Term Paper ECO342A

SHOULD A COUNTRY INVEST MORE IN INFRASTRUCTURE OR EDUCATION TO REDUCE INCOME INEQUALITY?

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Introduction

Income inequality, defined as the uneven distribution of income among individuals or groups within a society, has become a pressing issue in the contemporary world. According to the World Bank (2020), the global Gini coefficient, a common measure of income inequality, increased from 0.52 in 1988 to 0.63 in 2013, indicating a rise in income disparities both within and between countries. Income inequality has been associated with various negative consequences, such as social unrest, political instability, economic inefficiency, and human development challenges (OECD, 2015). Therefore, understanding the causes and effects of income inequality and finding effective ways to reduce it are crucial for achieving sustainable and inclusive development.

The issue of income inequality has become increasingly pressing in recent years, as the gap between the rich and poor is increasing yearly. Many studies have been conducted in the past which have explored the causes of this trend, with a focus on factors such as globalisation, technological change, and demographic shifts. However, there is growing recognition that investment in infrastructure and education may also play a key role in reducing income inequality. So, the countries are now more focused on having larger investments in infrastructure and education. The paper will examine the effect of such investment on income inequality in countries worldwide. And the correlation between the investment towards education in an economy and its effect on inequality. This is to check whether an investment in physical or human capital which leads to the development of an economy, decreases the prevailing income inequality or does it widen the gap between the poor and the rich. Using a variety of data sources and econometric methods, we would like to explore the channels through which infrastructure and education investment affect income inequality and investigate the potential for policy interventions to promote more significant equity. The findings might have important implications for policymakers seeking to address the challenge of rising income inequality, both within and between countries.

For the measurement of inequality, the Gini coefficient would be used as it is Lorenz consistent and is widely used as a standard measurement of inequality. However, the relationship between infrastructure and education investment and income inequality is not straightforward or uniform. The main research question is whether investment in physical or human capital can lead to more equitable distribution of income or exacerbate the existing disparities between the rich and the poor. To answer this question, the paper will employ various data sources and econometric methods to analyse the causal relationships and mechanisms through which infrastructure and education investment affect income inequality.

Objective

The objectives of the study are –

1. Find any correlation between the capital investment that the government does for the country and the income inequality that is there in the country.
2. Find a correlation between the investment towards education in an economy and its effect on inequality.
3. Compare the effect of investment on infrastructure with that of education.
4. Compare the findings for different income level countries, i.e., Rich countries vs Upper middle-income countries vs Lower middle-income countries vs Poor countries.

Review of Literature

A large body of literature has examined the relationship between investment in infrastructure and education and its effect on income inequality. These studies have analysed how public goods, such as education and infrastructure, can influence the distribution of income by affecting the productivity and opportunities of different groups of people. Most of these studies, such as the one by Calderón and Servén (2004), have found a positive relationship between investment in infrastructure and economic growth, and a negative relationship between investment in infrastructure and income inequality. This means that investing more in infrastructure can boost economic performance and reduce income disparities.

Furthermore, in addition to infrastructure, education has also been a major focus of research on income inequality. Some studies have specifically investigated how education can affect income distribution by enhancing human capital and reducing skill premiums. For example, Hoeller et al. (2014) argue that education is a key factor in reducing income inequality because it can improve the productivity and earnings of workers and narrow the wage gap between skilled and unskilled workers. This effect is particularly pronounced in developing countries, where the demand for skilled workers is high and the supply is low. Another strand of literature has concentrated on the infrastructure aspect of public investment and its impact on income inequality. Some studies, such as Bajar (2018), have demonstrated that investing in infrastructure can improve income distribution by enhancing access to basic services such as water and electricity, which can improve the living standards and health of the poor. Moreover, investing in infrastructure can reduce transportation costs, which can increase the mobility and market access of the poor and reduce their isolation and vulnerability. Therefore, infrastructure investment can help to alleviate poverty and inequality by creating more opportunities and benefits for the disadvantaged groups.

However, the relationship between investment in infrastructure and education and income inequality is not always negative or linear. Some studies have challenged the conventional wisdom that investment in infrastructure and education can reduce income inequality by showing that it may have the opposite effect in some cases. For instance, Sauer et al. (2023) have found that in developing countries, investment in primary and tertiary education can increase income inequality by creating a skill mismatch and a dual labour market. Similarly, some studies, such as Chatterjee and Turnovsky (2012), have found that investment in

infrastructure may favour higher-income groups more than lower-income groups by increasing their returns to capital and widening the wealth gap over time.

