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Research Paper

Comparative Study of the Quantitative Relationship between Gender Equality and Income Inequality in India and the United States of America

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Abstract
➢ *Income inequality has been presented to be a persistent phenomenon in both developed and developing countries, even in the presence of sustained macroeconomic growth. It has increased in most advanced and many developing countries over recent decades. This paper aims to develop a quantitative relationship between gender equality and income inequality, investigate which gender inequality factors contribute majorly to changes in income inequality and compare India's and USA's sensitivity of income distribution with changes in gender inequality. Results indicated that gender equality has a positive effect on income distribution i.e., as gender equality increases income inequality falls.*

Keywords
Income inequality, Gender equality, Gender gap, Income inequality pattern.

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I. Introduction

1.1 Relationship between gender inequality and income inequality

It has been found that gender inequality affects income inequality through a number of channels though the relationship between the two has been discussed very vaguely and there exists very little discussion on this subject within the income equality literature. Firstly, wage inequality between men and women directly contributes to higher income inequality. Women with the same skills are discriminated against and hence paid lower wages. Gender gap implies lower levels of education, reduced job opportunities, difficulty in accessing the labor market, high fertility rates and lower educational opportunities for the next generation. Thus, what started off with discrimination against women results in a ripple effect across the entire economy with lower economic growth and persistent income disparity.

1.2 Objectives

➢ Developing a quantitative relationship between gender equality (using Overall score of gender equality) and income inequality (using Gini Coefficient) to determine whether changes in gender equality lead to improvements/deterioration in income inequality
➢ Investigating which gender inequality **factors** (sub-indices) contribute majorly to changes in income inequality
➢ Comparing India's and USA's sensitivity of income distribution with changes in gender inequality

II. Review of Literature

This paper revolves around the assessment of the impact of gender equality on income inequality and draws from existing literature which elaborate on the links between gender inequality, economic growth, poverty and income distribution

According to the World Economic Forum, income inequality is associated with unequal access of opportunities to women. Gender wage gaps, greater employment of women in the informal sector and unequal

access to education, healthcare services and finance have been found to be the major channels through which gender inequality impedes the path to more equal income distribution in countries.

Inequality in labor force participation influences income inequality. Labor force participation gap has been cited as one of the major reasons for slow improvements in income distribution. Costa et al. (2009) find decreasing gender gap in labor participation would lead to significant reduction in income inequality and poverty. Harkness (2010) finds that the growth in female employment tend to have an equalizing effect on household earnings (in the 23 OECD countries studied), despite substantial differences in employment levels and type of employment and in pay gaps across countries. Chen (2015) adds that having more households with women in paid work, especially full-time work, means less income inequality.

Costa et al. study the impact of labor market participation differences, occupational status differences, wage discrimination and characteristics on income distribution in eight Latin American countries. Their findings highlight the significant impact of gender equality, especially through an increase in women's access of labor market, on raising household incomes and a fall in poverty and income inequality

Through a recent empirical study by Gonzales (2010), it was further noted that while gaps in economic participation due to gender inequality largely affected income distribution in advanced countries, in emerging markets and low-income countries, gender gaps were evident in education and health and appeared to impede more equal distribution of income

Many studies have highlighted the importance of increasing the quality and quantity of human capital, which will positively impact growth and lead to a decline in income inequality. This is primarily because lower gender inequality implies a rise in more skilled human capital.

Education is an essential factor, which impacts quality and quantity of human capital. For instance, Shahbadi (2018) states that primary and secondary education is one of the most effective ways to reduce income inequality. It creates economic opportunities and plays an important role as a signal of productivity in the labor market. Education also indirectly interacts with mortality, fertility and healthand ensures that greater proportion of the society is engaged in productive activities. It is a preparation to enter the labor force and better education is crucial in order to increase average earnings per worker. Hence, countries with better access and quality of education could be benefitted by better employment opportunities and lower inequality. According to Checchi, (2001) there exists a negative relationship between the average years of schooling and income inequality.

Climent (2019), on the other hand, emphasizes on eradicating illiteracy and completing primary schooling as necessary conditions for the subsequent improvement in per capita income and inequality. He also argues that for developing countries to achieve more equitable distribution of income, there is need of an equal access to the education sector.

