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Nexus between Green Finance, Renewable Energy, and Carbon Emission: Empirical Evidence from Indonesia

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Previous studies have investigated the influence of financial development on carbon emissions. However, there has been limited research conducted on the effects of green financing, specifically on carbon reduction. In order to address the aforementioned issue, the current study proposes the development of a green financing development index that incorporates four key factors: green credit, green investment, green insurance, and green securities. Utilising data spanning from 2000 to 2020, this study employs a vector error correction model (VECM) to investigate the interrelationships between the pace of green financing advancement, non-fossil energy utilisation, and carbon intensity. The findings indicate that the green finance sector in Indonesia experienced rapid growth. Additionally, the development index for green financing and the adoption of non-fossil energy sources were found to be associated with a decrease in carbon intensity. Similarly, an increase in the severity of carbon emissions has impeded the growth of non-fossil fuel energy consumption and has also hindered the funding of environmentally friendly initiatives, ultimately impeding the advancement of green finance. Moreover, the integration of green finance and carbon intensity played a pivotal role in shaping the adoption of non-fossil energy sources in Indonesia, yielding significant outcomes driven by policy measures. As a result, the outcomes of green finance initiatives have consistently proven to be inadequate and unsuccessful. The paper proposes strategies to bolster the implementation of green finance policies, promote the adoption of non-fossil energy sources, and establish a carbon trading platform.

Keywords: Carbon severity, non-fossil energy usage, index of green finance development, Emission depletion

INTRODUCTION

Despite the implementation of Indonesia's "open-door" strategy in 1978, the nation has achieved significant advancements in economic growth, manufacturing, and socioeconomic development. However, the utilisation of resources and the degradation of the environment have become significantly more severe during the course of this process. According to data from the Global Carbon Atlas (Global Carbon Project, n.d.), the emission of carbon dioxide (CO_2) in Indonesia experienced a significant increase from 1,455 million metric tonnes (Mt) in 1978 to 9,839 MT in 2017. Consequently, Indonesia has surpassed the United States and now ranks among the largest contributors to CO_2 emissions worldwide since 2006. While Indonesia has experienced a decrease in its carbon intensity, as indicated by the reduction in carbon emissions per unit of GDP over time, it remains considerably higher compared to several other economies. As an example, the carbon intensity of Indonesia in the year 2010 was recorded at 1.79 kg/USD, a value that was approximately 11 times higher than that of France, according to the World Bank (2019). The Indonesian government made a commitment at the 2009 Copenhagen climate conference to reduce carbon emissions, which have significant effects on global climate change and human social activities. Indonesia set a goal to cut CO_2 emissions per unit of GDP by 40% by 2020 compared to levels seen in 2005.

According to the Indonesia-US Collaborative Declaration on Climatic Changes, it is projected that Indonesia will experience an increase in carbon dioxide emissions around the year 2030. Additionally, the nation aims to enhance the proportion of non-fossil fuel sources used for energy production to reach 20 percent by 2030.

Consequently, green finance offers a distinct trajectory for the future of Indonesia. In general, green finance pertains to the provision of investment, funding, operational finances, and associated financial activities for environmentally sustainable initiatives, with a primary emphasis on the preservation of the natural environment[1]. On June 4, 2003, prominent international banks signed the widely recognised "Equator Principles" in London (Scholtens & Dam, 2007). These collaborative agreements aim to address environmental and social challenges that are related to financial matters.

Since the implementation of green finance regulations by the Indonesian administration in 2015, there has been a continuous advancement in Indonesia's green financial sector. Table 1 presents the various strategies and their corresponding ramifications. According to Guild (2020), the table displays green bonds as a significant source of financing for green investments. These bonds, which adhere to global regulations for green financing, accounted for 18 percent of the global market in 2018. Notably, Indonesia emerged as the second-largest issuer of green bonds worldwide, following the United States.

[1] The Bank of Indonesia, in collaboration with seven governments and authorities, published principles in the Handbook on Establishing a Green Financial Structure in 2016

In 2017, the total value of green credit generated by Indonesia's 21 prominent financial institutions amounted to 8.29 trillion rupiahs.

The total trading volume in the primary and subsidiary spot markets within the domestic carbon trading pilot programme reached 282 Mt by the conclusion of 2018, with a total trading turnover of 6.2 billion rupiahs.

