The causal effect of economic growth on gender inequality

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Introduction

Gender equality has always been an important topic in economics. This concept has caught the eyes of economists for years. Women experience gender discrimination throughout their life. According to the U.S. Census Bureau data, women received fewer resources in education and carried two-thirds of U.S. student loan debt. As for women in the labor force, they have fewer opportunities to be promoted and enter the decision-making team. Only 14.2% of the top five leadership positions in the S&P 500 companies are held by women (Judith Warner, 2018). Besides, female employees are receiving lower payments than male employees who have the same job position and similar work. The gender wage gap exists in different kinds of measurement (Gould et al., 2016).

The good news is that in the past few years, we see several huge progresses in fighting for women's rights. For instance, a few years ago, female engineers in Twitter Inc. and Microsoft Corp. failed to win the cases as they attempted to sue the companies for gender discrimination. However, in 2021, a San Francisco judge certified the case brought by 10,800 women in Google who claimed that they get paid less than men for doing the same job. The women allege violations of California's Equal Pay Act (Rosenblatt, 2021) which is made to protect workplace equality. This transformation not only represents big progress of female equal rights but also encourages women from all over the world to take action for their equality.

Additionally, it is interesting to see that California, where the case was held, has the highest Gross Domestic Product in the United States. And the ratio of payment of women to men is 89 percent which is larger than the average 88.3 percent in the nation according to U.S. Census. In other words, the gender pay gap is smaller in California. The coincidence between the figure of economic development and the gender wage gap made us interested in their relationship.

This paper attempts to address this specific question of whether an increase in economic development would improve gender equality.-We would focus on information about the United States since it is more manageable. The gender wage

gap and economic data will be collected from the U.S. Census and other government databases. All states in the U.S. would be in our observation.
The topic of the gender inequality issue has gradually increased these years. Most of them surround race, education, family status, employment, and working environment. Although people have made a lot of efforts in this area, in order to reveal the seriousness of the problem and present stronger evidence for women to defend their rights in court, still, all the information tells us that what we have done is not enough. Therefore, connecting gender inequality with economic growth might give people a way to analyze equal rights from a different perspective.

It is important to stress this topic about gender inequality. A recent study claims if women, who account for half of the world's working-age population, do not achieve their full economic potential, the global economy will suffer. On the contrary, achieving equality in economic opportunities for women and men can add as much as $12 trillion in global annual GDP by 2025 which is about the size of the Chinese and U.S. economy combined (McKinsey Global Institute, 2015). Also, increasing women's income and bargaining power would also help the younger generation and achieve sustainable development. We hope to provide suggestions for the policymakers to make a Quota and Labor Law that favors women to reduce the pay gap between females and males.

Literature review

We have found three literature that could help us build a better understanding of our research topic. Esther Duflo (Duflo, 2012) states the evidence on both sides of the women empowerment and economic development relationship and analyzes the possibility of creating a virtuous circle in motion. She concludes that the interrelationship is not strong enough to be self-sustaining. In order to bring parity between women and men, continuous policy actions which favor women would still be needed. Oostendorp (Oostendorp, 2009) examined gender inequality under the effect of globalization. By creating a formula of occupational wage gap through the data, Oostendorp claimed that the occupational gender wage gap tends to decrease with the increase of economic development. He concludes that this is a benefit from the globalization effects. In the journal written by Francine and Lawrence (Blau & Kahn, 2017), they examine factors from traditional analyses and add new perspectives to test which one has a better explanatory power under the trend of gender wage gap these years. They find out the traditional human capital factors (education and experience) explain relatively little of the wage gap at the aggregate level. However,

gender differences in occupations and industries are quantitatively the most important measurable factors explaining the gender wage gap.
The results from the literature above match the assumption of our study that there is a relationship between economic development and gender inequality. Nevertheless, even though most of the models include the communist variable and data from different countries, they did not consider other factors like the differences of culture, religion, and sex distribution in these areas. From our perspective, it might mean there is a need to narrow the scope of the target. Instead of using cross-country data, analysis on the United States region with states-level data allows us to eliminate factors that are inherently different in each country. Additionally, there are more observations under state-level data which helps us examine the statistical effect of economic development on the gender wage gap.