An enormous amount of literature is available about the determinants of income inequality as well as the reasons behind the persisting gender inequality across the countries worldwide

This paper aims at examining whether there exists a quantitative link between gender equality and income inequality and studying the relationship between these two variables closely.

III. Methodology

3.1 Data Sources

The data on gender inequality was constructed in the following way:

We chose Income inequality as the **dependent variable** and used **Gini coefficient to measure it.** We collected it for both the countries from 2007 to 2017 and the data was procured from Standardised World Income inequality Database (SWIID) Version 8, developed by Solt 2019. Gini coefficient is a tool used to gauge of economic inequality, measuring income distribution or, less commonly, wealth distribution among a population. The coefficient ranges from 0 (or 0%) to 1 (or 100%), with 0 representing perfect equality and 1 representing perfect inequality. Values over 1 are theoretically possible due to negative income or wealth.

We chose 4 **independent variables- Overall score of gender equality, economic participation and opportunity gender equality, political empowerment gender equality and educational attainment gender equality.** For the independent variables, we collected data from the World Economic Forum's Global Gender Gap index report introduced by Lopex-Claros Zahidi 2005 for the periods 2007 to 2017. The index varies between 0 (perfect gender inequality) and 1 (perfect gender equality)

Below is the description of the sub-indices:

- **Economic Participation and Opportunity gender equality** is captured through three concepts: the participation gap, the remuneration gap and the advancement gap. The participation gap is captured using the difference in labour force participation rates. The remuneration gap is captured through a hard data indicator (ratio of estimated female-to-male earned income) and a qualitative variable calculated through the World Economic Forum's Executive Opinion Survey (wage equality for similar work). Finally, the gap between the advancement of women and men is captured through two hard data statistics (the ratio of women to men among

legislators, senior officials and managers, and the ratio of women to men among technical and professional workers).

- **Political Empowerment gender equality** measures the gap between men and women at the highest level of political decision-making, through the ratio of women to men in minister-level positions and the ratio of women to men in parliamentary positions. In addition, we include the ratio of women to men in terms of years in executive office (prime minister or president) for the last 50 years. A clear drawback in this category is the absence of any indicators capturing differences between the participation of women and men at local levels of government. Should such data become available at a global level in future years, they will be considered for inclusion in the Global Gender Gap Index.
- **Educational Attainment** measures the gap between women's and men's current access to education is captured through ratios of women to men in primary-, secondary- and tertiary-level education. A longer-term view of the country's ability to educate women and men in equal numbers is captured through the ratio of the female literacy rate to the male literacy rate.
- The **Overall Score** comes from using the aforementioned 3 indices and coming to a number as given in the Gender pay gap reports of WEF.

3.2 Tools of Analysis

We will use the econometric method of Ordinary Least Squares (OLS) to explore the link between the variables by establishing a mathematical equation between gender equality and income inequality. OLS is a type of linear lest square method for estimating the unknown parameters in a linear regression model.
There are **six** assumptions, which are used to derive the OLS Estimators in a linear regression model:

- The linear regression model is "**linear** in parameters."
- There is a **random sampling** of observations.
- The conditional mean should be **zero**.
- There is **no multi-collinearity**
- Spherical errors: There is **homoscedasticity** and **no autocorrelation**
- (Optional) Error terms should be **normally distributed**.

3.2.1 For achieving the first objective we will use simple linear regression to find a relationship between Gini Coefficient (Income inequality) and Overall Score (Gender equality)
3.2.2 To achieve the second and third objective multi-linear regression is used

Regression has been carried out using the software STATA.

IV. Results

Empirical Results and Testing of OLS Assumptions

4.1 Simple Linear Regression Model

India

Table 1.1

	Coefficient	Standard error	t-ratio	p-value	95% confidence interval
Constant	3.234173	0.1777428	18.20	0.006	(2.832091,3.636256)
Ln (X_2) (Gender Equality)	-1.015125	0.2786489	3.64	0.005	(-1.3847773, 1.645472)

$$\widehat{lnY_t} = 3.234173 - 1.015125 \ln X_2 \text{ with } R^2 = 0.5959$$

USA

Table 1.2

	Coefficient	Standard error	t-ratio	p-value	95% confidence interval
Constant	3.291452	0.2746823	2.46	0.36	(0.0534057, 1.296155)
Ln (X_2) (Gender Equality)	-0.6747803	0.2786489	3.64	0.005	(-2.838302, 3.744602)

$$\widehat{lnY_t} = 3.291452 - 0.6747803 lnX_2 \text{ with } R^2 = 0.4014$$

4.2 Multiple Linear Regression Model

Interpretation:

Linear Model:

Y: Income Equality (Gini Coefficient)
X_2: Educational Attainment
X_3: Economic Participation
X_4: Political Empowerment

$E(Y_t)=B_1+B_2X_2+B_3X_3+B_4X_4+u_t$

$E(\widehat{Y_t}) = b_1+b_2\ln X_2+b_3\ln X_3+b_4\ln X_4+e_t$

where b_1 is the estimator of B_1,b_2 is the estimator of B_2,b_3 is the estimator of B_3,b_4 is the estimator of $b_4$and e_t is the residual term- sample counterpart of u

Apriori Expectations of Partial Coefficients:

Here, Apriori expectations of B_2, B_3, $B_4$is that it will be a negative value because as the Gender Inequality in Educational Attainment (X_2), Economic Participation (X_3) and Political Freedom (X_4) decreases, the income equality increases

4.2.1 Running the Regression by OLS method:

I. India

Table 2.1

Variables	Coefficient	Standard Error	t-ratio	p-value	95% Confidence Interval
ln(EconPart)	0.0124365	0.1027751	0.12	0.908	(0.2390452, 0.2639182)
ln(EduAtt)	-0.1643958	0.188199	-0.87	0.416	(-0.6249021, 0.2961106)
ln(PolEmp)	-0.2292753	0.0427109	5.37	0.002	(-0.2297655, 0.3337851)
Constant	7.48127	1.290467	5.80	0.001	(4.323611, 10.63893)

According to the regression run by OLS method, it can be seen that the regression function becomes:

$$\widehat{lnY_t} = 7.48127 + 0.0124365lnX_2 - 0.1643958lnX_3 + 0.2292753lnX_4 + e_t$$

Dependent variable: Income equality
Method: Least Squares
Sample: 2007-2017
Includedobservations: 11

Interpretation of the Partial Regression Coefficients

- In the above equation, the intercept value of 7.48127 means that if X_2, X_3, X_4 are equal to 1 (such that $\ln X_2$,$\ln X_3$, $\ln X_4$ are equal to 0) then the value of Gini coefficient (Y) is 2.0124 [ln(7.48127)= 2.0124]

- b_2 is a negative value equal to -0.0124365. This value indicates that the mean value of Y decreases by 0.0124365 per unit increase in X_2 when X_3, X_4 and X_5 are held constant.

- b_3 is a positive value equal to 0.1643958 indicating that mean value of Y increases by 0.1643958 per unit increase in X_3 when X_2 and X_4 are held constant.

- b_4 is a negative value equal to -0.2292753. This means that mean value of Y decreases by 0.2292753 per unit increase in X_4 when X_2 and X_3 are held constant.

- R^2 value (overall goodness of fit measure) of 0.8835 means that 88.35 % of total variation in income equality around its mean value is explained by gender gaps in educational attainment, economic participation, political empowerment.

- Adjusted $R^2 = 1 - (1 - R^2)\frac{n-1}{n-k}$= 0.9059, where k=4, n=11and R^2 = 0.8835

Testing OLS Assumptions

a. Test for statistical significance

- Coefficient b_1 is **statisticallysignificant** as its p-value is less than 5%(alpha), i.e., 0.001<0.05
- Coefficient b_2 is **statisticallysignificant** as its p-value is greater than 5%(alpha), i.e., 0.0908<0.05
- Coefficient b_3 is **statisticallyinsignificant** as its p-value is greater than 5%(alpha), i.e., 0.416>0.05
- Coefficient b_4 is **statisticallysignificant** since its p-value is less than 5% (alpha) i.e.,0.002<0.05
- Coefficient b_5 **statisticallysignificant** as its p-value is less than 5%(alpha), i.e., 0.038<0.05

The value of R^2 and Adjusted R **increases** for Multiple Variable Regression as compared to regressing Y only on X_2 or regressing Y only on X_3/ X_4. Thus, it is better to use the Multiple Regression Model.

