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The Implication of Energy Consumption, Corruption, and Foreign Investment for Sustainability of Income Distribution in Indonesia

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Abstract: Despite the recent reduction in the poverty rate in Indonesia, income inequality has not shown any improvement. Income inequality, also known as income disparity, has been a prolonged issue in Indonesia and has caused great dissatisfaction among the public. Many of them do not feel an improvement in their wellbeing. Most studies explore these issues based on microeconomics perspectives, and limited studies focus on macroeconomic determinants. Thus, it is imperative to investigate the potential macroeconomic determinants of income inequality in Indonesia, particularly energy consumption (ENC), corruption (COR), foreign direct investment (FDI), and other supporting determinants such as economic growth (GDP), financial development (FD), and CO_2 emissions. Data from 1984 to 2020 were collected and analyzed, employing the autoregressive distributed lag (ARDL) approach. The findings indicate that economic growth, corruption, and FDI can contribute to a smaller gap between the rich and the poor. At the same time, greater CO_2 emissions can intensify income inequality in Indonesia both in the short and long run. Pollution, as captured by CO_2 emissions, can affect the health of the poor. Health problems create difficulties for poor people to work and reduce the probability of earning income, ultimately widening income inequality. FD and energy use, on the other hand, do not influence income distribution in the long and short run. The findings indicate that boosting economic growth and FDI significantly reduce income disparity in Indonesia. Various policy recommendations are suggested in these studies based on the long-run outcomes.

Keywords: governance; energy consumption; foreign direct investment; income distribution

JEL Classification: Q01; Q50; L51

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1. Introduction

Geopolitical tension, climate change, the COVID-19 pandemic, and economic recession are recent catastrophic events that have surged income inequality. The World Economic Forum, in the 2022 World Inequality Report, indicated that the bottom 50 percent of the global population captures 8.5 percent of total income and 2.0 percent of wealth measured at purchasing power parity (PPP) (see Figure 1) [1]. This situation is more alarming

for developing countries, where nearly two-thirds of the world's poorest people live, exacerbating socioeconomic issues. In Indonesia, rising income inequality is one of the government's primary worries as the country continues to grow [2]. The struggle against poverty is undermined by increasing inequality and corruption, slowing economic growth, and endangering social cohesion. Income inequality in Indonesia is also associated with energy poverty and private sector funding [3]. However, the dynamics between income inequality, corruption, energy consumption, and private investments are inconclusive. Despite applying several concepts, theories, and hypotheses, no conclusive result has been reached [4]. This study seeks to address this gap.

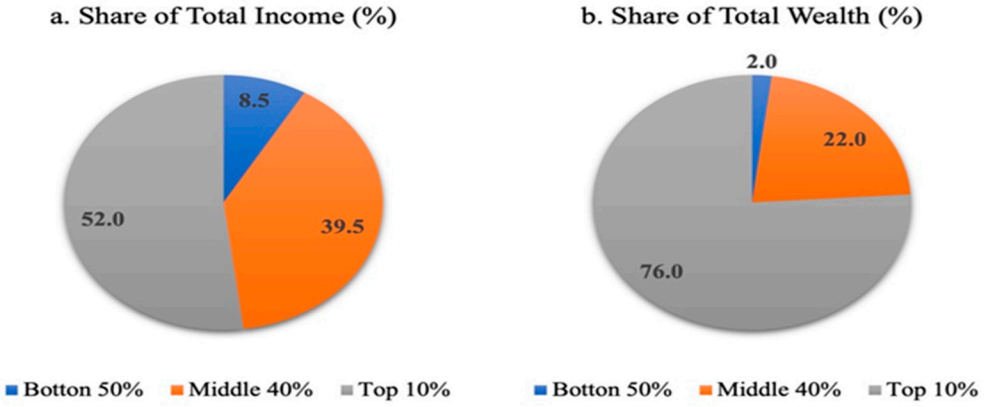


Figure 1. Global share of total income and wealth. Source: [1].

As of July 2021, the world's fourth most populous nation fell from an upper-middle-class income to lower-middle-income status. The poverty level increased from 9.2 percent to 9.7 percent from September 2019 to 2021, hampering the nation's earlier progress toward poverty reduction [5]. The standard indicator that measures income inequality on the Gini index ranges from 0 (perfect equality) to 1 (perfect inequality). Indonesia's Gini coefficient in 2021 was 37.9. From 2010 to 2021, the Gini coefficient increased by 1.9% [6]. Inequality in Indonesia has not altered significantly over the past 15 years, fluctuating between 0.3 and 0.4. (moderate). It is complicated for Indonesia to contain income inequality due to its geographical disparities and the diverse socioeconomic environment—7500 islands, high rural population density (more than 43 percent), and more than 300 ethnic groups. Most areas lack access to essential infrastructure and services, such as electricity or decent roads for transportation [5,7]. In addition, inequality is rampant in education, health, and access to quality jobs [8].

Indonesia saw a reduction in poverty by easing the travel activities associated with the COVID-19 pandemic. However, income inequality did not improve along with decreasing poverty rates. In July 2022, the Indonesian Central Statistics Agency reported a decline in domestic poverty rates by 0.17 percentage points compared to the last survey conducted in September 2021. However, on the same day, the Indonesian Central Statistics Agency reported that the Gini index increased by 0.003 to 0.384 [7]. This is a significant cause of concern for a nation that exhibits outstanding economic growth after a severe crisis such as the Asian financial crisis in the late-1990s [5]. The Indonesian government made every effort to reduce poverty [9,10], yet inequality remains significant in the country [11,12]. If policies are not working, the governance issue requires immediate attention since it hampers egalitarian growth.

