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Foreign Direct Investment and its Implications for Achieving the Sustainable Development Goals: A Comprehensive Analysis of G20 Nations

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Abstract : This study examines the impact of Foreign Direct Investment (FDI) on the dimensions of sustainable development in the G-20 countries, focusing on human development, poverty reduction, and environmental sustainability. Using a panel of 19 countries over the period 2010-2020, we explore the effects of FDI on the Human Development Index (HDI), household consumption expenditure (as a proxy for poverty reduction), and CO2 emissions. Our findings show that FDI positively contributes to human development and helps reduce poverty. However, FDI is associated with increased CO2 emissions, indicating a negative effect on environmental quality.

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IndexTerms **- Foreign Direct Investment, Sustainable Development, Human Development, Poverty Reduction, CO2 Emissions, G-20.**

INTRODUCTION

Sustainable development is the need of the hour in these unprecedented times of environmental and social degeneration. In the beginning of the 21st century UN came up with the idea of Millenium development goals to deal with the extreme social and environmental degradation. The MDG targeted the global south countries wherein the participation of them in the policy making and policy designing was minimal. MDG was criticised of being only targeting the global south and not focusing on the social and environmental consequences born by the developed world. In 2015 United Nations take a step further to introduce 17 SDG goals that focused on the collective and comprehensive development of the world which is inclusive in every dimension. This approach took care of the social environmental political challenges of the contemporary world.

The FDI role gains importance in developing countries, as it is the largest source of external finance for these countries ("UNCTAD Handbook of Statistics 2017," 2017). FDI inflows play major role in the economic development of the countries. It has also been shown in studies that it facilitates the improvements in maintaining the SDG targets. It is considered as one of the ways through private sector to mobilizing the capitals to meet 2030 targets. UN in 2015 estimated that the Initiative requires the funding of the $ 2.25 trillion to meet the SDG, the developing world is the main source of the FDI to the World. The increase of global crisis and economic slowdown the revised estimates have increased to $ 4 trillion.

The adoption of the 17 SDGs will require considerable investment needs that will create several challenges to the international community. While the public sector should play a fundamental role in mobilizing capital for investment in the SDG project, the private sector, including foreign direct investment (FDI), constitutes a fundamental source of external finance, although mostly for developing countries ("UNCTAD Handbook of Statistics 2014," 2015)

Numerous studies have tried to find out the linkages between Sustainable Development Goals and Economic growth, Environment, Social and Governmental, how we focus on financing to meet the desired target is a task. Public sector plays a big role in the mobilisation of the funds to achieve the desired SDG goal. The implementation of SDG in itself is a complex and challenging task for the public sector that it requires the additional fundings such as the private sector investment, international organisation assistance to provides funds to fill the gaps. FDI (Foreign direct Investment) is a channel which provides some positive spillover effects in achieving sustainable development goals. While there is a large number of studies that investigate the impact of FDI on

the economic development and environmental sustainability, less research is done with regard to the relationship of FDI and the achievement of SDGs with their three pillars: economic, social, and environmental. (Aust et al 2020).

This study fills the gap in the literature by examining the potential effect of FDI on the achievement of SDGs in G20 countries. G20 countries consists of the greatest 20 countries which accounts for over 80% of the world's GDP and 75% of world Trade, and about two-thirds of the world population. The main objective of our study is to analyse the impact of inward FDI on the different components of SDG in G20 countries. G20 countries have taken the commitments to meet the SDG targets for 2030. A comprehensive analysis of these countries can provide the diversity and relevance that is required. These countries are divided into Developed economies i.e. United States, Canada, United Kingdom, Germany, France, Italy, Japan, Australia, South Korea and European Union. It also consists of the counties that are characterised by the rapid economic growth are in the phase of rapid industrialisation and rapid economic growth, they have the potential to become the developed country in near future. In the contemporary period they play a significant role in the global trade and development. These countries are China, India, Brazil, Russia. South Africa, Mexico, Indonesia, Turkey, Argentina, Saudi Arabia.
The few available studies analysed the effect of FDI mainly on the ecological aspect (Guoyan et al., 2021; Shahbaz et al., 2019). We have tried to include the environmental assessment too.