Data Description

For our study, we use published data, information from the National Historical Geographic Information System (NHGIS), and US Census Bureau. These data sources were chosen because they are trustworthy and contain quality and adjusted data. We collect the time-series state-level data in four time periods: 2000, 2010, 2015, and 2019. The selection of time is consistent with the data availability.

We decided to use the difference between the median earnings of men and women relative to the median earnings of men (WG) as the dependent variable. It is the definition of the gender wage gap from the OECD perspective. Although the statistic does not compare males and females under identical work and having the same responsibility, it does capture some of the ideas of discrimination. The number is valuable because it includes not only wage discrimination but also the gender difference in jobs, education, experience, risk preference, and other things that affect one's decision of his or her career.

In the real world, men and women usually do not hold the same job. Neither do they share the same responsibility of childcare and eldercare nor have the same working hour. All of these factors make women on average are in lower pay. As a result, that is the meaning of the gender wage gap we would like to cover in this paper.

The independent variables include real GDP per capita (Y), the diversity index (D), education (EDU), unemployment rate (UEMR), family size (FS), and gender gap for annual hours worked (HWG). Diversity index is a mathematical measure of species diversity in a community. In this paper, we will use it as a method of presenting

$$D = 1 - \left(\frac{\Sigma\, n(n-1)}{N(N-1)} \right)$$

n = number of individuals of each race

N = total number of individuals of all races

the degree of racial diversity in a state. High scores indicate high diversity. Education is the percentage of bachelor's degree or more in population over 25. Family size refers to the average number of people who reside together in the same household and who are related by birth, by marriage, or by adoption. Gender gap for annual hours worked is the difference of hours worked for male workers over female workers. The hours worked data are not available in 2000, as a result, they are only recorded in the time period: 2010, 2015, and 2019. Since the hours worked data is relevant to our main independent and dependent variable, we still decided to include it as the control variable. [Table 1] provides the variable's name and corresponding labels.

[Table 2] shows the descriptive statistics information of all the variables. All of them, except for WG and D, are right-skewed. And Y presents a positive skew that follows the intuition of the income distribution in our society. The mean values from all the variables are positive. And from the [Figure 1] correlation table, we see strong correlations between Y and EDU (0.61). Intuitively, it is not strange to see economic growth has a high relationship with education. However, as constructing an effective model, this relationship might lead to a multicollinearity problem which will undermine our statistical significance of the independent variable. Therefore, we should notice this problem in the following process.

Furthermore, [Figure 2] shows the heterogeneity across states. Each state has a different range and different average levels of the gender wage gap. The causality can be their differences in culture, history, or religion. And [Figure 3] provides us an opportunity to view the relationship between economic growth and the gender wage gap. As we can see in the graph that most of the points are clustered together and have a negative slope when grouping them by state.

Hypothesis and Econometric Model

Our hypothesis is that "real GDP per capita" decreases the "gender wage gap" in each state. In other words, when the Y increases by a positive amount in each state, then the WG would decrease within that state accordingly. There are several reasons why economic growth would have a narrowing effect on the gender wage gap. First, economic growth could lead to improving the availability and quality of public service which makes a better education. According to a recent study, the returns to schooling are higher for women than for men (Christopher, 2005). Second, improving government finance makes government implement more policies that favor women. For example, financial subsidy on raising children or regulation on working disparities. All of these add together could narrow the wage gap between males and females.

Many kinds of literature study the relationship between economic development and gender inequality. However, few of them study the potential effect of the gender wage gap on economic development in the state unit. In other words, by using state-level data, we provide a more specific study on their relationship.