Income inequality is strongly associated with energy consumption, corruption, and foreign direct investment. The former UN Secretary-General, Ban Ki-Moon, claims that "the golden thread" connecting economic progress, social fairness, and environmental sustainability is access to electricity [13]. Indonesia still faces significant energy poverty issues since many people lack access to electricity. Indonesia is leaving no stone unturned in finding the best solutions to lowering its carbon emissions to meet its target under the

Paris Climate Agreement. However, these solutions demand a considerable amount of private funding. It is estimated that for Indonesia to meet the 23 percent renewable energy target, it requires a projected budget of USD 36.95 billion [14]. Private sector funding and foreign direct investments are pivotal to funding these ambitious renewable energy targets because they are beyond the state's capacity and resources [3]. It is important to note that such investments require good governance to achieve social equity [15].

In Indonesia, uneven infrastructure investment and distribution of development funds between provinces cause widening inequality [16]. The nation's economic and social policies prioritize sectors and segments that benefit high-income earners [17]. Moreover, industrial policies support established entrepreneurs more than small ones [18]. The Indonesian business environment is dominated by small enterprises and informal workers requiring greater support from the government [16]. Policies that favor the rich are corrupted, and corruption creeps in when there is an abuse of entrusted power by public or corporate institutions for private gain. Corruption hinders the implementation and enforcement of the principle's good governance and effective governance structure to serve the nation. Indonesia's corruption perception index (CPI) in 2021 is 38/10 (0 = highly corrupted and 100 = very clean), ranking 96th among 180 countries. The Indonesian CPI is skewed towards zero, which requires assessing its impact on the country's income inequality.

Investment is necessary to reduce income disparity, yet it is still unclear how globalization has affected economic development, living standards, and inequality in the colonized countries [19]. Governments, especially those of developing nations, depend on capital accumulation to drive economic growth [20] and compensate for domestic savings gaps. However, foreign investment primarily does not benefit countries at the microeconomic level. To prevent income inequality, foreign capital should be evenly distributed across regions and sectors in a country. Only then can the economy benefit from an increased national income, average earnings, and employment rate [21]. Uneven access to foreign capital leads to heterogenous growth opportunities across sectors [22], dwindling wage levels, prices, and profits.

The literature on the effect of FDI on income distribution is divided. One stream supports equal income distribution [23–25], and others suggest unequal income distribution [26,27]. In the Indonesian case, empirical evidence on the link between foreign investment and income inequality is somewhat mixed, suggesting a direct or indirect connection. While FDI negatively affected income inequality, Fazaalloh [28] and Kuncoro et al. [29] found the link indirectly via economic growth. This warrants further investigation.

An interesting determinant of income inequality that has caught the attention of scholars is the energy market. There is a strong dynamism between these two [30–32]. The use of renewable energy is accounted for in reducing income inequality [32]. Energy security plays a vital role in economic and social development. Energy security is achieved when an economy can supply a sustainable volume of energy at stable prices while not impacting economic efficiency [33]. Energy is a fundamental requirement for domestic activities, including lighting, cooking, heating, and others [34]. If access to energy is disrupted, households suffer significantly, affecting their social and economic activities. Thus, the effect of energy consumption on income inequality provides valuable insights for policymakers.

This paper aims to offer new insights into reducing income inequality. The rising income inequality is one of the Indonesian government's primary worries. Still, whether efforts to curb corruption, attract more FDI, and improve access to energy consumption solve Indonesia's income inequality remains unsettled. The government intends to devise various strategies to reduce the Gini index [35]. Therefore, understanding the causes of income inequality is essential to formulating effective policies and revising existing ones. This study investigated three core variables to assess their impact on income inequality: governance (corruption perception index), foreign investment (FDI), and energy consumption.

The rest of the paper is organized as follows: The next section provides a literature review. Then, Section 3 presents the methodology, and Section 4 provides the results and discussion. Finally, Section 5 concludes the research.

2. Theoretical Background and Literature Review

The currently available literature provides a wealth of empirical, analytical evidence that explains income distribution and the level of corruption [36–41], energy consumption, pollution, and CO_2 emissions [31,32,42–44], as well as macroeconomic perspectives such as FDI [45–48] and the growth rate [49,50]. We attempt to provide a succinct overview of the body of literature in this section.

2.1. The Conceptual Impacts of Energy Consumption on Income Inequality

Energy is a basic home requirement for lighting, cooking, and heating. The availability of energy significantly impacts the community's economic and social activities [34,51,52]. When analyzing a country's economic progress, energy use has become a critical problem that must be investigated [53,54]. Through four hypotheses, Walheer [55] and Mutumba et al. [56] demonstrate that energy has an influence and causality on economic growth from a broader perspective: (i) according to the growth hypothesis, energy consumption has a direct causal relationship with the process of economic growth; (ii) the conservation hypothesis posits that energy conservation programs aim to reduce energy use, and waste may not have a detrimental influence on economic growth; (iii) the feedback hypothesis explains the connection between energy use and economic growth; and (iv) the neutrality hypothesis states that because energy is a minor component of total economic output, it may not affect economic growth.