We have chosen to concentrate on FDI for a number of reasons, even though we are aware of how crucial this source of finance is for developing nations. It is given preference from ODA because G20 countries attract the substantial amount of FDI compared with ODAs. In 2022, global FDI exceeded $1.58 trillion, significantly higher than the global ODA which was around $204 billion (OECD, 2023). ODA remains restricted in fulfilling targets which focuses on the social aspects, while the FDI can be used to boost the overall sustainable financing needs via infrastructure development, foster innovation, capacity development, promoting public private partnership. Overall, it contributes to the sustainability and long-term development

Literature Review

We have organised the existing literature into different strands for simplicity, in the first strand the link between FDI and growth is general is discussed

Aust et al 2020 states that their results show that an increase in FDI leads to an increase in the SDG scores that indicates foreign investors play a fundamental role in the achievement of SDG in developing countries, their results have a significant relationship between SDG and FDI inflow. The paper shows a significant positive relationship between the FDI and SDG.
(Safa et al 2023) studied the impact of FDI on different dimensions of SDG i.e. Social, Environmental, Economic. Using a panel of 14 countries in the MENA region over the period 1996-2020. Using Panel data Regression, they showed that the FDI inflow in MENA countries improve human development and it reduces the poverty, on the contrary it also finds the negative impact of the FDI on environmental quality by increasing the Co_2 levels.
We generally have this intuition that the FDI only helps attaining SDG goals but some aspects of SDF are impacted negatively by FDI inflows A study finds a relationship between the FDI and CEM (minimize carbon emission) The Panel Smooth Transition Regression Model (PSTR) is applied, and the result confirmed that the nexus between the two variables is nonlinear in MENA countries. This study further finds out as the economy progresses the relation between these two factors become negative.
In their paper Voica et al. (2015) discussed about how sustainable development is linked to the FDI inflows in European Union. They find out that the environmental sustainability in comparatively more important aspect to consider that social and econom ic. FDI in general has significant impact on the different dimensions of sustainable development. Since EU consists of countries that are doing economically efficient and socially equitable, the private mobilisation of funds through FDI is rather encouraged than public funding.
A case Study based on Singapore, wherein the data is fetched annually from 2010- 2013 Ridzuan et al. (2017), 3 pillars of sustainability are impacted by FDI i.e income distribution, environment quality and economic growth. The results shows that the FDI inflows bring favourable outcomes in Economic growth and Environmental quality, the income distribution impact is negatively impacted by the FDI inflows.
Chnundovsky and Lopez (1999) talks about the positive correlation between the FDI and GDP per capita and human and gender development indicator, but contrastingly it has a negative impact on the environmental quality.
Chipalkatti et al. (2021) discussed the relationship between the FDI and different dimensions of Sustainability using a panel of 161 countries including the low middle- and high-income countries. The results indicated the significant relationship between GDP and FDI. A non-linear relationship was found between the environmental quality and FDI. For Low Income countries the high level of CO2 emissions were correlated with the higher FDI.
Shahbaz et al. 2018 conducted the study to find the determinants of Carbon emission in France having the FDI as main factor. They concluded that FDI has positive impact on the carbon emission. Khan et al. (2019) also concluded that Foreign direct investment has a positive effect on CO_2 emissions in Pakistan.

In (Sheikh et al 2021), It was found that trade openness, along with FDI inflows, increased pollutant emissions and therefore caused environmental damage. In the continuation the long run, trade openness, foreign direct investment, and energy consumption share a negative association, while economic growth and population growth improve sustainability.
Rieter et al 2010 have tried to find out the interaction between FDI policy and the Human development using a panel data study, they conclude that FDI may or may not enhance the human development in developing country, it all depends only when FDI policy

ensures that FDI aligns with and promotes development. Corruption as a factor is introduced to find its impact on the various dimensions of development, the relationship between FDI and improvement in human development is also more strongly positive when corruption is low.

Yang,2021 in their study focused on Chinese FDI inflow in Africa and its positive impact on the SDG goals concerning to environment and economic dimensions but it doesn't find any significant relationship between the social dimension and trends of SDG.