To sum up, the literature review indicates that investment in infrastructure and education may have a significant effect on income inequality in a country. The majority of studies have found that investment in education or infrastructure can reduce income inequality by enhancing productivity, growth, and human capital. However, some studies have challenged this view by showing that investment in education or infrastructure may increase income inequality in some contexts by creating skill mismatches, dual labour markets, or wealth disparities. Therefore, the relationship between investment in infrastructure and education and income inequality is complex and contingent on various factors.

Methodology

The data for this research was collected from various reliable sources, such as the world inequality database, the world bank, and other reputable organisations that provide data on income distribution and public investment. The data consisted of four main variables: Gini coefficient, which measures the degree of income inequality in a country; investment in infrastructure as a percentage of GDP of the country, which reflects the amount of public spending on physical facilities and systems that support economic and social activities; government spending on education as a percentage of GDP, which indicates the level of public investment in human capital development; and income per capita for the country, which represents the average income of individuals in a country. The data covered more than 100 countries from different regions and income levels and spanned over a decade, depending on the availability of data for each country. The data was first cleaned to remove any errors or inconsistencies that might affect the quality and accuracy of the analysis and then merged into one file to create the final dataset that was used for the analysis. The analysis was conducted using panel regression on the software STATA. Panel regression is a method that allows for both cross-sectional and time-series variation in the data, which means that it can capture both the differences among countries and the changes over time. The analysis involved two steps: first, bivariate regression was run to examine the effect of each independent variable (investment in infrastructure and education) on income inequality (Gini coefficient) separately, without controlling for other variables; second, multivariate regression was run to compare the effects of different independent variables on income inequality simultaneously, while controlling for other variables. As the data was panel, test for stationarity was also done using unit root test. The data available was unbalanced so Fisher type was used. For checking which panel to use, Hausman test was also conducted. The analysis also included a categorical variable that divided the countries into different income groups based on their income per capita. This allowed for testing whether the relationship between investment in infrastructure and education and income inequality varied across different income levels or was consistent across all income groups.

Hypotheses

The hypotheses for this study will be as follows:

1. H1: Investment in infrastructure reduces income inequality in the country.
2. H2: Investment in education reduces income inequality in the country.
3. H3: Investment in education reduces income inequality in the country more than investment in infrastructure.
4. H4: Investment in infrastructure reduces income inequality more in rich countries than in poor countries.
5. H5: Investment in education reduces income inequality more in poor countries than in rich countries.

Output

```
. xtreg gini_index invest__gdp , fe

Fixed-effects (within) regression               Number of obs      =       976
Group variable: id                              Number of groups   =       111

R-squared:                                      Obs per group:
     Within  = 0.0045                                         min =         3
     Between = 0.0027                                         avg =       8.8
     Overall = 0.0016                                         max =        11

                                                F(1,864)           =      3.88
corr(u_i, Xb) = -0.0571                         Prob > F           =    0.0493

------------------------------------------------------------------------------
  gini_index | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
invest__gdp |   .0170549   .0086626     1.97   0.049     .0000527    .0340571
       _cons |   36.96907   .2097473   176.26   0.000      36.5574    37.38075
-------------+----------------------------------------------------------------
     sigma_u |  8.0418769
     sigma_e |  1.0937668
         rho |   .98183756   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(110, 864) = 477.59                     Prob > F = 0.0000
```

```
. xtreg gini_index invest__gdp , re

Random-effects GLS regression                   Number of obs      =       976
Group variable: id                              Number of groups   =       111

R-squared:                                      Obs per group:
     Within  = 0.0045                                         min =         3
     Between = 0.0027                                         avg =       8.8
     Overall = 0.0016                                         max =        11

                                                Wald chi2(1)       =      3.69
corr(u_i, X) = 0 (assumed)                      Prob > chi2        =    0.0547

------------------------------------------------------------------------------
  gini_index | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
invest__gdp |   .0165913   .0086343     1.92   0.055    -.0003316    .0335143
       _cons |    37.3047   .7928999    47.05   0.000     35.75064    38.85875
-------------+----------------------------------------------------------------
     sigma_u |  8.0514134
     sigma_e |  1.0937668
         rho |   .98187978   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

The output above is for bivariate regression with capital investment as explanatory var.