Energy and energy security significantly impact long-term economic development, and their impact on wealth inequality is a major policy concern for policymakers. In theory, the effect on income inequality might arise through a multitude of mechanisms. First, energy security can provide a steady energy supply, lowering income disparity. Second, energy security reduces economic inequality by keeping energy prices stable. As energy security improves, domestic energy prices will stabilize. Third, energy security promotes economic growth, decreasing or exacerbating income inequality [31]. As for household reactions to changes in energy costs, according to Schulte and Heindl [57], low-income families showed weaker reactions to price fluctuations than high-income households.

The energy tax has a regressive effect, meaning that low-income households bear a disproportionate burden. Several empirical research projects on the relationship between energy and income changes, such as that of Lee [31], have examined the impact of income distribution using global panel data from 68 nations from 2001 to 2018. The findings suggest that energy security tends to exacerbate income distribution in the early stages of economic development but improves it after a certain degree of development. Evidence also shows that income inequality has a long-term effect. Topcu and Togcu [32] examined the impact of renewable energy usage on income inequality in a panel of industrialized economies from 1990 to 2014. The findings suggest that increased consumption of renewable energy reduces income inequality. According to Li et al. [42], environmental degradation can expand the income difference between skilled and unskilled workers.

2.2. The Conceptual Impacts of Corruption and Income Equality

An economy with a robust anticorruption system, effective governance, and a stable political system will foster economic growth, eliminate income distribution conflicts, and reduce poverty [58]. Corruption can affect income inequality and poverty through various channels, including growth, low-income-people's costs, biased tax revenues, social assistance targets, ownership of public goods, inequality in asset ownership, allocation of low-income-people's assistance such as education and health to programs that benefit corruption, and decision-making regarding public spending [38,59]. Lastly, corruption raises the expense of providing public goods while decreasing the quantity delivered by

the government. This situation advantages the wealthy for two reasons. First, low-income people benefit the most from government-provided public goods; second, high-income persons can dodge taxes by bribing government officials [59].

The impact of corruption on income distribution has varied effects in empirical studies (not always increasing the negative effect on income distribution). The first considers that corruption exacerbates income inequality [38,40,41,60]. On the other hand, the second point contends that corruption reduces inequality and enhances social welfare [36,39,41]. Among the empirical studies concerning the relationship between corruption and income inequality are Tebaldi and Mohan [58] on the quality of the regulatory system, the rule of law, the right to speak up and be heard, and the risk of expropriation, which are all inversely connected to poverty. Moreover, Gupta et al. [38] discovered that the Gini coefficient is affected by the extent of corruption. Income inequality in developing countries decreases with increasing corruption due to the unequal distribution of political power, causing nondominant groups to engage in corruption to access public services to which they are entitled or obtain credit to support their income-generating activities, according to Keneck-Massil et al. [61].

2.3. The Conceptual Impacts of FDI and Income Equality

Developing and transition countries increasingly see FDI as a role in economic development and modernization, income growth, and job creation [62]. According to modernization theory, the origin of investment, both foreign and domestic, is crucial. This capital fuels growth and, in turn, influences the entire economy. Even if FDI initially only stimulates growth in a few leading sectors, growth in leading sectors can generate a more equitable income distribution in the long run [63]. FDI can contribute to long-term income growth through productivity effects and technological spillovers. The added value of FDI productivity spillover can have two effects on regional revenue growth: First, through foreign companies' vertical engagement with domestic companies, which results in closer client and supplier relationships and spillovers. Second, through horizontal relationships, international corporations can produce spillovers to domestic companies in the same industry because the demonstration benefits local companies [64].

Several studies have looked into the impact of FDI inflows on income inequality, with inconsistent results. Bhandari [65] uses the fixed effect to evaluate the correlation between FDI and income inequality in transitional nations in Eastern Europe and Central Asia from 1990 to 2002. FDI did not influence income inequality. Song et al. [66] examine annual data from 1980 to 2016 for a selection of 20 developing countries that receive the majority of remittances. According to the long-run elasticity data, increased FDI inflows and remittances enhance income inequality while diminishing economic growth. According to Li et al. [42], FDI tends to increase income disparity, and the effect of FDI on income inequality in Vietnam varies depending on the degree of education and institutions. According to Ofori et al. [46], FDI is negatively associated with income inequality. The negative relationship suggests that macroeconomic instability can worsen Africa's income disparity. Wu and Hsu [50] used data from 54 nations from 1980 to 2005 to examine the impact of FDI on income disparity and the absorption capacity of relationship-dependent children. The findings suggest that FDI has a greater positive effect on income distribution in countries with low absorption, whereas it has a small effect in nations with higher absorption. Huang et al. [49] discovered that FDI increases inequality in low-income countries, has little effect on middle-income nations, and reduces inequality significantly in high-income countries. This observation implies that FDI can increase income disparity when a country first develops but reduce inequality as development continues.

3. Research Methodology

3.1. Data and Variables Explanation

This study used annual data ranging from 1984 up to 2020 (36 years) as a sample period. A summary of the data and its sources is shown in Table 1 below.

Table 1. Variable description.