RESEARCH METHODOLOGY

The original sample consists the data on FDI and other macroeconomic variable from G20 countries over the period from 2010 to 2020. Our sample consists of Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Republic of Korea, Mexico, Russia, Saudi Arabia, South Africa, Türkiye, United Kingdom and United States) and the European Union. The empirical study has taken is a balanced panel data having 210 observations.

Following Wooldridge (2010), panel data is ideal for the measurement of relationships that cannot be explored by specific time series analysis or cross-section model analysis.

Three main variables are taken to analyse different aspect of the sustainability i.e. social and environmental sustainability. Under the social sustainability we have taken two different human dimensions i.e. Human development index and Household final consumption Expenditure. Given below are the detailed definition and explanation of the dependent variables.

(a) Human Development Index – The data regarding this variable has been gathered from annual reports of the Human Development index by **UNDP (United Nations Development Program)**. HDI covers three dimensions i.e. education, health and standard of living. It is the geometric mean of the values gathered from these three dimensions, generally falls between zero and one.

(b) Household Final Consumption Expenditure- it is measured by the household consumption in percentage of GDP growth. Data is fetched from the **World bank database**.

(c) **CO2 emissions (metric tons per capita)** is a widely recognized measure for assessing the environmental dimension of sustainable development. It represents the amount of carbon dioxide emitted by a country divided by its total population. This indicator is derived from the **World Development Indicators (WDI)** database, a reliable source for global development statistics.

Often used as a proxy for evaluating a nation's efforts to combat climate change and reduce greenhouse gas emissions, this measure reflects its capacity to address environmental challenges, particularly those related to carbon dioxide. As such, it provides critical insights into the effectiveness of policies aimed at minimizing pollution and transitioning towards a more sustainable economy.

Table 1 (in the Appendix) presents a detailed breakdown of the various dimensions of sustainable development for the countries in our sample, covering the analysis period and based on the three measures outlined earlier.

RESULTS AND DISCUSSION

1. FDI and Human Development

Objective: This part aims to analyse the effect of FDI on human development, measured by the Human Development Index (HDI).

Model:

$$HDI_{it} = \alpha + \beta 1FDI_{it} + \beta 2OPEN_{it} + \beta 3GDPG_{it} + \beta 4POP_{it} + \beta 5CCORR_{it} + \mu_i + \delta T_t + \varepsilon_{it}$$

2. FDI and Poverty

Objective: This analysis explores the social dimension of sustainable development by examining FDI's influence on poverty. Household final consumption expenditure is used as a proxy for poverty, following the approach of Dada and Akinlo (2021) in Sub-Saharan African nations.

Model:

$$HCE_{it} = \alpha + \beta_1 FDI_{it} + \beta_2 OPEN_{it} + \beta_3 GDPG_{it} + \beta_4 POP_{it} + \beta_5 CCORR_{it} + \beta_6 LEAB_{it} + \mu_i + \delta T_t + \varepsilon_{it}$$

3. FDI and Environmental Quality

Objective: The relationship between FDI and environmental quality is examined by focusing on CO2 emissions per capita as a measure of environmental impact, as proposed by Ridzuan et al. (2017).

Model:

$$CO2_{it} = \alpha + \beta_1 FDI_{it} + \beta_2 OPENit + \beta_3 GDPG_{it} + \beta_4 POP_{it} + \beta_5 CCORR_{it} + \beta_6 EUit + \mu_i + \delta_{Tt} + \varepsilon_{it}$$

In all models, $\boldsymbol{\mu_i}$ represents country-specific effects, $\boldsymbol{\delta T_t}$ captures year-specific factors, and $\boldsymbol{\varepsilon_{it}}$ is the error term assumed to be independent and identically distributed. Each model investigates the distinct but interconnected relationships between FDI and the key components of sustainable development.

Results

To begin with, we conducted the Hausman test to select between the fixed-effects and random-effects models. This test helps identify which model provides more accurate results. The outcome of the Hausman test favoured the fixed-effects model for all three specifications. As a result, we proceeded with estimating a fixed-effects panel model.

Results from different models are presented in the appendix in form of tree different tables which are derived from different models used.