```
. xtreg gini_index edu_invest__gdp , fe

Fixed-effects (within) regression               Number of obs      =       976
Group variable: id                              Number of groups   =       111

R-squared:                                      Obs per group:
     Within  = 0.0104                                         min =         3
     Between = 0.0124                                         avg =       8.8
     Overall = 0.0146                                         max =        11

                                                F(1,864)           =      9.08
corr(u_i, Xb) = 0.0828                          Prob > F           =    0.0027

------------------------------------------------------------------------------
    gini_index | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
---------------+----------------------------------------------------------------
edu_invest__gdp |  -.1999916   .0663592    -3.01   0.003    -.3302357   -.0697475
         _cons |    38.2969   .3074769   124.55   0.000     37.69342    38.90039
---------------+----------------------------------------------------------------
       sigma_u |  8.0063637
       sigma_e |  1.0905006
           rho |   .9817863   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(110, 864) = 474.15                     Prob > F = 0.0000
```

```
. xtreg gini_index edu_invest__gdp , re

Random-effects GLS regression                   Number of obs      =       976
Group variable: id                              Number of groups   =       111

R-squared:                                      Obs per group:
     Within  = 0.0104                                         min =         3
     Between = 0.0124                                         avg =       8.8
     Overall = 0.0146                                         max =        11

                                                Wald chi2(1)       =      9.88
corr(u_i, X) = 0 (assumed)                      Prob > chi2        =    0.0017

------------------------------------------------------------------------------
    gini_index | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
---------------+----------------------------------------------------------------
edu_invest__gdp |  -.2066841   .0657528    -3.14   0.002    -.3355573   -.077811
         _cons |   38.64143   .8173126    47.28   0.000     37.03952    40.24333
---------------+----------------------------------------------------------------
       sigma_u |   8.012094
       sigma_e |  1.0905006
           rho |   .98181187   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

The output above is for bivariate regression with investment on education as explanatory var.

```
. xtreg gini_index invest__gdp edu_invest__gdp  , fe

Fixed-effects (within) regression               Number of obs      =       976
Group variable: id                              Number of groups   =       111

R-squared:                                      Obs per group:
     Within  = 0.0145                                         min =         3
     Between = 0.0078                                         avg =       8.8
     Overall = 0.0095                                         max =        11

                                                F(2,863)           =      6.33
corr(u_i, Xb) = 0.0567                          Prob > F           =    0.0019

------------------------------------------------------------------------------
   gini_index | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
--------------+---------------------------------------------------------------
   invest__gdp |   .0162747   .008628     1.89   0.060    -.0006596    .033209
edu_invest__gdp |  -.1961707   .0662921   -2.96   0.003    -.3262834   -.066058
        _cons |   37.89078   .3749917   101.04   0.000     37.15478    38.62679
--------------+---------------------------------------------------------------
      sigma_u |  8.0131248
      sigma_e |  1.0888899
          rho |   .98186917   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(110, 863) = 474.82                     Prob > F = 0.0000

. estimate store fixed
```

```
. xtreg gini_index invest__gdp edu_invest__gdp  , re

Random-effects GLS regression                   Number of obs      =       976
Group variable: id                              Number of groups   =       111

R-squared:                                      Obs per group:
     Within  = 0.0145                                         min =         3
     Between = 0.0081                                         avg =       8.8
     Overall = 0.0098                                         max =        11

                                                Wald chi2(2)       =     13.29
corr(u_i, X) = 0 (assumed)                      Prob > chi2        =    0.0013

------------------------------------------------------------------------------
   gini_index | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
--------------+---------------------------------------------------------------
   invest__gdp |   .0158093   .0085975     1.84   0.066    -.0010414    .0326601
edu_invest__gdp |  -.2030523   .0656698    -3.09   0.002    -.3317626   -.0743419
        _cons |   38.24262    .84764     45.12   0.000     36.58127    39.90396
--------------+---------------------------------------------------------------
      sigma_u |  8.041107
      sigma_e |  1.0888899
          rho |   .98199287   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. estimate store random
```

The output above is for multi-variate regression with capital investment and investment on education as explanatory variables for fixed effect and random effect.

```
. hausman fixed random

                 ---- Coefficients ----
                 |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
                 |    fixed       random       Difference          Std. err.
-----------------+------------------------------------------------------------
   invest__gdp   |   .0162747    .0158093       .0004654        .0007252
edu_invest~p     |  -.1961707   -.2030523       .0068816        .0090626
------------------------------------------------------------------------------
                           b = Consistent under H0 and Ha; obtained from xtreg.
            B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

    chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =   0.88
Prob > chi2 = 0.6434
```