Variables	Description	Sources
LNGINI	Gini coefficient index (GINI)	UTIP
LNGDP	GDP per capita (constant 2015 US$)	WDI
LNCOR	Corruption perception index	Transparency International
LNFDI	Foreign direct investment, net inflows (% of GDP)	WDI
LNFD	Financial sector development	WDI
LNCO2	CO_2 emissions (metric tons per capita)	WDI
LNENC	Energy use	WDI

Note: WDI stands for World Development Indicator 2022, UTIP stands for University of Texas Income Inequality Project. The GINI index values range from 0 to 100, where 0 represents perfect equality while 100 represents perfect inequality. The higher the value of the coefficient, the higher the degree of inequality.

3.2. Estimation Procedures

The general functional form of the income distribution model for Indonesia was derived as follows:

$$GINI_t = f(GDP_t, COR_t, FDI_t, FD_t, CO2_t, ENC) \quad (1)$$

where

$GINI_t$ represents income distribution,
GDP_t represents economic growth,
COR_t represents corruption,
FDI_t represents foreign direct investments inflows,
FD_t represents financial sector development,
CO_{2t} represents environmental quality.

The variables in Equation (2) were transformed into log-linear forms (LN). The log version of the variables indicate the short-run and long-run elasticity. According to Shahbaz et al. [67], the log version of the tested variables can produce a consistent and reliable estimation. The log version of the model derived from Equation (1) can be seen as follows:

$$LNGINI_t = \delta_0 + \alpha_1 LNGDP_t + \beta_2 LNCOR_t + \sigma_3 LNFDI_t + \phi_4 LNFD_t + \tau_7 LNCO2_t + \psi_8 LNENC + \mu_t \quad (2)$$

Higher growth in a country will usually lead to higher income inequality within the society unless the government carefully monitors the situation and implements appropriate and effective policies, such as a fiscal policy, to curb the problem. However, GDP is expected to influence income distribution in Indonesia positively. Meanwhile, the impact of FDI on income distribution is expected to be negative. According to Mundell's hypothesis, an increase in FDI inflows will reduce income inequality in middle-income countries due to the higher movement of capital from foreign investors. Technically, Mundell [68] believes that using more foreign capital will increase marginal labor productivity, leading to higher wages, and finally, less inequality will be achieved. In layperson's terms, foreign investors will build up their operations in the local country and usually offer the locals competitive salaries and new jobs. Thus, it will reduce the income disparity in society. Another variable included in the model is FD, another important factor affecting income inequality. Greenwood and Jovanovich [69] have postulated that FD will increase income inequality initially but later lead to its decline once the financial sector matures. Lastly, a United Nations report [70] has indicated that environmental degradation appears to be another side effect of economic inequality. The deterioration of the environment will exacerbate social and economic inequality, mainly among rural people in poverty and disadvantaged groups, because poor people are unlikely to avoid pollution, affecting their health and productivity, which ultimately limits their ability to earn income. The degradation of natural resources has bad implications for rural people. It can potentially increase income inequality due to their inability to earn for living. As for these studies, we expected a

positive sign between LNCO2 and LNGINI. To conclude, θ1 and θ3 were expected to have a negative sign, while the others (θ2, θ4, θ5, and θ6) were expected to be mixed, either positive or negative. The ARDL model based on the unrestricted error correction model (UECM) is stated below:

$$\Delta LNGINI_t = \beta_1 + \theta_0 LNGINI_{t-1} + \theta_1 LNGDP_{t-1} + \theta_2 LNCOR_{t-1} + \theta_3 LNFDI_{t-1} + \theta_4 LNFD_{t-1} + \theta_5 LNCO2_{t-1} + \theta_6 LNENC_{t-1} + \\ + \sum_{i=1}^{a} \beta_i \Delta LNGINI_{t-i} + \sum_{i=0}^{b} \gamma_i \Delta LNGDP_{t-i} + \sum_{i=0}^{c} \delta_i \Delta LNCOR_{t-i} + \sum_{i=0}^{d} \lambda_i \Delta LNFDI_{t-i} + \sum_{i=0}^{e} \vartheta_i \Delta LNFD_{t-i} + \sum_{i=0}^{f} \psi_i \Delta LNCO2_{t-i} + \sum_{i=0}^{g} o_i \Delta LNENC_{t-i} + v_t \quad (3)$$

$$\Delta LNGDP_t = \beta_2 + \theta_0 LNGINI_{t-1} + \theta_1 LNGDP_{t-1} + \theta_2 LNCOR_{t-1} + \theta_3 LNFDI_{t-1} + \theta_4 LNFD_{t-1} + \theta_5 LNCO2_{t-1} + \theta_6 LNENC_{t-1} + \\ + \sum_{i=1}^{a} \beta_i \Delta LNGDP_{t-i} + \sum_{i=0}^{b} \gamma_i \Delta LNGINI_{t-i} + \sum_{i=0}^{c} \delta_i \Delta LNCOR_{t-i} + \sum_{i=0}^{d} \lambda_i \Delta LNFDI_{t-i} + \sum_{i=0}^{e} \vartheta_i \Delta LNFD_{t-i} + \sum_{i=0}^{f} \psi_i \Delta LNCO2_{t-i} + \sum_{i=0}^{g} o_i \Delta LNENC_{t-i} + v_t \quad (4)$$

