surpass men's earnings in "Other Industries", mainly insurance companies which offer nursing graduates a good alternative to the Healthcare sector and have a stronger presence in the Twin Cities than in Greater Minnesota.

In the field of Engineering women in the Metro also fared well, earning even higher wages than men ($38.82 versus $36.81). This excellent performance is partially driven by the fact that women were able to find jobs in highly related industries at the exact same rate as men, and in these well-matched industries they clearly thrived to the point of out-earning their male peers in the 23 to 30 age group. Women employed in other industries, however, earned 3.1 percent less than men.

It is also important to note that Greater Minnesota is not a monolith. Gender gaps tend to be small in urban areas, especially in Rochester, and bigger in rural/micropolitan areas. Given the mobility of the workforce, we cannot rule out that part of the reason women fare better in urban areas is that the most career-oriented and high performing women decide to move to urban areas from other areas of the state.[14]

The broader implication from these examples is that education reduces gender wage gaps, and so women are increasingly investing in their college education to offset the disadvantages they face on other fronts. They are, however, hurt more than men when they do not find work in related industries. Urban economies tend to offer more alternatives when the best matching jobs are out of reach, but the phenomenon is still present.

There is another set of reasons often put forward when trying to explain gender pay gaps. Women may be more likely to accept mismatched positions in exchange for other non-monetary characteristics such as convenient location and flexible hours that help them balance work and family responsibilities. These preferences might carry more weight in Greater Minnesota if traditional gender roles are more influential or if the policy and infrastructure framework is insufficient to help women balance family and work. The analysis controls for labor supply choices and residence,[15] but not for number and age of children, to see if these characteristics have a bigger effect on gender gaps in different regions of the state.

Even without being able to quantify the effect of all possible factors at play, the implications of the analysis are clear: men, especially in Greater Minnesota, have access to more options for skills acquisition and therefore do not have to invest as much in post-secondary education as women. This exposes women to a higher risk of defaulting on their student loans and of not being able to leverage their skills across jobs and industries fully if they fail to complete their program.

Table 6: Industries of Employment and Gender Wage Gaps for RN and Education Program Completers Working in the Twin Cities

	Share, All Ages		Wages Earned By Workers Who Exited School At Age 23-30		Gap
	Men	Women	Men	Women	Gender Gap
REGISTERED NURSING, ASSOCIATE'S DEGREE					
Hospitals and Clinics	83.4%	82.4%	$38.39	$37.72	-1.7%
Nursing and Residential Care Facilities	6.6%	7.3%	$33.16	$32.70	-1.4%
All Other Industries (Mainly Insurance Firms)	10.0%	10.3%	$27.40	$31.30	14.2%
Total	361	4,076	$37.89	$36.39	-4.0%
ENGINEERING, BACHELOR'S AND MASTER'S DEGREES					
Manufacturing	39.5%	39.2%	$38.05	$41.05	7.9%
Professional and Technical Services	23.2%	23.0%	$34.46	$34.38	-0.2%
Firm Headquarters	10.8%	12.7%	$39.55	$41.18	4.1%
All Other Industries	26.5%	25.0%	$35.23	$34.13	-3.1%
Total	2,582	408	$36.81	$38.82	5.5%

Conclusions and Implications

This study compared hourly wages of men and women who are equal with respect to key productivity characteristics with the goal of identifying if the gender pay gap is explained by differences in the distribution of these characteristics or by gender differences in the returns to investment to these characteristics. The most important finding is that, while the single biggest driver of the gender pay gap is the concentration of females in majors and industries that pay lower wages, differential returns to full-time experience for females are also at play. This implies that women's disadvantage increases over time.

Summary of findings:

- The gender wage gap among young, white workers is 6.4 percent. This amounts to the average white female earning 94 percent of the average white male wage. This gap is already established five years after school exit and grows over the course of the career.

- Most of the characteristics that are relevant to earnings do little to explain the gender wage gap, and in some cases make it bigger. For example, the gap grows nearly by half when taking into account educational attainment because women have higher educational attainment than men. Controlling for observable individual and job characteristics only reduces the gap from 6.4 to 5.4 percent.