Based on a recent report by the Climate Bonds Initiative (CBI) in 2019, Indonesia has become a notable contributor to the worldwide green finance sector. Significant advancements have been observed in Indonesia's green financial sector subsequent to the enactment of green finance regulations in 2015. Indonesia has emerged as a significant participant in the green bond market, attaining the second highest position worldwide in terms of the volume of bonds issued, with the United States being the sole country ahead (Guild, 2020). In 2018, the issuance of green bonds from Indonesia made a significant contribution to the global market, accounting for 18 percent of the total circulation.

Furthermore, significant progress has been achieved in Indonesia's green credit initiatives. According to the results of a study by the Indonesian Financial Services Authority (OJK) in 2018, the top 21 financial institutions in Indonesia generated 8.29 trillion rupiahs worth of green credit overall in 2017. The aforementioned significant figure serves as a prime illustration of the unwavering commitment exhibited by these financial institutions towards endorsing environmentally conscious initiatives and fostering the advancement of sustainable development.

Additionally, it is noteworthy to mention Indonesia's endeavours in the realm of carbon trading. According to recent data provided by the Indonesian Ministry of Environment and Forestry (2022), the domestic carbon trading pilot programme has experienced notable expansion. By the end of 2018, the aggregate trading volume in both the primary and secondary spot markets amounted to 282 Mt, suggesting a growing interest and active participation in carbon trading endeavours within the nation. The outcome of this led to a cumulative trading turnover of 6.2 billion rupiahs, highlighting the potential for a thriving carbon market in Indonesia.

The recent advancements observed in Indonesia's green financial sector, which include the implementation of green bonds, green credit, and carbon trading, demonstrate the nation's unwavering dedication to sustainable finance and its capacity to emerge as a prominent figure in the international green finance arena (CBI, 2019; OJK, 2018; Indonesian Ministry of Environment and Forestry, 2022) (Guild, 2020).

Table 1. Green financial strategies and implementations of Indonesia from 2015

Years	Strategies	Ramifications
2015	Comprehensive Organizational Development Strategy to Encourage Ecological Prosperity	An overall concept for constructing a green financial structure has been established for the first time in Indonesia.
2016	The 13th Five-Year Plan's Overview Recommendations on Establishing a Green Financial Sector	It is planned to "build a green financial framework, green credit and bonds, and a green development fund." A strategy to promote green finance in Indonesia has been outlined.
2017	Statement on the Communist Party of Indonesia's 19th National Congress	It is planned to struct a market-oriented green, technologically network, green financing, vitalize energy preservation and eco-friendly safety, clean manufacture and non-fossil energy businesses.
2018	Sustainable Finance Roadmap	roadmap aimed to integrate ecological, social, and governance (ESG) considerations into the pecuniary sector. It emphasized the importance of sustainable financing, including green bonds and green banking practices, to support the country's transition to a low-carbon and environmentally sustainable economy
2019	organizational development strategy	strategy aimed to promote sustainable and environmentally friendly economic growth
2020	Indonesia Green Finance Initiative	aimed to mobilize private sector investments towards environmentally friendly projects

Source: The writers gathered and arranged the information

This study primarily centres on the period spanning from 2000 to 2020, with the objective of constructing a green financial development index. To achieve this, a vector error correction model is employed to empirically investigate the relationship between green financing, non-fossil energy consumption, and CO2 emissions in the context of Indonesia. The study contributes to the existing body of literature in three distinct ways. Prior studies have primarily concentrated on financial development rather than green finance, with a limited number of investigations exploring the relationship between green financing and CO2 emissions. Despite previous significant growth in green finance and Indonesia's current status as the world's leading emitter of carbon, this study aims to examine the relationship between green finance and carbon intensity.

Additionally, the research will consider nonfossil energy usage as a third crucial factor. Secondly, The study intends to establish a green financial development index based on government records. It is believed to be one of the pioneering endeavours in this field, according to the researchers' knowledge. The index comprises four financial factors, namely green credit, green securities, green insurance, and green investment. The indicators presented in the paper titled "Guidelines on Constructing a Green Financial Network" by the Bank of Indonesia in 2016 are considered authoritative and serve as a reflection of the green finance structure. Thirdly, the Vector Error Correction Model (VECM) offers the advantage of identifying causal relationships among variables, which aligns with another key objective of the present study, in addition to enabling the examination of long-term equilibrium associations.