b. Multicollinearity:

Variable	VIF	1/VIF
lneducatio~t	**3.13**	**0.319053**
lnpolfree	**2.82**	**0.354228**
lneconomic~n	**1.30**	**0.768353**
Mean VIF	**2.42**	

The VIF command on Stata helps us identify whether there exists the issue of Multicollinearity
Since the VIF value for all the variables are less 10 it implies there is no Multicollinearity between the variables

The table below shows a matrix which shows the degree to which one independent variable is related to another independent variable

	LnEconPart	**LnPolFree**	**LnEduAtt**
LnEconPart	1.0000	-0.0066	-0.3152
LnPolFree	-0.0066	1.0000	0.7647
LnEduAtt	-0.3152	0.7647	1.0000

c. Heteroskedasticity:

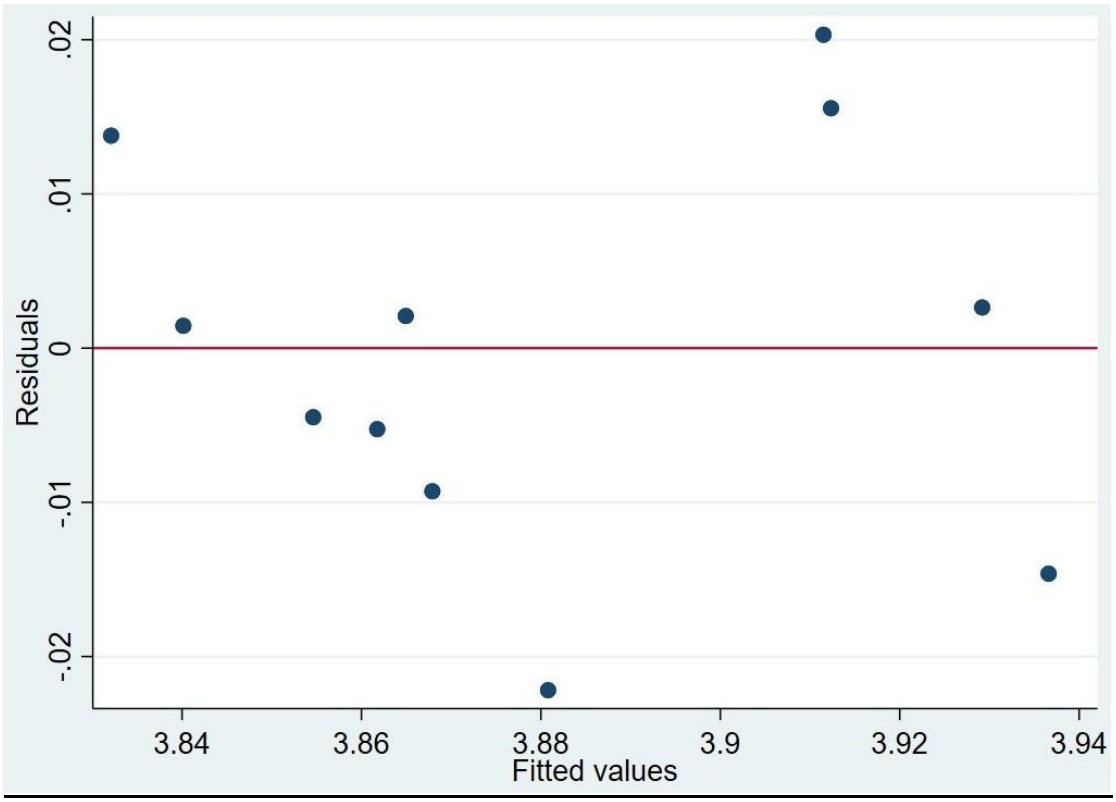
Null hypothesis: Heteroskedasticity not present (Coefficients in test equation are 0)
Alternative hypothesis: Heteroskedasticity is present (Coefficients in test equation are 0)

Breusch-Pagan Test:

Chi(square)(1)= 0.69

Prob> Chi(square)= 0.4070

Since p-value is greater than alpha (5%) we fail to reject the null hypothesis and we can conclude that **no Heteroskedasticity** exists in the model.