- Job sorting in the form of industry allocation is a primary mechanism through which gender wage inequalities develop. The analysis quantifies the effect of this through a regression model. The fact that gender differences in job sorting are found to be factors in the gender pay gap among young workers, even after controlling for their educational characteristics, points to a problem of equal opportunities in the labor market. In fact, major and industry reflect not only different occupational goals of women relative to men but also gender segregation with respect to both occupation and industry.

- Choice of major drives gender gaps in Minnesota, but a detailed analysis by region reveals that this result applies predominantly to the Twin Cities Metro. In Greater Minnesota gender pay differences in the dataset persist even within the same majors. Because of this, in Greater Minnesota we are able to explain 60 percent of the variation in wages but are left with a gender pay gap of 7.7 percent, while in the Twin Cities the remaining gap is 3.8 percent. This suggests that in Greater Minnesota gender segregation in job sorting is more pronounced and accounts for a larger portion of the gender pay gap than in the Metro. These differences are in part structural because the industry mix in Greater Minnesota offers men greater access to productivity-enhancing opportunities in male-dominated industries than to women.

- We also found in both regions evidence of greater wage penalties suffered by women working in industries that do not fit with their educational background. This suggests that women who miss the chance of finding education-related employment have less access to alternative sources for skills development, such as work-based training, compared to men.

- Men and women had almost indistinguishable work patterns, especially in the youngest age group, but aren't getting the same benefits from accumulated work experience. We found evidence of differential returns by gender on work experience, specifically full-time experience, which is often cited as the reason why men earn more. It is not that women are less likely to work full-time, a difference that is fading away among younger generations of women, but primarily that their full-time experience enhances

[14]The possibility for self-selection bias is partially controlled for in the regression model by including residence at the time of college entry.
[15]The measures include length of previous full-time employment, part-time employment, and industry tenure; therefore, we can control for any differences in work effort in the two regions. The model also controls for region of residence in order to identify women who moved to the Twin Cities for work.

their productivity less or is valued less relative to men. Therefore the problem is not simply one of "equal pay for equal work" but of a much more fundamental and harder to address inequality in access to opportunities for skills acquisition. While these differences start small, they can eventually lead to a female wage penalty. To put it another way, what starts as an opportunity gap eventually turns into a productivity gap.

In sum, part of the wage gap is explained by women's choices, including major; another part by gender segregation in industry and by slightly higher rates of part-time work and multiple job holding; another part is explained by differential returns to work experience; and another component of the gap remains unaccounted for.

In light of this evidence the improvements most likely to be needed to equalize wages between men and women are the following:

- The under-representation of women in the skilled trades, STEM majors, and quantitative business fields must be addressed all across the state. STEM majors have the advantage of being highly transferable across sectors and jobs, while skilled trades have the advantage of paying higher wages even for those with relatively lower levels of educational attainment. Greater diversification will allow women to break their over-reliance on Education and Healthcare, which require highly specialized skills that have little transferability across economic sectors and that perpetuate the cultural image of women as caregivers. As automation and other technological breakthroughs transform the world of work by de-emphasizing physical tasks and emphasizing knowledge, more opportunities can open up for women even in traditionally male-dominated occupations, but only if girls are encouraged to acquire technology-related skills and pursue careers in these fields.

- Efforts to desegregate fields of study, however, go only so far in mitigating the pay gap in the absence of other policies that allow women to enter industries and job types where their academic qualifications are fully leveraged and rewarded. This will require employers to make a strategic effort to recruit and retain qualified women, especially in Greater Minnesota where female talent is more often at risk of being diverted towards low-productivity industries or job roles.

- Closing gender gaps in frequency of full-time work or narrowing the difference in wage progression between full-time and part-time workers are important but cannot be expected to close the gender wage gap if the obstacles that hinder skills acquisition by women in the workplace are not removed. This is especially urgent among women without a college degree in Greater Minnesota, who have fewer paths towards career entry and advancement than their male peers. Policies that could help remove barriers include access to child care, elder care, and sick and parental leave as well as a concerted effort to diversify recruitment and advancement in the workplace.

As long as women reap lower returns than men to their full-time work experience above and beyond differences in individual characteristics, major, degree level, industry, and a host of other factors included in this analysis, progress in other areas will not be enough to remove wage inequalities. Increasing women's access to productivity by enhancing skills acquisition opportunities on the job would reduce women's over-reliance on increasingly costly higher education investments and offer an alternate path towards economic self-sufficiency.

by Alessia Leibert