Alternative methodologies employed in comparative research, which have focused on time-series statistics and examined long-term equilibrium relationships, have not established comparable causality. The primary objectives of this proposed paper are to provide novel evidence regarding the role of green finance in reducing CO2 emissions, with the aim of supporting and guiding Indonesia's environmental management efforts. Likewise, this paper aims to put forth additional recommendations to facilitate the country's transition towards a green economy.

RELATED RESEARCH

Numerous scholars have conducted investigations on the correlation between financial development and carbon intensity (Ameyaw, Yao, Oppong, & Agyeman, 2019; Haifeng, Yang, & Huang, 2017; La Rovere, Grottera, & Wills, 2018; Zhou & Li, 2019). Despite the utilisation of various study techniques, empirical investigations have been conducted to examine information from multiple countries, including Pakistan (Abbasi & Riaz, 2016), Kuwait (Salahuddin, Alam, Ozturk, & Sohag, 2018), Malaysia (Shahbaz, Solarin, Mahmood, & Arouri, 2013), economies with low middle income (Khan, Yaseen, & Ali, 2018), regions with upper middle income (Khan, Yaseen, & Ali, 2017), and states with higher income (Khan, Yaseen, & Ali, 2019). The economies of South Asia, as discussed by Nasreen, Anwar, and Ozturk (2017), encompass the countries within this region. Additionally, the economies of the Asia Pacific Economic Cooperation (APEC) states, as examined by Zaidi, Zafar, Shahbaz, and Hou (2019), are also included. Also, this encompasses the territory of China. The nations within the European Union have indeed confirmed, as stated by He, Tang, and Wang (2016) and Haifeng, Yang, and Huang (2017), that there is a negative correlation between carbon intensity and financial variables.

However, it is important to note that this correlation varies across different nations. Yet a limited number of research findings have yielded contrasting results. Acheampong (2019) demonstrated a significant positive relationship between financial development and CO2 emissions in a study encompassing 46 sub-Saharan African nations from 2000 to 2015. Acheampong employed the generalised method of moments (GMM) methodology in their study to accurately investigate associations by effectively addressing the issue of endogeneity (Shao, Schaffartzik, Mayer, & Krausmann, 2017). In line with the aforementioned findings, a research study conducted in Turkey revealed that the advancement of financial systems played a substantial role in the generation of carbon dioxide emissions, ranking it second only to economic growth and urbanisation (Pata, 2018). Similar findings were observed in the case of 24 MENA (Middle East and North Africa) countries, wherein financial indicators (specifically, the ratio of domestic funding to the private sector as a percentage of the actual gross domestic product) exhibited no significant association with carbon emissions reduction (Charfeddine & Kahia, 2019).

Moreover, it is imperative to establish specific essential prerequisites in order to establish a significant correlation between financial development and carbon intensity. The reduction of emissions in medium-sized countries, such as Pakistan, is influenced by phases of significant financial sector expansion and high levels of liberalisation. However, it is important to note that financial factors have a relatively lower impact on carbon reduction compared to production measures like per capita income. This suggests that strategies aimed at promoting the financial development of such countries are crucial (Abbasi & Riaz, 2016). The impact of carbon dioxide emissions varies depending on the specific financial measures used, as the definition of financial development can vary across different contexts

According to an econometric analysis conducted on Indonesia's regional panel data, the impact of financial development and the volume of stock trading on carbon reduction is of significant importance. The quantification of carbon dioxide (CO2) emissions reduction can be assessed through two distinct approaches: the magnitude of financing development and the marketplace cost of publicly traded corporations (Guo, Hu, & Yu, 2019). Consistent results were derived from other assessments investigating the impact of financial development on carbon dioxide emissions. The process of financial-scale development has been widely recognised as a significant contributor to the increase in emissions. Conversely, the concepts of financial effectiveness and financialization have been found to have a mitigating effect on the emissions associated with the production and exchange of goods and services (Huang & Zhao, 2018). Previous studies have also demonstrated a correlation between carbon dioxide emissions and financial factors. The impact of financial development on CO2 emissions is relatively insignificant when compared to the utilisation of renewable energy sources. Charfeddine and Kahia (2019) conducted a study in the MENA area and discovered that financial development does not appear to have a discernible effect.