The output above is for Hausman test for checking which panel regression to use.

```
. xtunitroot fisher gini_index, dfuller lags(0)

Fisher-type unit-root test for gini_index
Based on augmented Dickey-Fuller tests

H0: All panels contain unit roots               Number of panels      =     111
Ha: At least one panel is stationary            Avg. number of periods =    8.79

AR parameter: Panel-specific                    Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Not included
Drift term:   Not included                      ADF regressions: 0 lags

                                     Statistic      p-value
----------------------------------------------------------
Inverse chi-squared(222)  P        766.6340       0.0000
Inverse normal            Z         -5.9926       0.0000
Inverse logit t(464)      L*       -13.7860       0.0000
Modified inv. chi-squared Pm        25.8472       0.0000
----------------------------------------------------------
P statistic requires number of panels to be finite.
Other statistics are suitable for finite or infinite number of panels.
```

```
. xtunitroot fisher invest__gdp, dfuller lags(0)

Fisher-type unit-root test for invest__gdp
Based on augmented Dickey-Fuller tests

H0: All panels contain unit roots               Number of panels      =     111
Ha: At least one panel is stationary            Avg. number of periods =    8.79

AR parameter: Panel-specific                    Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Not included
Drift term:   Not included                      ADF regressions: 0 lags

                                     Statistic      p-value
----------------------------------------------------------
Inverse chi-squared(222)  P        434.7777       0.0000
Inverse normal            Z         -2.7899       0.0026
Inverse logit t(529)      L*        -5.6117       0.0000
Modified inv. chi-squared Pm        10.0980       0.0000
----------------------------------------------------------
P statistic requires number of panels to be finite.
Other statistics are suitable for finite or infinite number of panels.
```

```
. xtunitroot fisher edu_invest__gdp, dfuller lags(0)

Fisher-type unit-root test for edu_invest__gdp
Based on augmented Dickey-Fuller tests

H0: All panels contain unit roots               Number of panels      =     111
Ha: At least one panel is stationary            Avg. number of periods =    8.79

AR parameter: Panel-specific                    Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Not included
Drift term:   Not included                      ADF regressions: 0 lags

                                     Statistic      p-value
----------------------------------------------------------
Inverse chi-squared(222)  P        446.3047       0.0000
Inverse normal            Z         -4.5706       0.0000
Inverse logit t(534)      L*        -7.0380       0.0000
Modified inv. chi-squared Pm        10.6450       0.0000
----------------------------------------------------------
P statistic requires number of panels to be finite.
Other statistics are suitable for finite or infinite number of panels.
```

These are the output for the unit root test for the panel data. p-values for all the variables turned out to be 0.

```
. xtreg gini_index invest__gdp edu_invest__gdp  if(IncomeGroup =="Low income")

Random-effects GLS regression                   Number of obs     =        89
Group variable: id                              Number of groups  =        13

R-squared:                                      Obs per group:
     Within  = 0.1143                                         min =         3
     Between = 0.0941                                         avg =       6.8
     Overall = 0.1472                                         max =        10

                                                Wald chi2(2)      =      9.97
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0068
```

gini_index	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
invest__gdp	.0543476	.017557	3.10	0.002	.0199366	.0887586
edu_invest__gdp	.110603	.3213917	0.34	0.731	-.5193131	.7405191
_cons	40.29797	2.567385	15.70	0.000	35.26598	45.32995
sigma_u	7.9966975					
sigma_e	1.2446691					
rho	.97634676	(fraction of variance due to u_i)				

```
. xtreg gini_index invest__gdp edu_invest__gdp  if(IncomeGroup =="Lower middle income")

Random-effects GLS regression                   Number of obs     =       224
Group variable: id                              Number of groups  =        29

R-squared:                                      Obs per group:
     Within  = 0.0007                                         min =         3
     Between = 0.0001                                         avg =       7.7
     Overall = 0.0000                                         max =        11

                                                Wald chi2(2)      =      0.13
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.9375
```

gini_index	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
invest__gdp	.0013132	.0181487	0.07	0.942	-.0342576	.0368839
edu_invest__gdp	-.0412242	.1175427	-0.35	0.726	-.2716037	.1891553
_cons	38.2457	1.471641	25.99	0.000	35.36133	41.13006
sigma_u	6.9747456					
sigma_e	1.1271085					
rho	.97455051	(fraction of variance due to u_i)				

```
. xtreg gini_index invest__gdp edu_invest__gdp  if(IncomeGroup =="Upper middle income")

Random-effects GLS regression                   Number of obs     =       242
Group variable: id                              Number of groups  =        26

R-squared:                                      Obs per group:
     Within  = 0.0162                                         min =         6
     Between = 0.1715                                         avg =       9.3
     Overall = 0.1125                                         max =        11

                                                Wald chi2(2)      =      2.43
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.2974
```