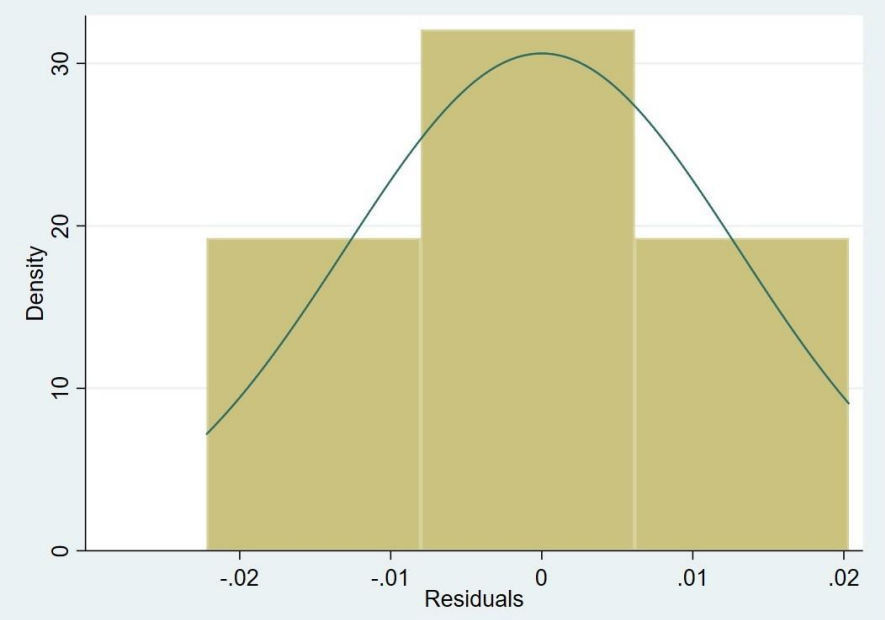


d. Normality of Residuals:

Test for normality of residuals:
Null hypothesis: Error is normally distributed.
Alternative hypothesis: Error is not normally distributed.

Test statistic: Chi-square (2) = 0.12
p-value =0.9415

Since p-value is greater than alpha (5%), we fail to reject the null hypothesis. Therefore, residuals are normally distributed and can be visually validated with the graph given below.



e. Test for Autocorrelation

Breusch-Godfrey LM test for correlation			
Lags (p)	Chi2	df	Prob>chi2
1	0.030	1	0.8620

Since the Chi(2) value is greater than 5% there exists no autocorrelation in the model

f. ANOVA Table:

Source	SS	df	MS	F (=MS_{ESS}/MS_{RSS})
ESS	0.01288024	2	0.003220051	11.38
RSS	0.001698199	8	0.000283033	
TSS	0.014578403	10	0.00145784	

- To check if the model is statistically significant:

H_0: $R^2 = 0$
H_A: $R^2 \neq 0$

F Test Statistic= 11.38

Variables	Coefficient	Standard Error	t-ratio	p-value	95% Confidence Interval
EconPart	-0.1840292	0.0876528	2.10	0.041	(-0.0304496, 0.398508)
PolFree	-0.1072635	0.1307671	0.82	0.443	(-0.2127121, 0.4272392)
EduAtt	-0.907215	0.4888177	1.86	0.013	(-0.2888789, 2.103309)
Constant	1.667937	0.5225558	3.19	0.019	(0.3892886, 2.946584)

Critical value (0.05, 2, 8) = 4.46

Since F statistic is greater than critical value is greater than the critical value it can be concluded that at alpha=0.05 the model is statistically significant

II. United States of America

Table 2.2

According to the regression run by OLS method, it can be seen that the regression function becomes:

$$\widehat{lnY_t} = 1.667937 - 0.1840292X_2 - 0.907215X_3 - 0.1072635X_4 + e_t$$

Dependent variable: Income Equality
Method: Ordinary Least Squares (OLS)
Sample: 2007-2017
Included observations: 11

Interpretation of the Partial Regression Coefficients

- In the above equation, the intercept value of means that 1.667937 if X_2, X_3, X_4 and X_5 are equal to 0then the value of Gini coefficient (Y_t) is 5.301 [$e^{1.667937}$]

- b_2 is a negative value equal to-0.1840292

This value indicates that the mean value of Y increases by 0.1840292 per unit decrease in X_2 when X_3, X_4 are held constant.