However, they did find that it can effectively mitigate CO2 emissions. Furthermore, a study conducted by Charfeddine and Kahia (2019) revealed a negative correlation between financial indicators and the adoption of sustainable energy. This finding implies that the expansion of financial activities in the MENA region may potentially lead to a reduction in the implementation of sustainable energy practises. The evidence suggests that it is imperative for the MENA nations to enhance the efficiency of their financial resource allocation.

Moreover, substantial evidence exists supporting the pivotal role of financial development in mitigating the magnitude of energy consumption and carbon emissions. For instance, prior research has established a positive relationship between financial development and carbon intensity in Indonesian provinces. The amount of CO2 emissions per unit of GDP serves as a proxy for this relationship. However, it has also been found that this effect is mitigated in neighbouring towns, resulting in a decrease in the overall severity of carbon emissions (Liu & Song, 2020). According to Fang, Gao, and Sun (2020), there exists a positive relationship between financing size in Indonesia and carbon severity, both in the short-term and long-term. This connection implies that larger financing sizes are associated with increased carbon emissions, which contradicts the anticipated positive outcome. The researchers argue that the promotion of financial development within the nation should be pursued as a means to identify strategies for reducing carbon emissions. The utilisation of multiple interpretations of financial indicators, along with the adoption of various data formats and methodologies, may contribute to the conflicting outcomes observed in previous research. Hence, in this regard, Liu and Song (2020) employed the ratio of financial institution loans to GDP as a measure of financial development.

In contrast, Fang, Gao, and Sun (2020) utilised the ratio of bank payments to gross domestic product (GDP). Similarly, Liu and Song (2020) utilised a spatial econometrics technique to construct panel data, whereas Fang, Gao, and Sun (2020) employed the autoregressive distributed lag method-error correction model (ARDL-ECM) using time series data. Three gaps in the existing body of research can be identified based on the aforementioned evaluation.

One of these factors is pertinent to the subject matter of the study. The examination of the relationship between green funding and carbon severity has received limited attention in prior scholarly investigations. It is imperative to comprehend the correlation between green finance and carbon intensity. The field of green finance has experienced substantial growth in recent years, with Indonesia emerging as the leading contributor to global carbon emissions. The incorporation of alternative energy sources, specifically those that are not derived from fossil fuels, represents an additional pivotal factor that warrants careful consideration. The second gap pertains to the process of index creation. Previous research in this particular domain has predominantly focused on investigating the impact of financial development on environmental stress while paying limited attention to the concept of "green growth."

In light of the growing societal inclination towards sustainable development, there is an urgent requirement for further research. In accordance with legal documentation, we have established a green financial development index, representing a pioneering endeavour within this domain. The employed strategy is associated with the third identified gap in the existing research literature. Researchers have employed the autoregressive distributed lag (ARDL) framework to ascertain enduring correlations between variables, despite its limitations in capturing causal relationships among factors (Abbasi & Riaz, 2016; Fang, Gao, & Sun, 2020; Pata, 2018; Salahuddin, Alam, Ozturk, & Sohag, 2018). The present study addresses this matter by investigating the enduring employment phenomenon through the utilisation of the Vector Error Correction Model (VECM) and Granger causality analysis.

PLAN OF THE STUDY

According to prior studies, there is evidence suggesting that the expansion of financial resources plays a role in promoting the development of industrial frameworks. According to the works of Ameyaw, Yao, Oppong, and Agyeman (2019) and Zhou and Li (2019), there is also a direct correlation between carbon dioxide (CO2) emissions and changes in a region's industrial system. In addition, prior research has already confirmed that the utilisation of non-fossil energy sources leads to a substantial decrease in carbon intensity and emissions of carbon dioxide (Chen et al., 2018). This study aims to examine the correlations among three variables, namely, short-run, long-run, and casual, through the utilisation of the Vector Error Correction Model (VECM) methodology.