Meanwhile, we would like to introduce control variables that might also have a relationship to WG and Y. The control variables are D, EDU, UEMR, FS, MH, and FH. Otherwise, we might suffer from omitted variable bias which will cause our regression model biased and lead to an overestimated potential effect.

Econometric model

For our study, we established an equation to test our hypothesis.

$$WG_{it} = \beta_0 + \beta_1 \log Y_{it} + \beta_2 D_{it} + \beta_3 EDU_{it} + \beta_4 UEMR_{it} + \beta_5 FS_{it} + \beta_6 HWG_{it} + \mu_{it}$$

Where i is the individual states and t is the time dimension. WG refers to the gender wage gap, Y is GDP, D is diversity index, EDU is education, UEMR is the unemployment rate, FS is family size, HWG is gender gap for hours worked, and μ is the error term.

In order to learn the common and consistent effect happening in each state for our independent variable, we decided to use fixed-effect panel data regression. We are worried about the lack of control variables that should be included in the model. For

example, history and culture play important roles in the discussion of gender inequality. However, it is hard to collect them as meaningful and useful numeric variables. Also, variation occurs across years due to economic situation or national policies' change. Therefore, by applying the fixed-effect panel data regression by state and by year, we can neglect the constant variables across states and years and focus on the key predictors at the group level. Additionally, we introduce the calculation of robust standard errors to help us solve a potential heteroskedasticity.

Before running the regression model, we made an adjustment to our variables to do a better estimation. We make a log transformation to the main independent variable GDP per capita (Y). Instead of finding how one dollar change to the "real GDP per capita" changed the "gender wage gap", we think it is more practical to see how 1 percent change to the real GDP per capita affects the gender wage gap.

Empirical Finding

[Table 3] shows the side-by-side regression table. Model (1) includes only the independent variable "real GDP per capita" and Model (2) to (6) include covariates that shall capture the effect of the economic conditions as well as the human capital in different states. Considering Model (1) as our baseline regression, we find that including more control variables does not lead to a major reduction of the estimated effect of Y. The sign also changes frequently as we extend more control variables. Importantly, the coefficient is not significantly different from zero which suggests that the estimate is rather imprecise.

Results for Model (2) show that the diversity index (D) significantly explains the WG. One unit point decrease in D will lead to (-0.062) percentage point change in WG. The result matches the intuition that it is more peaceful and equal if one population does not have the advantage in number. Also, the R-squared increases substantially which suggests the model has better explanatory power.

In Model (3), (4), and (5), two of the additional control variables (EDU and UEMR) show a negative effect on the gender wage gap. A percentage point increase in EDU decreases WG by (-0.254), (-0.258), and (-0.254) percentage points respectively. The negative and significant effects are consistent with the study of Christopher Dougherty (2005); She states the returns to schooling are higher for women than for men. The negative sign of UEMR and the positive sign of FS both match the intuition as well, even though they are not significant. However, none of the three variables

pick up the effect which Y has on WG. Therefore, Model (2) is still enough to interpret our topic.

Model (6) reveals interesting results. After adding HWG, all of the coefficients either turn their sign or change their value dramatically. The HWG itself is the only one that has a significant effect on the WG. Due to the substantial change in p-value, signs, and values, we do not think Model (6) is a reliable estimator. This might cause by the loss of observations.

Conclusion and policy recommendation

This paper attempts to address the effect of economic growth on gender inequality. Many of the studies have contributed to the analysis of gender inequality, however, few studies have been conducted in the state-level data in the United States. We use the fixed-effect panel data regression to provide more accurate estimates. The results in Model (2) explain the negative effect of economic growth on WG. A hundred percent increase in Y decreases WG by (-1.037) percentage point. Economically speaking, the effect is too small to be meaningful in real life. It is not practical significance nor statistical significance. Therefore, according to the model we build, we can not interpret the result as the causal effect of interest. The explanatory power of economic growth on the gender wage gap is too weak to be discovered.