The analysis of the HDI variable reveals that the coefficient for FDI is both statistically significant and positive at the 1 percent level. Specifically, a 1 percent increase in FDI inflows is associated with a 6.22e-08 increase in the human development index. These findings are consistent with those of Sharma and Gani (2004) and Reiter and Steenesma (2010), who highlighted that FDI contributes to human development in developing countries. The value of 6.22e-08 is very small, and such a result could be considered practically insignificant, even though it is statistically significant. While the result indicates that FDI has a positive effect on the Human Development Index (HDI), the magnitude of the effect may be too small to have a meaningful impact in real-world terms.
For the control variables, the coefficient for trade openness is significant and negative, suggesting that increased trade is linked to lower HDI in G20 countries. While increased trade is generally associated with higher human development, studies suggest that in some G20 countries, the relationship may not be straightforward. For example, India and South Africa, despite significant trade, still exhibit lower HDI scores, highlighting challenges in translating trade into human development (MoSPI, 2023). Additionally, the OECD (2024) notes that trade liberalization benefits may not be evenly distributed, potentially leading to disparities in HDI within G20 nations. These findings suggest that trade's impact on HDI can vary based on factors like income distribution and domestic policies. Additionally, the coefficient for population growth is significant and positive at the 5 percent level, indicating that higher population growth rates are associated with an increase in HDI.
Regarding GDP growth, the results show that it does have a significant effect on human development. Some studies suggest that trade can have a negative effect on human development in certain G20 countries. For instance, the UN Sustainable Development Solutions Network (2022) highlights that trade-related environmental degradation can offset development gains.
Population growth can negatively impact human development in G20 nations due to factors like resource strain, infrastructure challenges, and lower per capita income growth. Research by Bloom et al. (2011) suggests that high population growth may reduce investments in education and healthcare, leading to slower improvements in HDI. Similarly, the OECD (2024) highlights that rapid population increases can exacerbate inequality and hinder the distribution of economic benefits, affecting overall human development outcomes. Finally, the coefficient for control of corruption has an insignificant relationship with HDI.

The results in second model indicate that FDI has a positive and significant impact on household consumption. An increase in FDI flows leads to higher household consumption, which in turn helps reduce poverty. FDI facilitates income distribution, thereby boosting consumption expenditure among the population. This finding aligns with the conclusions of Meyer (2004), who highlighted that FDI drives economic growth and plays a key role in poverty alleviation.
The coefficient for trade openness is statistically insignificant. A similar pattern is observed with GDP growth. Studies suggest that trade openness and GDP growth may not always significantly affect development outcomes. For instance, research by Barro (2003) shows that GDP growth can fail to reduce inequality and may not always correlate with improvements in household consumption or poverty reduction, indicating its limited role in certain contexts. Bourguignon (2002) suggests that economic growth does not always contribute to poverty reduction. In contrast, the results show that higher population growth is linked to increased household consumption, which aligns with existing literature. Lastly, life expectancy has a significant positive effect on household consumption in G20 countries, Life expectancy has a significant positive effect on household consumption in G20 countries, as healthier populations tend to have higher productivity and income levels, which in turn increases their capacity to consume. Study by Bloom et al. (2001) suggest that improvements in life expectancy led to greater economic stability and more disposable income, thereby boosting household consumption. Additionally, longer life expectancy is often associated with better access to healthcare and social services, further promoting consumer spending (OECD, 2020).

Results of the third model of shows that FDI significantly increases CO2 emissions in the G20 countries, confirming the findings of Abdouli and Hamammi (2017) and Shahbaz et al. (2019) that FDI contributes to environmental degradation. Trade openness has an insignificant effect on CO2 emissions. Research on the relationship between trade openness and CO_2 emissions in G20 countries shows mixed results. Some studies indicate an insignificant effect of trade openness on CO_2 emissions. These mixed findings highlight that the impact of trade openness on emissions varies by country and context. Population growth also significantly increases CO2 emissions, consistent with Shi (2003). Lastly, higher energy consumption significantly raises CO2 emissions, at 10 percent level of significance, supporting Abdallah and Abugamos (2017), who found non-renewable energy consumption as a key driver of environmental degradation in the region.