Modelling stipulation

Numerous frameworks examine the enduring and sustainable relationships between various factors. Nevertheless, it is worth noting that in the face of exogenous shocks, there is a tendency for factors to deviate from their long-term equilibrium values within a shorter time frame (Shao, Wang, Zhou, & Balogh, 2019). The Vector Error Correction Model (VECM) not only estimates the long-term equilibrium relationships between variables, but it also uses a correction mechanism to align short-term deviations with the long-term equilibrium position. This is a dynamic process. Moreover, it is assumed that these factors are endogenous in order to mitigate potential endogeneity concerns. The authentication and installation of the VECM framework require the execution of multiple processes, which encompass evaluation as a crucial component. Firstly, it is necessary to conduct a unit root test in order to ascertain the dependability of a variable. The Dickey-Fuller (DF), augmented Dickey-Fuller (ADF), and Phillips-Perron (PP) tests are frequently employed as unit root tests.

Consequently, the study utilises a unit root test with a time trend to examine the time patterns of the green financial development index, carbon severity, and the percentage of nonfossil energy utilisation. Furthermore, the selection of the optimal lag order has been based on a discriminatory criterion, and the assessment of the number of cointegrations has been conducted through cointegration testing. Cointegration occurs when a set of two or more nonstationary time series combine to form a stationary time series. The Johansen maximum likelihood approach and the Engle-Granger dual-step technique are widely used methodologies for conducting cointegration tests (Shao, Wang, Zhou, & Balogh, 2019). In previous studies, the co-integration relationship between variables was examined using a linear model.

In the latter case, the determination of the number of cointegration vectors is exact, and the testing of cointegration interaction is also conducted. Consequently, the aforementioned study utilises the Johansen maximum likelihood methodology. Further, in light of the findings from the aforementioned experiments, virtual environment and cognition (VEC) simulations were also constructed. In order to investigate the relationships between green financing (GF), carbon intensity (CI), and the proportion of nonfossil energy usage (NFE) in existing research, a VEC model has been constructed to analyse the logarithm of GF as well as the logarithm of NFE.

$$DY_t = \alpha_0 + \sum_{i=1}^{M} \alpha_i \, DY_{t-i} + \sum_{i=1}^{M} \beta_j \, DY_{t-j} + \theta VECM_{t-1} + \varepsilon_i \quad (1)$$

The variable M represents the lag order, ε denotes the error term, and 〖DY〗_t represents the first difference of Y_t.

The error correction term, denoted as 〖VECM〗_(t-1), represents the long-term equilibrium relationship between factors. The adjusting coefficient θ quantifies the speed and direction of the equilibrium adjustment between factors when it deviates from the long-term equilibrium position. The coefficients of the difference term for each independent factor reflect the impact of the short-term fluctuations of every variable on the short-run variations in the outcome factor.

The measurement of the effect of a single standard deviation ("impulse") from a disturbance term originating from an indigenous factor on both the current and anticipated outcomes of all endogenous factors is conducted through the utilisation of an impulse response function (IRF). Furthermore, the utilisation of variance decomposition (VD) has been employed to evaluate the contribution of each effect to the variation observed in endogenous factors. This approach allows for the determination of the relative significance of each impact on the endogenous factors within the analytical framework used to analyse the influence of structural impacts on said endogenous factors.

Moreover, the Vector Error Correction Model (VECM) technique offers the following advantages: 1) The utilisation of the Vector Error Correction Model (VECM) enables the assessment of the presence of a sustainable, long-term relationship between two variables through the application of unit root tests and cointegration analysis. While alternative methodologies like ARDL share a similar objective, the methodologies employed in VECM, such as ADF and PP testing for unit root analysis and cointegration verification, seem to be more comprehensive in nature. These approaches have already garnered support from various scholarly articles (Fang, Gao, & Sun, 2020; Salahuddin, Alam, Ozturk, & Sohag, 2018). Furthermore, the inclusion of a time trend in the unit root test enhances the robustness of the findings. 2) While the Vector Error Correction Model (VECM) can be employed for conducting causal analysis, methodologies such as Autoregressive Distributed Lag (ARDL), Fully Modified Least Squares, and Dynamical Ordinary Least Squares (DOLS) are not suitable for determining the causality of factors (Jin-pei et al., 2019; Rahman, Khattak, Ahmad, & Khan, 2020; Ulucak & Khan, 2020).