$$\Delta LNCOR_t = \beta_2 + \theta_0 LNGDP_{t-1} + \theta_1 LNGINI_{t-1} + \theta_2 LNCOR_{t-1} + \theta_3 LNFDI_{t-1} + \theta_4 LNFD_{t-1} + \theta_5 LNCO2_{t-1} + \theta_6 LNENC_{t-1} + \\ + \sum_{i=1}^{a} \beta_i \Delta LNCOR_{t-i} + \sum_{i=0}^{b} \gamma_i \Delta LNGDP_{t-i} + \sum_{i=0}^{c} \delta_i \Delta LNGINI_{t-i} + \sum_{i=0}^{d} \lambda_i \Delta LNFDI_{t-i} + \sum_{i=0}^{e} \vartheta_i \Delta LNFD_{t-i} + \sum_{i=0}^{f} \psi_i \Delta LNCO2_{t-i} + \sum_{i=0}^{g} o_i \Delta LNENC_{t-i} + v_t \quad (5)$$

$$\Delta LNFDI_t = \beta_1 + \theta_0 LNGDP_{t-1} + \theta_1 LNCOR_{t-1} + \theta_2 LNGINI_{t-1} + \theta_3 LNFDI_{t-1} + \theta_4 LNFD_{t-1} + \theta_5 LNCO2_{t-1} + \theta_6 LNENC_{t-1} + \\ + \sum_{i=1}^{a} \beta_i \Delta LNFDI_{t-i} + \sum_{i=0}^{b} \gamma_i \Delta LNGDP_{t-i} + \sum_{i=0}^{c} \delta_i \Delta LNCOR_{t-i} + \sum_{i=0}^{d} \lambda_i \Delta LNGINI_{t-i} + \sum_{i=0}^{e} \vartheta_i \Delta LNFD_{t-i} + \sum_{i=0}^{f} \psi_i \Delta LNCO2_{t-i} + \sum_{i=0}^{g} o_i \Delta LNENC_{t-i} + v_t \quad (6)$$

$$\Delta LNCO2_t = \beta_1 + \theta_0 LNGDP_{t-1} + \theta_1 LNCOR_{t-1} + \theta_2 LNFDI_{t-1} + \theta_3 LNFD_{t-1} + \theta_4 LNGINI_{t-1} + \theta_5 LNCO2_{t-1} + \theta_6 LNENC_{t-1} + \\ + \sum_{i=1}^{a} \beta_i \Delta LNCO2_{t-i} + \sum_{i=0}^{b} \gamma_i \Delta LNGDP_{t-i} + \sum_{i=0}^{c} \delta_i \Delta LNCOR_{t-i} + \sum_{i=0}^{d} \lambda_i \Delta LNFDI_{t-i} + \sum_{i=0}^{e} \vartheta_i \Delta LNFD_{t-i} + \sum_{i=0}^{f} \psi_i \Delta LNGINI_{t-i} + \sum_{i=0}^{g} o_i \Delta LNENC_{t-i} v_t \quad (7)$$

$$\Delta LNENC_t = \beta_1 + \theta_0 LNGDP_{t-1} + \theta_1 LNCOR_{t-1} + \theta_2 LNFDI_{t-1} + \theta_3 LNFD_{t-1} + \theta_4 LNGINI_{t-1} + \theta_5 LNCO2_{t-1} + \theta_6 LNENC_{t-1} + \\ + \sum_{i=1}^{a} \beta_i \Delta LNENC_{t-i} + \sum_{i=0}^{b} \gamma_i \Delta LNGDP_{t-i} + \sum_{i=0}^{c} \delta_i \Delta LNCOR_{t-i} + \sum_{i=0}^{d} \lambda_i \Delta LNFDI_{t-i} + \sum_{i=0}^{e} \vartheta_i \Delta LNFD_{t-i} + \sum_{i=0}^{f} \psi_i \Delta LNGINI_{t-i} + \sum_{i=0}^{g} o_i \Delta LNCO2_{t-i} v_t \quad (8)$$

where Δ is the first difference operator, and ut is the white-noise disturbance term. Residuals for the UECM should be serially uncorrelated, and the model should be stable. This validation can be addressed with a series of diagnostic tests shown in the analysis section. The final version of the model represented in Equations (4)–(7) above can also be viewed as an ARDL of order (a, b, c, d, e, f, g). Based on the main model, the income distribution (LNGINI) level can be influenced and explained by its past values. Hence, it involves other disturbances or shocks. From the estimation of UECM, the long-run elasticity is the coefficient of the one-lagged explanatory variable (multiplied by a negative sign) divided by the coefficient of the one-lagged dependent variable. The coefficients of the first differenced variables capture the short-run effects. The null of no cointegration in the long-run relationship is defined by:

Hypothesis H0 (H0). *θ0 = θ1 = θ2 = θ3 = θ4 = θ5 = θ6 = 0 (there is no long-run relationship), is tested against the alternative of.*

Hypothesis H1 (H1). $\theta 0 \neq \theta 1 \neq \theta 2 \neq \theta 3 \neq \theta 4 \neq \theta 5 \neq \theta 6 \neq 0$ *(there is a long-run relationship exists).*

employing the familiar F-test. Suppose the computed F-statistic is less than the lower bound critical value. In that case, we do not reject the null hypothesis of no cointegration. However, suppose the computed F-statistics is greater than the upper bound critical value of at least the 10% significant level. In that case, we reject the null hypothesis of no cointegration.