Conclusion and Summary

This study investigated the relationship between Foreign Direct Investment (FDI), trade openness, population growth, control of corruption, and their effects on human development, household consumption, and environmental quality in G20 countries. The findings revealed that FDI significantly influences human development and household consumption, although the magnitude of its effect on human development was small. Trade openness showed a mixed relationship with human development, with some G20 countries experiencing lower HDI despite significant trade activity. Population growth was found to positively affect human development and household consumption, but it may also exert pressure on resources and infrastructure. The relationship between control of corruption and human development was found to be insignificant, pointing to the complex role of governance in influencing developmental outcomes.

In terms of environmental quality, FDI was found to significantly increase CO2 emissions, supporting previous studies that argue FDI contributes to environmental degradation. Trade openness, on the other hand, showed an insignificant effect on CO2 emissions, suggesting that the relationship may vary depending on the country and its policies. Population growth and energy consumption were both found to significantly increase CO2 emissions, highlighting the challenges G20 countries face in balancing development with environmental sustainability.

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Appendix

Descriptive Analysis Summary

country_id	hdi	hce	co2met~a
Argentina	.8463636	82.56579	4.081226
	.0058527	1.783272	.2835875
	.834	79.39783	3.405617
	.853	85.27528	4.34225
Austrailia	.9343636	74.26286	16.44496
	.0070608	1.317444	.9451226
	.924	72.45525	14.77614
	.948	76.87511	17.97375
Brazil	.7482727	82.43565	2.191486
	.0144713	2.362136	.179702
	.722	78.94311	1.942523
	.764	85.12763	2.514592
Canada	.9243636	78.06715	15.46639
	.0066674	1.164846	.6693853
	.911	76.06287	13.59937
	.932	79.53235	15.99827
China	.7402727	53.16012	7.210761
	.0280182	2.391916	.3893755
	.698	48.91336	6.33542
	.781	56.01857	7.756138
France	.8931818	78.10815	4.771297
	.0082319	.7914235	.3973262
	.88	76.59272	3.953682
	.905	79.34495	5.350408
Germany	.9410909	73.01617	8.877686
	.0062362	.9715299	.7193114
	.929	71.94884	7.255221
	.951	74.67189	9.624229
India	.6145455	69.08603	1.59124
	.02356	2.062887	.1421678
	.572	65.73247	1.338034
	.638	72.71058	1.795595
Indonesia	.6953636	66.41222	1.940359
	.0167408	1.108662	.156342
	.667	64.48203	1.702906
	.718	68.58965	2.245286
Italy	.8860909	79.86252	5.718564
	.0065185	1.030914	.6375396
	.88	78.43446	4.732373
	.899	81.27829	6.836875
Japan	.9113636	75.8179	9.14891
	.0057667	1.512359	.571725
	.902	74.02549	8.031496
	.918	77.99283	9.944495
Korea Republic	.9079091	64.619	11.83492
	.0110041	1.049001	.3433427
	.89	62.96445	10.99003
	.922	65.95358	12.21646
Mexico	.7655455	80.48695	3.8549
	.0110577	1.523436	.3383582
	.747	78.30988	3.040766
	.781	82.5623	4.202414
Russian federati	.8205455	70.34174	11.36348
	.0124207	1.411276	.3266124
	.797	68.01044	10.88743
	.839	71.84092	11.88495
Saudi Arabia	.8389091	59.91462	15.77298
	.0185551	9.130162	.9470764
	.805	46.11572	14.26659
	.862	72.21804	17.25779
South Africa	.7115455	82.55999	7.749749
	.0197604	.9878753	.4287494
	.675	80.36356	6.687563
	.741	83.67294	8.217612
Turkey	.8085454	74.10812	4.603882
	.032614	2.104548	.3719076
	.75	70.69058	4.071715