gini_index	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
invest__gdp	.0043762	.0280898	0.16	0.876	-.0506787	.0594312
edu_invest__gdp	-.2426883	.1560564	-1.56	0.120	-.5485533	.0631767
_cons	42.6027	2.01697	21.12	0.000	38.64951	46.55589
sigma_u	8.9096987					
sigma_e	1.4456444					
rho	.97434859	(fraction of variance due to u_i)				

```
. xtreg gini_index invest__gdp edu_invest__gdp  if(IncomeGroup =="High income")

Random-effects GLS regression                   Number of obs     =       421
Group variable: id                              Number of groups  =        43

R-squared:                                      Obs per group:
     Within  = 0.0551                                         min =         3
     Between = 0.2928                                         avg =       9.8
     Overall = 0.2621                                         max =        11

                                                Wald chi2(2)      =     26.77
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000
```

gini_index	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
invest__gdp	-.0170308	.0112022	-1.52	0.128	-.0389867	.0049251
edu_invest__gdp	-.423482	.0825858	-5.13	0.000	-.5853472	-.2616168
_cons	36.27819	.8571725	42.32	0.000	34.59816	37.95822
sigma_u	4.4156599					
sigma_e	.72431893					
rho	.97379783	(fraction of variance due to u_i)				

The output above is for multi-variate regression with capital investment and investment on education as explanatory variables for different income groups.

Stata Commands

#	Command
1	import excel "C:\Users\dell\Desktop\342 Proj\data.xlsx", sheet("Sheet1") firstrow
2	destring Year, replace
3	egen id = group(Country)
4	xtset id Year , yearly
11	xtreg gini_index invest__gdp , fe
12	xtreg gini_index edu_invest__gdp , fe
13	xtreg gini_index invest__gdp , re
14	xtreg gini_index edu_invest__gdp , re
15	xtreg gini_index invest__gdp edu_invest__gdp , fe
16	estimate store fixed
17	xtreg gini_index invest__gdp edu_invest__gdp , re
18	estimate store random
20	hausman fixed random
21	xtunitroot fisher gini_index, dfuller lags(0)
22	xtunitroot fisher invest__gdp, dfuller lags(0)
23	xtunitroot fisher edu_invest__gdp, dfuller lags(0)
24	xtreg gini_index invest__gdp edu_invest__gdp if(IncomeGroup =="Low income")
25	xtreg gini_index invest__gdp edu_invest__gdp if(IncomeGroup =="Lower middle income")
26	xtreg gini_index invest__gdp edu_invest__gdp if(IncomeGroup =="Upper middle income")
27	xtreg gini_index invest__gdp edu_invest__gdp if(IncomeGroup =="High income")

Conclusion

Investment in infrastructure increases inequality. This means that spending more money on building roads, bridges, power plants, and other public facilities will widen the gap between the rich and the poor. One reason for this may be infrastructure projects often benefit those who already have access to markets, services, and opportunities, while excluding or displacing those who are marginalized or vulnerable.

Investment in education has a significant impact on reducing inequality. This means that spending more money on improving the quality and accessibility of schooling, training, and lifelong learning tends to narrow the gap between the rich and the poor. One reason for can be education equips people with the skills and competencies that enable them to find better jobs and increase their incomes.

The effect of investment in infrastructure has a significant impact in increasing inequality in poor countries. This means that in countries with low levels of income and development, spending more money on infrastructure projects tends to exacerbate the existing disparities between different groups and regions. One explanation for this can be that poor countries often lack the institutional capacity and governance mechanisms to ensure that infrastructure investments are inclusive, transparent, and accountable.

Investment in education has a greater impact in rich countries to reduce income inequality. This means that in countries with high levels of income and development, spending more money on education programs tends to have a stronger effect on lowering the differences in earnings and wealth among individuals.

For middle income countries, nothing significant result has been obtained. One reason to explain why it is so can be middle income countries often face complex and diverse challenges that require a balanced and holistic approach to development that goes beyond investing in physical or human capital.

Therefore, it is essential for policymakers to carefully consider the specific context and needs of their countries, such as the level of income and development, the existing inequalities among different groups and regions, and the potential opportunities and challenges that arise from globalization and technological change, when they design and implement development strategies that aim to promote both economic growth and social equity in a sustainable manner.

Limitations of the Study

The limitations of this study include the availability and reliability of the data.

The accuracy of the Gini coefficient as a measure of income inequality.

The external factors that may affect income inequality in the country which is not taken into account in the model.

The investment in education also includes some infrastructure investments so there might be some correlation between the two variables.

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