4. Empirical Results

The procedures of times series analysis usually begin with testifying the unit root of each variable used in the study. Two types of unit root tests namely Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) were used to detect the stationarity of the data. The result is displayed as shown in Table 2. Based on ADF at level, it is found that all variables are not stationary except for LNGINI for intercept and trend. Based on the first difference, all variables are found to be stationary, mostly at a 1% level, except for LNFD for intercept

and trend. Due to the mixed stationarity of this outcome, we proceed to the PP unit root, considered more powerful than the ADF unit root test. The trend of mix stationarity is again detected for the PP unit root test, both at the level and at intercept and trend. Thus, we concluded that the mixed stationarity model fulfills the bound test requirement, also known as ARDL estimation. This technique captures the short- and long-run elasticities that can provide meaningful input to policymakers.

Table 2. Testing ADF and PP unit root.

Level I (0)	**ADF Unit Root**		**PP Unit Root**	
	Intercept	**Intercept and Trend**	**Intercept**	**Intercept and Trend**
LNGINI	−2.192 (1)	−3.762 (0) **	−3.695 (4) ***	−3.929 (4) **
LNGDP	−0.434 (0)	−2.426 (1)	−0.434 (0)	−1.948 (1)
LNCOR	−1.448 (0)	−1.959 (0)	−1.762 (2)	−2.380 (2)
LNFDI	−2.106 (0)	−2.211 (0)	−2.310 (2)	−2.436 (2)
LNFD	−2.208 (1)	−2.207 (1)	−3.299 (2) **	−3.105 (1)
LNCO2	−1.320 (0)	−2.712 (0)	−1.649 (12)	−2.711 (2)
LNENC	−2.206 (0)	−1.931 (0)	−4.925 (18) ***	−1.769 (8)
First difference I (1)	ADF Unit Root		PP Unit Root	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
LNGINI	−9.321 (0) ***	−9.215 (0) ***	−9.524 (1) ***	−9.408 (1) ***
LNGDP	−4.234 (0) ***	−4.142 (0) **	−4.216 (2) ***	−4.119 (2) **
LNCOR	−4.148 (0) ***	−4.085 (0) **	−4.162 (1) ***	−4.099 (1) **
LNFDI	−5.358 (0) ***	−5.276 (0) ***	−5.359 (1) ***	−5.277 (1) ***
LNFD	−3.379 (0) **	−3.082 (0)	−3.275 (5) **	−2.930 (5)
LNCO2	−5.207 (1) ***	−5.269 (1) ***	−6.834 (9) ***	−7.688 (12) ***
LNENC	−6.222 (0) ***	−6.834 (0) ***	−6.222 (1) ***	−7.439 (12) ***

Note: 1. ** and *** 5% and 1% of significant levels, respectively. 2. The optimal lag length is selected automatically using the Schwarz info criteria (SIC) for the ADF test. The bandwidth was selected using the Newey–West method for PP.

Next, before we proceed to ARDL short-run and long-run forecasting, we have to detect the presence of long-run cointegrating for our proposed model. The main model is listed in the first line, as shown in Table 3, while each independent variable introduced in our main model will be treated as a dependent variable. The F statistic confirmed the long presence of a long-run cointegrating relationship with LNGINI, LNGDP, LNCOR, LNFD, and LNCO2 as a dependent variable. Based on the income distribution model, the F statistic of 3.652 is larger than the 10% level, thus validating the existence of a long-run cointegrating vector in this model at a 10% significance level. The following analysis will solely be based on the model of income distribution, as this research focuses on this theme. In comparison, the long-run cointegration for other models could be considered a recommendation for future studies.

To ensure that we could produce a reliable outcome, we conducted several diagnostic tests such as serial correlation, functional form, normality test, heteroscedasticity, and CUSUM/CUSUMSQ test. The outcomes are displayed in Table 4 and Figure 2. Given that probability value of all the tests is larger than the 10% significant level, it is confirmed that the model is free from all diagnostic problems. The CUSUM and CUSUMSQ test exhibit a blue line within two dotted lines, indicating the model's stability in the short and long term.

Table 3. Detecting the presence of long-run cointegration based on F stat.