Although we do not obtain statistically significant findings, we provide a new angle of this topic and leave some issues that could be avoided by future studies. The signs of the effect of economic growth, diversity index, education, unemployment rate, family size, and gender gap for hours worked, give us a clear direction for progress. For example, the negative sign of economic growth on the gender wage gap suggests that gender equality benefits from economic growth. People not only get a better standard of living but also get a more equal society. Additionally, the positive sign of family size refers that women dedicate themselves more than men do. Because it takes time to take care of children and the elderly, girls have less time to devote to work which results in inequality of income between men and women.

The results of this study allow the policymakers to view gender inequality from a broader perspective. For instance, the government can focus more on household support or on education opportunities. Still, further studies can be conducted on the issue of gender inequality. If the salary in the workplace is more transparent, people will learn more about the real situation of gender inequality.

Appendix

Table 1. Variable table

Name	Class	Label	Values
Year	numeric	Year	Num: 2000 to 2019
State	character	State	
WG	numeric	Difference between the median earnings of men and women relative to the median earnings of men	Num: 3 to 33.2
Y	numeric	Real GDP per capita	Num: 30922.256 to 76798.353
D	numeric	Diversity Index	Num: 3.654 to 66.013
EDU	numeric	Percentage of bachelor's degree or more in population over 25	Num: 14.832 to 44.979
UEMR	numeric	Unemployment rate	Num: 2.3 to 13.5
FS	numeric	Average number of people who reside together in the same household and who are related by birth, by marriage, or by adoption	Num: 2.84 to 3.69
HWG	numeric	Gender gap for annual hours worked	Num: 3.4 to 8.8

Data source: sources of the data are the NHGIS (National Historic Geographic Information System) and the U.S. Census Bureau for years: 2000, 2010, 2015, and 2019

Table 2. Descriptive statistics table

Variable	Mean	Median	Skew	Sd	Min	Pctile[5]	Pctile[25]	Pctile[50]	Pctile[75]	Pctile[95]	Max
WG	20.9	20.9	-0.1	5	3	13.1	17.2	20.9	24	29.6	33.2
Y	50160.7	48443.5	0.6	10235.4	30922.3	36385.2	42408.8	48443.5	55936.5	70544.2	76798.4
D	37	37.2	-0.2	16.9	3.7	8.2	25.5	37.2	51.5	61.3	66
EDU	28.3	27.8	0.3	5.8	14.8	19.5	24.4	27.8	32.2	38.7	45
UEMR	5.3	4.5	1.2	2.4	2.3	2.7	3.6	4.5	6.3	10.4	13.5
FS	3.1	3.1	1	0.2	2.8	2.9	3	3.1	3.2	3.5	3.7
HWG	5.4	5.3	0.9	1	3.4	3.9	4.8	5.3	5.7	7.4	8.8