One of the main objectives of this study is to analyse the causal relationships among the three factors. Therefore, we believe that the Vector Error Correction Model (VECM) is a more suitable methodology. 3) The utilisation of factors that exhibit the potential for either being stationary at order zero (I(0)) or at order one (I(1)) is a notable advantage of the autoregressive distributed lag (ARDL) approach. This feature allows for a relaxation of the statistical assumption that an entire data series must be stationary at certain levels. This observation has been highlighted by Stoian and Iorgulescu (2020) as one of the key benefits of employing the ARDL methodology. 4) Upon employing the Vector Error Correction Model (VECM), it is observed that nearly all variables under scrutiny exhibit integrated order one (I(1)). 5) Consequently, the aforementioned advantage appears inconsequential in relation to the subject matter under investigation. Based on the findings of the present study (Liddle, 2012), it has been observed that the use of DOLS may result in a reduction of degrees of freedom (df) in cases where there are numerous explanatory factors and limited timeframe annotations. 6) The inclusion of the Vector Error Correction Model (VECM) in this study is justified due to its established reputation and reliability as a tool for examining causal relationships between green financing, non-fossil energy consumption, and carbon intensity.

Collection and evaluation of variables

Using time series data from Indonesia covering the period of 2000 to 2020, this study examines the interrelationships between green financing, carbon intensity, and the utilisation of nonfossil energy sources. This section provides a comprehensive description of the three factors, along with their respective approximations.

Calculation of the development index for green financing

Choosing a set of favourable financial measures

According to the Instructions on Establishing a Green Financing Sector published in 2016, the green financial structure comprises four key components: green credit, green sanctuaries, green assurance, and green investment. The classification of the intended layer in this system is based on Liu et al.'s (2019) framework for green finance development. Accordingly, the criteria layers encompass green credit, green sanctuaries, green insurance, and green investment. Subsequently, each layer of criteria is followed by a corresponding layer of indications. The establishment of the four components of green financing is as follows:

- **Green credit**

The term "green credit" primarily refers to the sector of green deposit and lending, encompassing venture and mortgage lending activities. Based on the findings of He et al., (2022) and Zhang, Xiao, and Gao (2018), the authors examined the green credit balance statistics obtained from the Document on Social Obligation of Indonesia's Finance Sector. The study reveals that the state's efforts to establish consistent empirical benchmarks and enhance the capacity of green finance statistics were only initiated in 2014, despite the fact that Indonesian banks had already started providing documentation on social responsibility as early as 2006. Consequently, Indonesia's production of green credit statistics has encountered various issues, such as inconsistencies in disclosure practices, a restricted timeframe for disclosure, and conflicting statistical criteria. Consequently, the study proposes utilising the proportion of environmentally friendly loans issued by publicly traded companies as a metric to represent the green credit factor. The aforementioned ratio has been derived by dividing the aggregate green credit generated by publicly traded enterprises with the overall credit generated by said enterprises.

The utilisation of such an index would yield several advantages. The provided sample is initially characterised by its broad inclusivity, encompassing a wide range of subjects, and it also covers an extensive time frame. By the conclusion of the year 2020, the number of registered businesses in Indonesia had experienced a substantial rise, reaching a total of 3,549 entities. This represents a notable increase compared to the reported figure of 1,086 firms in the year 2000. The aforementioned enterprises were widely distributed across various sectors and geographic regions within Indonesia. Furthermore, the provided information appears to be of high quality. It is worth noting that, in accordance with the regulations of the disclosed business system, reputable accounting institutions have thoroughly assessed the data pertaining to the volume and purposes of bank loans offered by registered enterprises in their financial statements. The aforementioned factors contributed to the determination that the utilisation of this index for the research objective appeared suitable.

- **Green securities**

He et al., (2022) computed the green security index by determining the ratio between the market value of ecological security firms and the total market value of registered corporations. However, there are three flaws that can be identified in this index. The market valuation of corporations listed in Indonesia exhibits significant variability. Furthermore, it is evident that this index lacks a discernible correlation with green finance, which primarily aims to secure financial resources for the establishment of environmentally sustainable businesses. Furthermore, it can be argued that the index fails to provide an accurate representation of the current condition of the Indonesian securities market.

Therefore, recent scholarly investigations reject the measurement methodology utilised by He et al., (2022), opting instead to consider the ratio of energy-saving and environmentally protective firms or initiatives within the sanctuaries industry, along with the total financial value in the securities industry. The overall value of financing in the securities market, as calculated within the index, encompasses various activities such as primary public offerings, further issuances, and the issuance of common and convertible bonds on the stock exchange.