- b_3 is a positive value equal to -0.907215 indicating that mean value of Y decrease by 0.907215 per unit increase in X_3 when X_2, $X_4$are held constant.

- b_4 is a negative value equal to -0.1072635. This means that mean value of Y decreases by 0.1072635 per unit increase in X_4 when X_2, $X_3$are held constant.

- R^2 value (overall goodness of fit measure) of 0.8901means that 89.01 % of total variation in income equality around its mean value is explained by gender gaps in educational attainment, economic participation and political empowerment
- Adjusted $R^2 = 1 - (1 - R^2)\frac{n-1}{n-k}$= 0.91098, where k=4, n=11 and R^2 = 0.8835

Testing OLS Assumptions

a. Test for statistical significance:

- Coefficient b_1 is statistically **significant** as its p-value is less than 5%(alpha), i.e., 0.019<0.05
- Coefficient b_2 is statistically **significant** as its p-value is greater than 5%(alpha), i.e., 0.013>0.05
- Coefficient b_3 is statistically **insignificant** as its p-value is greater than 5%(alpha), i.e., 0.081>0.05
- Coefficient b_4 is statistically **insignificant** since its p-value is less than 5% (alpha) i.e., 0.443>0.05
- Coefficient b_5 statistically **significant** as its p-value is less than 5%(alpha), i.e., 0.004<0.05

The value of R^2 and Adjusted R **increases** for Multiple Variable Regression as compared to regressing Y only on X_2 or regressing Y only on X_3/ X_4/ X_5. Thus, it is better to use the Multiple Regression Model.

The health indicator and GDP per capita variables were removed since they led to a decrease in adjusted R^2 value

b. Multicollinearity:

Variable	VIF	1/VIF
politicalf ~m	**2.50**	**0.400677**
economicpa ~n	**1.87**	**0.535746**
educationa ~t	**1.61**	**0.619870**
Mean VIF	**1.99**	

The VIF command on STATA helps us identify whether there exists the issue of Multicollinearity

Since the VIF value for all the variables are less 10, it implies there is **no**Multicollinearity between the variables

The table below shows a matrix, which shows the degree to which one independent variable is related to another independent variable

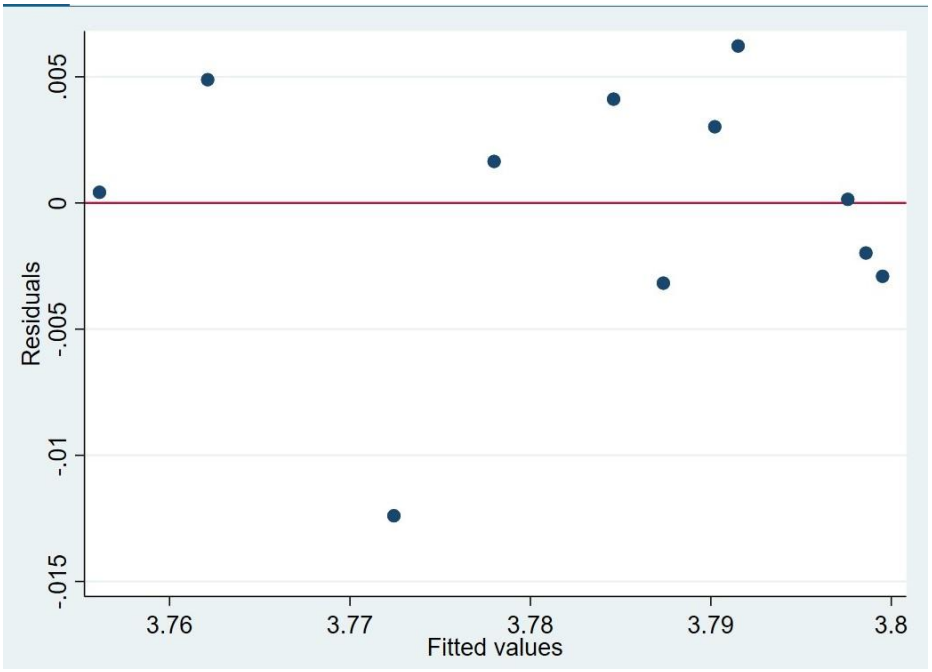
	EconPart	**PolFree**	**EduAtt**
EconPart	1.0000	0.6813	0.4136
PolFree	0.6813	1.0000	0.6165
EduAtt	0.4136	0.6165	1.0000

c. Heteroskedasticity:

Null hypothesis: Heteroskedasticity not present (Coefficients in test equation are 0)
Alternative hypothesis: Heteroskedasticity is present (Coefficients in test equation are 0)

Breusch-Pagan Test:
chi2(1)= 0.99
Prob > chi2=0.3193

Since p-value is greater than alpha (5%) we fail to reject the null hypothesis and we can conclude that **no Heteroskedasticity** exists in the model.



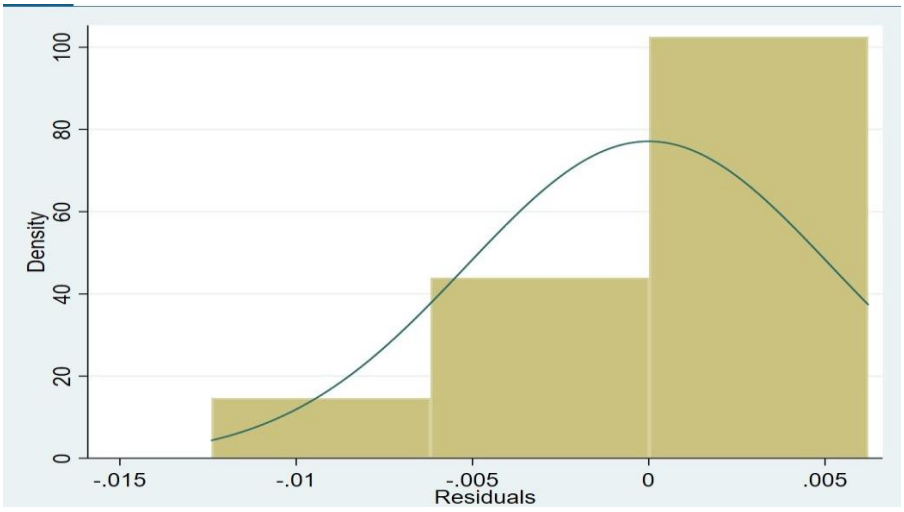
d. Normality of Residuals:

Test for normality of residuals:

Null hypothesis: Error is normally distributed
Alternative hypothesis: Error is not normally distributed

Test statistic: Chi-square (2) = 6.19
p-value =0.0452

Since p-value is smaller than alpha (5%), we reject the null hypothesis. Therefore, residuals are**not normally distributed**. This is observable with the graph below



e. Test for Autocorrelation:

Breusch-Godfrey LM test for correlation			
lags (p)	Chi2	df	Prob>chi2
1	5.289	1	0.0215

Since the Chi(2) value is less than 5% there was serial correlation which was then corrected for on STATA.

f. **ANOVA Table:**

Source	SS	df	MS	F (=MS_{ESS}/MS_{RSS})
ESS	0.002168748	2	0.000542187	12.153
RSS	0.000267681	8	0.000044613	
TSS	0.002436429	10	0.000243643	

- To check if the model is statistically significant:

H_0: $R^2 = 0$
H_A: $R^2 \neq 0$

Test Statistic= 12.153
Critical value (0.05, 2, 8) = 4.46
Since F statistic is greater than critical value it can be concluded that at alpha=0.05 the **model is statistically significant**

4.3Data Analysis

Table 1.1 and 1.2 list the impact of overall gender equality in India and the US respectively and Table 2.1 (India) and 2.2 (US) show the effect each dimension of gender equality- educational attainment, economic participation and opportunity and political empowerment on income inequality. While the relationship of income inequality and gender inequality follows the double log model the relationship for the US follows the semi-log model.

The results in Table 2.1 and 2.2 show that that overall gender equality generally exerts a negative and statistically significant effect on income inequality, suggesting that a higher gender equality (equality between male and female) results ina lower income inequality. As the results in Table 2.1 show, the constant elasticity is-1.015125, suggesting that if overall gender equality for India increases by1 unit,then income inequality decreasesby 1.015125%. On the contrary, the constant elasticityfor theUS is -0.6747803,indicating that 1 unit increase in overall gender equality leads to a decrease in income inequality by 0.6747803%.It can be concluded that India's income distribution is more sensitive to changes in gender parity as compared to the US.