Figure 1. Correlation table

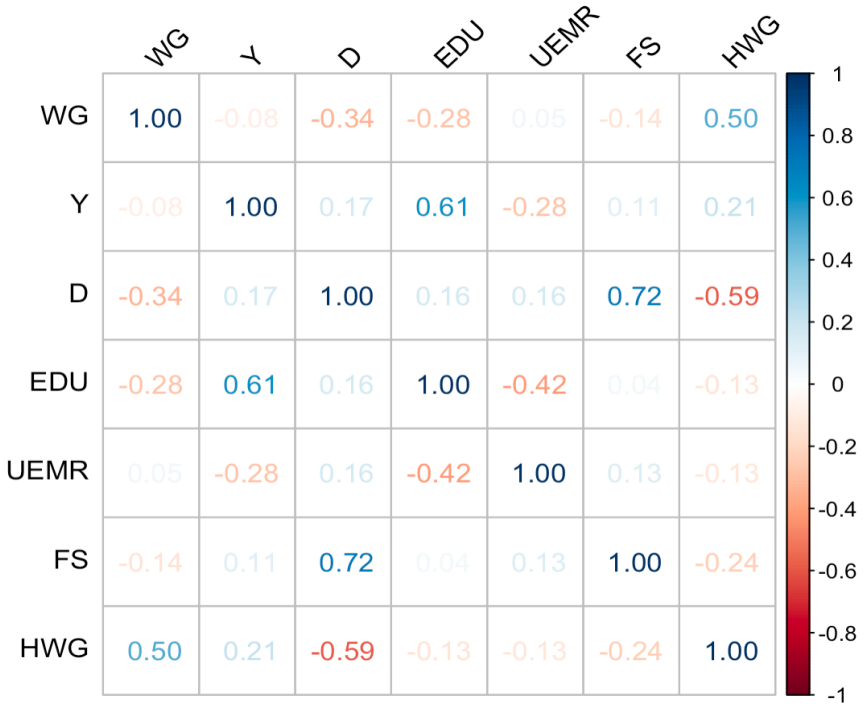

Figure 2. Relationship between economic growth and gender wage gap

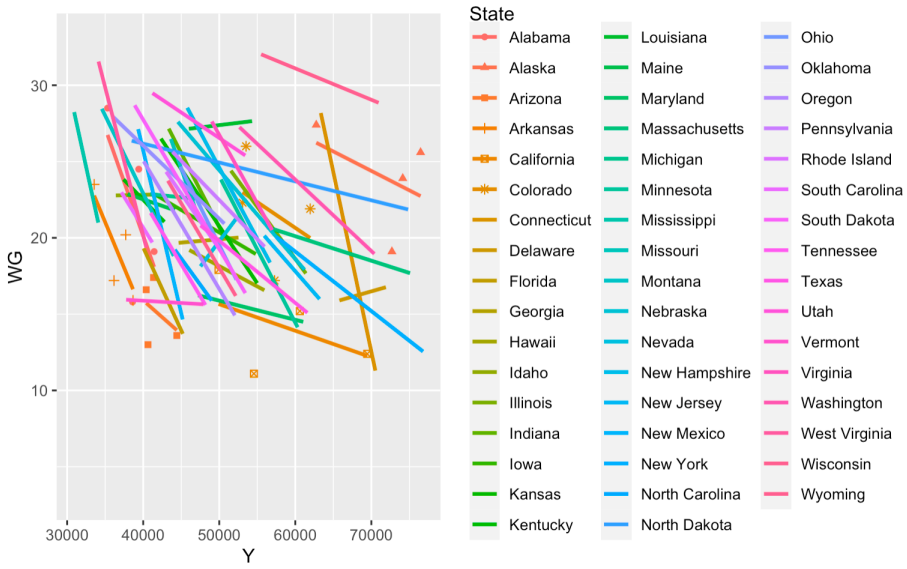

Table 3. Side-by-side Fixed effect regression table

Side-by-side Fixed Effect regression table

	Dependent variable:					
	WG					
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
log (Y)	-1.929	-1.037	3.147	3.086	2.678	-3.540
	(1.706)	(1.807)	(2.522)	(2.456)	(2.453)	(2.638)
D		-0.062***	-0.066***	-0.064***	-0.086***	0.045
		(0.019)	(0.018)	(0.019)	(0.023)	(0.042)
EDU			-0.254**	-0.258**	-0.254**	-0.075
			(0.105)	(0.113)	(0.113)	(0.122)
UEMR				-0.065	-0.111	-0.007
				(0.278)	(0.290)	(0.304)
FS					4.124	-1.074
					(2.921)	(2.935)
HWG						2.552***
						(0.579)
Observations	200	200	200	200	200	150
R2	0.007	0.065	0.112	0.112	0.124	0.249
Adjusted R2	-0.326	-0.257	-0.202	-0.210	-0.202	-0.055
Note:				*p<0.1; **p<0.05; ***p<0.01		

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