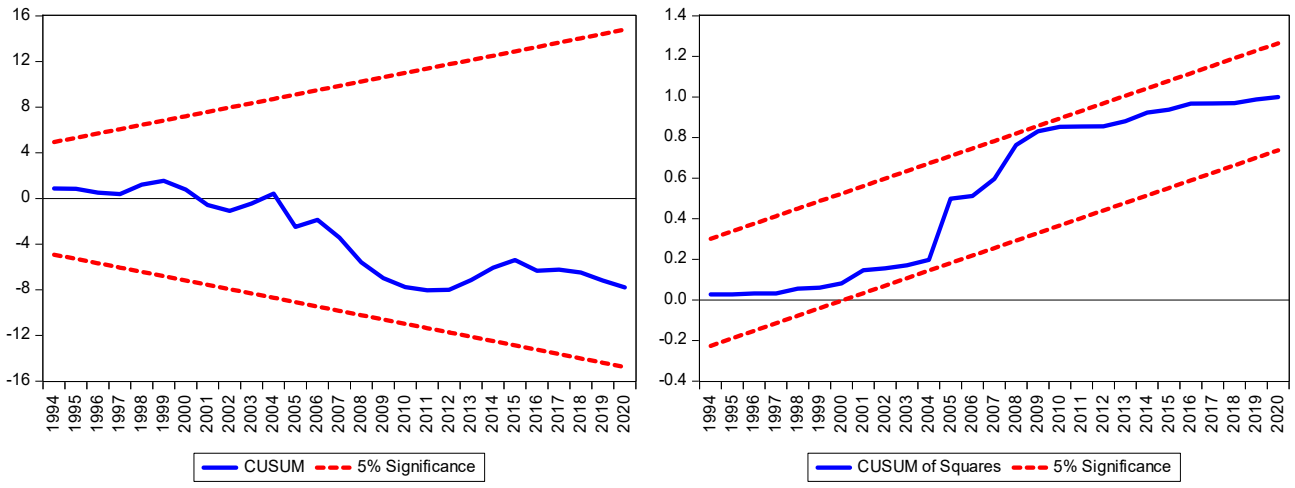
Model	Lag Order	F Statistics
LNGINI = f (LNGDP, LNCOR, LNFDI, LNFD, LNCO2, LNENC)	(1, 0, 0, 0, 0, 0, 1)	3.652 **
LNGDP = f (LNGINI, LNCOR, LNFDI, LNFD, LNCO2, LNENC)	(1, 2, 0, 1, 1, 1, 1)	3.773 **
LNCOR = f (LNGDP, LNGINI, LNFDI, LNFD, LNCO2, LNENC)	(2, 1, 2, 1, 1, 1, 0)	9.770 ***
LNFDI = f (LNGDP, LNCOR, LNGINI, LNFD, LNCO2, LNENC)	(1, 1, 0, 0, 0, 1, 0)	1.485
LNFD = f (LNGDP, LNCOR, LNFDI, LNGINI, LNCO2, LNENC)	(1, 0, 0, 0, 0, 0, 0)	6.321 ***
LNCO2 = f (LNGDP, LNCOR, LNFDI, LNFD, LNGINI, LNENC)	(2, 1, 0, 0, 0, 2, 1)	9.559 ***
LNENC = f (LNGDP, LNCOR, LNFDI, LNFD, LNCO2, LNGINI)	(1, 0, 0, 0, 0, 0, 0)	1.7767
Critical Values for F stat	Lower I (0)	Upper (1)
10%	2.26	3.35
5%	2.62	3.79
1%	3.41	4.68

Note: 1. The critical values are based on Pesaran et al. (2001), case III: unrestricted intercept and no trend. 2. k is a number of variables equivalent to 6. 3. **, and *** represent 5% and 1% significance, respectively. Estimation was based on Schwarz criterion (SC). The maximum lag set is (2, 2).

Table 4. Diagnostic tests.

(A)	(B)	(C)	(D)
Serial Correlation [*p*-Value]	**Functional Form [*p*-Value]**	**Normality [*p*-Value]**	**Heteroscedasticity [*p*-Value]**
1.042 [0.367]	0.205 [0.654]	2.023 [0.363]	1.342 [0.265]

Note: The diagnostic test performed as follows: A. Lagrange multiplier test for residual serial correlation; B. Ramsey's RESET test using the square of the fitted values; C. based on a test of skewness kurtosis of residuals; D. based on the Harvey.



(**a**) CUSUM (**b**) CUSUMSQ

Figure 2. CUSUM and CUSUMSQ.

After confirming the model's reliability, we were ready to proceed with short- and long-run elasticities for our empirical model. Based on the short-run elasticities, we found that LNGDP, LNCOR, and LNFDI have a negative relationship with LNGINI. Statistically, a 1% increase in these variables will reduce the GINI index by 0.42%, 0.13%, and 0.07%, respectively. A lower GINI index indicates a better income distribution. With better economic growth in Indonesia and higher FDI inflows in the country, the country experiences reduction in income inequalities in the short run, indicating good conditions for its people. However, the findings also discovered that corruption (LNCOR) helped reduce the country's income distribution.

Meanwhile, higher environmental degradation captured by LNCO2 causes higher disparity among Indonesians. Meanwhile, the other two variables, such as LNENY and LNMS, are insignificant at any level and thus not fit to explain the model. The negative sign of the ECT value proved that the set of variables used in this study would be converged in the long run. Given its value between −1 and −2, the convergence rapid will take less than a year. This convergence is compulsory as it indicates that all the potential drivers for income distribution have a connection with each other.

Next, we will discuss the long-run elasticities outcome as these results provide more significant inputs to the policymakers. The long-run elasticities outcome is the core findings in this research and needs more discussion.

First, it is found that there is a negative and significant relationship between economic growth and income distribution. Statistically, a 1% increase in LNGDP reduces LNGINI by 0.342%. According to economics theory, an increase in economic growth causes a decline in income inequality, while higher economic growth reflects an increase in value added in economic sectors, then lowers income inequality. Furthermore, greater economic growth creates increasing activity in the economic sectors, subsequently absorbing labor. This, therefore, results in equal income. The negative relationship between the variables is in line with the previous findings, such as Ridzuan et al. [71] for Indonesia, Jun et al. [72] for China, and Bouincha and Karim [73] for 189 selected countries using panel estimation.

The highlight of this research is revealed through the statistical relationship between corruption and income distribution. There is a significant and negative relationship between LNCOR and LNGINI. A higher corruption level in the country improves the income inequality problem by 0.11%. This result is in line with the findings of Li et al. [42], who also found a negative relationship between corruption and income distribution. The practice of corruption may enrich officials and private individuals who obtain a larger share of public benefits or bear a lower share of public costs. As a large group of people comprising all levels took advantage of the weak corruption regulation, they earned more income, thus reducing the income distribution. The high corruption level, however, may distort the government's role in resource allocation.