	.842	77.55369	5.205879
United Kingdom	.9216364	83.88675	6.211582
	.0079028	1.093819	.9914123
	.909	81.81822	4.601142
	.933	85.38307	7.689568
United States of	.9239091	82.37457	15.49451
	.0050883	1.354585	1.14595
	.916	81.00092	13.03283
	.933	84.86497	17.43174
Total	.8333589	74.2677	8.122573
	.0951936	8.69067	4.893894
	.572	46.11572	1.338034
	.951	85.38307	17.97375

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Table: Regression results

Model-1

```
Fixed-effects (within) regression               Number of obs      =       209
Group variable: country_id                      Number of groups   =        19

R-sq:                                           Obs per group:
     within  = 0.2318                                         min =        11
     between = 0.2947                                         avg =      11.0
     overall = 0.2155                                         max =        11

                                                F(5,18)            =     16.73
corr(u_i, Xb)  = -0.5972                        Prob > F           =    0.0000

                                 (Std. Err. adjusted for 19 clusters in country_id)
------------------------------------------------------------------------------
             |               Robust
         hdi |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      fdigdp |    6.22e-08   3.08e-08     2.02   0.059    -2.57e-09    1.27e-07
        open |  -.0005252   .0002797    -1.88   0.077    -.0011129    .0000625
        gdpg |  -.0017553    .000624    -2.81   0.012    -.0030664   -.0004443
        popg |  -.0048667   .0018785    -2.59   0.018    -.0088133    -.00092
       ccorr |  -.0128744    .014547    -0.89   0.388    -.0434366    .0176878
       _cons |   .8738565   .0128789    67.85   0.000      .846799    .900914
-------------+----------------------------------------------------------------
     sigma_u |  .10649528
     sigma_e |  .01355528
         rho |  .98405677   (fraction of variance due to u_i)
------------------------------------------------------------------------------
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Model-2

```
Fixed-effects (within) regression               Number of obs      =       209
Group variable: country_id                      Number of groups   =        19

R-sq:                                           Obs per group:
     within  = 0.3389                                         min =        11
     between = 0.0975                                         avg =      11.0
     overall = 0.1151                                         max =        11

                                                F(5,18)            =     27.03
corr(u_i, Xb)  = -0.1124                        Prob > F           =    0.0000

                                 (Std. Err. adjusted for 19 clusters in country_id)
------------------------------------------------------------------------------
             |               Robust
         hce |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      fdigdp |    6.76e-06   2.00e-06     3.37   0.003     2.55e-06    .000011
        open |  -.1995181   .1235594    -1.61   0.124    -.4591068    .0600706
        gdpg |   -.127107   .0829189    -1.53   0.143    -.3013132    .0470993
        popg |  -.8239177   .2168465    -3.80   0.001    -1.279495    -.36834
        leab |   .1142264   .2290513     0.50   0.624    -.3669925    .5954454
       _cons |   76.87745   19.32976     3.98   0.001     36.26714    117.4878
-------------+----------------------------------------------------------------
     sigma_u |  8.1778473
     sigma_e |  2.1151667
         rho |  .93729698   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Model-3

```
Fixed-effects (within) regression               Number of obs      =       209
Group variable: country_id                      Number of groups   =        19

R-sq:                                           Obs per group:
     ithin  = 0.1007                                          min =        11
     between = 0.8979                                         avg =      11.0
     overall = 0.8722                                         max =        11

                                                F(4,18)            =      4.00
corr(u_i, Xb)  = 0.9023                         Prob > F           =    0.0170

                                              (Std. Err. adjusted for 19 clusters in country_id)
------------------------------------------------------------------------------
                             |               Robust
co2metrictonspercapita       |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-----------------------------+------------------------------------------------
                       fdigdp |   3.13e-06   1.53e-06     2.05   0.055    -8.08e-08   6.33e-06
                         open |  -.0063994   .0082693    -0.77   0.449    -.0237726   .0109737
                         popg |   .3201334   .1009351     3.17   0.005     .1080767   .5321901
eukgofoilequivalentpercapita |   .0005015   .0010368     0.48   0.634    -.0016768   .0026798
                        _cons |   6.36789    3.787169     1.68   0.110    -1.588657   14.32444
-----------------------------+------------------------------------------------
                      sigma_u |  3.9518471
                      sigma_e |  .57813846
                          rho |  .97904602   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```