For India's case, the coefficient of political empowerment gender equality is -0.23, suggesting that if gender equality in political empowerment was to increase by one unit, then income inequality would decrease by 0.23%. However, economic participation and opportunity gender equality and educational attainment gender equality have**statisticallyinsignificant** coefficients and thus,according to the results,it implies that they play little/no role in impacting the income distribution in India.

On the other hand, in the US the coefficients of Economic Participation and Educational Attainment are -0.18 and -0.91 respectively suggesting that if gender equality in economic participation and educational attainment were to increase by one unit, then income inequality would decrease by 0.18% and 0.91%. Political empowerment's coefficient on the other hand is statistically insignificant in the US suggesting the negligible effect it has on impacting income inequality.
This implies that the higher gender equality provides equal opportunities for women in education helping them increase their skills and productivity. This positively impacts their ability to find better employment opportunities. Therefore, better access to educationresults in better wage prospects and reduces income inequality. Gender equality increases women's access of labor market resulting in a rise in household income and a decline income inequality. Higher gender equality also leads to higher wages for women in the marketplace that leads to improve income equality.

The purpose of choosing India and the US for this paper was to also get an opportunity to examine how a developing and a developed country differ in the way increases in gender equality impacts income inequality and also which dimensions of gender equality play a more significant role in influencing the income distribution. From the above analysis, it can be deduced that in India (developing country) income inequality is more sensitive to changes in gender equality as compared to US (developed country). Additionally, only the coefficient of political empowerment is statistically significant in India while in educational attainment and

economic participation are the only dimensions within the Global Gender Gap Index, which have been found to be influencing income parity in the US.

Nevertheless, the main findings in our paper show the considerable effect that gender equality and its sub-indices have on income inequality highlighting the role gender equality has on income disparity. It has also been deduced that there exists a negative association between the variables under study- ***as gender equality increases, there is improvement in the way income is distributed in the economy.***

V. Conclusion and Summary

The analysis in this paper shows that gender equality has a positive effect on income distribution i.e., as gender equality increases income inequality falls. The result is the same as that of Baloch et al (2018) who carried out research for the same variables from 2006-2013 using panel data of 103 countries. This paper confirms the finding using time series data of India and US from 2007-2017

Income inequality is an issue that is engraved within most of the economies in the world today. The fact that gender equality leads to improvements in income distribution highlights the need of acknowledging its role and developing an inclusive economic system with equal opportunities for both men and women. Data from India highlights the importance of political empowerment of the women to influence income distribution more effectively. One possible explanation for such a result is that greater political empowerment might encourage women to participate in polity and on the other hand, data from US emphasizes the importance of lowering disparity in educational opportunities as well as access to the labor market.

However, at the same time, it is important to consider the limitations in the study. First, since the global gender gap index only included data from 2007-2017, we had to limit the investigation to these periods. Other indices such as the GII can be used in which greater datasets are available but were not chosen since we wanted to separately assess the effect different dimensions of gender equality on income inequality. Secondly, it cannot be said with confidence as to whether the results obtained can be generalized to other countries or to predict how developing and developed might differ in their behavior. Each country's demographics are different andhavea variant social fabric and therefore the relationship between gender inequality and income inequality is likely to differ. To be able to better predict the differences in developing and developed countries, a panel regression might be more useful. Additionally, there are other variables that affect income inequality such as globalization, GDP/Capita and overall educational attainment in an economy. Including these in the regression would increase the precision of the data analysis as well as eliminate potential omitted variable biases. These variables could not be included since we faced issues of multi-collinearity, which is an integral assumption in the OLS method. Finally, the channels through which political empowerment gender inequality or educational attainment gender inequality affect income inequality remain unclear. Giving women voting opportunities and allowing them to participate in decision-making is one type of political empowerment. Reduction in educational attainment inequality can be achieved through laws making girl education mandatory or by building of more women colleges. If the channel within the sub-indices is precisely identified, policies can be made accordingly to improve gender equality and also help eliminating income gaps considerably and more systematically. This study, however, is left for future research.

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