Next, the analysis also exhibits a negative and significant relationship between LNFDI and LNGINI. Statistically, a 1% increase in foreign direct investment will reduce the income distribution by 0.064%. This result supported the Mundell hypothesis, as described in the estimation procedure in Section 3.2. Besides Mundell's point of view, Dollar and Kraay [74] support the view that economic growth raises the income of the poor correspondingly more than that of the rich, making FDI useful to cut poverty. If FDI created the demand for unskilled workers or offered economic chances for those deemed unemployable, then host FDI nations would feel an enhancement in income inequality [75].

LNCO2 exhibits a positive and significant relationship with LNGINI. Statistically, a 1 percent increase in carbon emissions causes an increase of 0.33% in income inequality in Indonesia. Angelsen et al. [76] argue that poor people are more unprotected from air pollution and have fewer ways to defend themselves. Pollution affects the health of the poor. Health problems create difficulties for poor people to work and reduce the probability of earning income, ultimately widening income inequality. According to a survey of households in developing nations, earnings from natural resources accounted for 28% of their overall household income, of which 77% came from natural forests. This earning rate was higher among the poorest households, signaling the importance of environmental protection for the poor [76]. Based on Indonesia's findings, the repercussions of pollution are heavier on people in poverty and the disadvantaged. These people do not have enough earnings to implement initiatives to avoid pollution or seek assistance when their health and productivity are affected [77]. Environmental degradation is riskier and gave bad effects to the poor and disadvantaged people who depend on natural resources for earnings more than others. Again, similar to the short-run elasticities analysis, both LNENC and LNFD are insignificant at any level, thus failing to explain the model (Table 5).

Table 5. Short-run and long-run elasticities.

Short-Run Elasticities		Long-Run Elasticities	
Variables	**Coefficient**	**Variables**	**Coefficient**
D(LNGDP)	−0.422 **	LNGDP	−0.342 **
D(LNCOR)	−0.130 **	LNCOR	−0.106 ***
D(LNFDI)	−0.078 ***	LNFDI	−0.064 ***
D(LNENC)	−0.417	LNENC	−0.339
D(LNFD)	0.093	LN	0.075
D(LNCO2)	0.435 *	LNCO2	0.594 ***
CointEq(−1)	−1.230 ***	C	3.669

Note: 1. ***, **, and * are 1%, 5%, and 10% of significant levels, respectively. 2. D refers to the difference.

5. Summary and Conclusions

This research aims to examine the dynamics of the interaction between GDP, corruption, FDI, FD, and CO_2 on income distribution in Indonesia from 1984 to 2020. The autoregressive distributed lag (ARDL) method was used to examine the dynamics of the short- and long-term effects of GDP, corruption, FDI, FD, and CO_2 variables on income distribution. The study's findings revealed that the variables of GDP, corruption, FDI, and CO_2 each had short- and long-term effects during the study period. GDP, corruption, and foreign direct investment all have a detrimental impact on income distribution, whereas CO_2 has a beneficial impact. In Indonesia, FD does not influence income distribution.

As for policy recommendations, higher economic growth in Indonesia has led to lower income distribution, thus improving people's wellbeing through fair income distribution. To maintain this condition, the government should be focused on boosting the development of labor-intensive sectors, particularly the agricultural and manufacturing sectors. Moreover, the policymakers can suggest that the government focuses development on the economic growth center outside Java Island. This will create more job opportunities and thus reduce income inequality.

Better income distribution is also achieved through foreign direct investment. This indicates the success of various strategies implemented by the Indonesian government. Among the policies that need to be highlighted is the tax reform, with corporate income tax expected to be reduced from 25% to 20% by 2023. This will attract more foreign investors to invest in the country. Besides tax reform, the government can also allocate more funds to improving the infrastructure, ensuring more high-skill workers through educational spending, and enhancing government procedures from manual to digital platforms.

Corruption has a negative effect on income equality, which means that higher corruption can lower the income distribution problem. Despite its positive reaction in improving the welfare of the people, corruption should not be allowed to be spread among society as it will have more negative implications for the economy. This is consistent with the views of Policardo and Cerrera [39], Berggren and Bjrnsko [36], and Saha et al. [41], who all believe that corruption can boost welfare temporarily and bring negative consequences in the long run. This indication provides an alarming sign to the government to ensure that the country must take drastic action to combat the problem of corruption through the full enforcement of the Indonesia Integrity Initiative (Integritas). The Integritas program addresses corruption by promoting civic engagement and integrity in business and government sectors.

Lastly, high-CO_2-emitting development will worsen income disparity. Most CO_2 emissions are caused by waste from the manufacturing process and the use of unfriendly fuels. This will cause environmental pollution and thus affect the health of the local people. More income is needed to gain health, and this will lead to higher income disparity among them. For instance, the policymakers in the government must take the initiative to promote the use of cleaner or renewable energy, especially in CO_2-producing industries. Tax exemption policies might attract industries to convert dirty energies such as coal and fuel to cleaner energy such as solar and hydropower, thus reducing emissions.

For future recommendations, human capital could be considered as one of the indicators for the model of income distribution for Indonesia. Furthermore, the researcher can introduce the Granger causality test to define the causality between the variables and thus provide more information to help generate better policy recommendations.

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