- **Green insurance**

Environmental contamination liability insurance appears to be a recently introduced concept in the Indonesian context. As per the findings of Jianguo and Fanli (2019), the present study utilises agriculture insurance as a means to represent green insurance. Agricultural insurance has emerged as a form of insurance that is closely intertwined with the preservation of the natural environment. Additionally, it exhibits a plethora of remarkable social attributes, thus rendering the aforementioned strategy widely regarded as suitable (Jianguo & Fanli, 2019).

- **Green investment**

The term "green investments" refers to financial allocations made towards initiatives aimed at conserving energy and protecting the environment. The primary focus of this study has been on the public sector. To assess green investment, the ratio of Indonesia's fiscal expenditure on environmental preservation and energy conservation to its total fiscal expenditure has been utilised. The selection of this index was influenced by two factors. At first glance, there appears to be a lack of credible data regarding the financial investments made by corporations in the domains of environmental conservation and energy efficiency. Furthermore, the aforementioned discussions on green credit finance and green securities primarily focus on the corporate sector, thereby highlighting the impact of private enterprise investment on the field of green finance. The exclusion of corporate area equity investment from the green investment index is necessary in order to accurately assess the influence of government expenditure on the green finance index.

Synthesis techniques and relevant data for green financial variables

The selection of weights plays a critical role in the calculation of a compound index. The main methodologies employed for weight determination include the entropy approach, primary module evaluation, systematic hierarchy method, and expert consultation approach. The predominant method employed in constructing the index of green finance is the amalgamation technique, specifically the weighted synthesis approach. This approach heavily depends on the expert's subjective evaluation to determine the significance of the standard level. However, it is generally preferred to utilise objective weighing techniques as opposed to subjective ones. In this study, the objective entropy weighting technique was chosen over the subjectively weighted approach (Shao, Li, & Zhao, 2019).

In order to provide a more accurate representation of the entire magnitude, we also employ the technique of multiplication synthesis (Qiu, 1991). The Wind dataset, available at https://www.wind.com.cn/en/edb.html, was utilised to obtain data pertaining to green securities, specifically focusing on green credit. In order to address the missing data in the green credit dataset of 2008, an interpolation technique was employed to fill these gaps. The Indonesia Insurance Yearbook was utilised as a primary source of information pertaining to green insurance. The data pertaining to the Gross Domestic Product (GDP), utilisation of nonfossil energy sources, and investments in environmentally sustainable initiatives have been extracted from the Indonesia Statistical Yearbook.

Data collection and computation of nonfossil energy use

An essential approach for attaining energy conservation and reducing emissions appears to involve increasing the utilisation of non-fossil energy sources. Hydroelectric power, nuclear power, and wind power are the primary non-fossil fuel sources utilised in Indonesia (Wang & Li, 2019). Consequently, this study calculates the proportion of non-fossil energy consumption in Indonesia by examining the percentage of total energy consumption attributed to hydroelectric power, nuclear power, and wind energy. The information was derived from the Indonesia Statistical Yearbook (Pusat Statistik Badan, 2019).

Indonesian estimates of carbon intensity and emissions

The data regarding Indonesia's carbon dioxide (CO2) emissions has been sourced from the official portal of the International Energy Agency (IEA), an authoritative organisation in this field. The International Energy Agency (IEA) has released a comprehensive report on carbon dioxide (CO2) emissions, covering the period from 1999 to 2015. To supplement this dataset, the IEA has utilised a regression interpolation method to analyse and estimate the annual CO2 emission data for the years 2016 to 2020. The total carbon emissions for the years 2016, 2017, and 2018 were recorded as 9,319.14 Mt, 9,749.84 Mt, and 10,184.72 Mt, respectively. Table 3 presents the minimum and maximum values for green financing rates, carbon severity, and the proportion of nonfossil energy usage. Additionally, it includes the corresponding observations, means, and standard deviations. Figure 1 illustrates the developmental trajectories of three measures in Indonesia from 2000 to 2020.

Table 2. Summarises the results for the three primary factors employed in this research: non-fossil energy usage (lnNFE), carbon severity (lnCI), and green funding (lnGF).

Factors	Observations	Mean	Std. Dev	Minimum	Maximum
lnGF	19	-0.231	0.315	-0.830	0.362
lnCI	19	0.072	0.342	-0.499	0.467
lnNFE	19	10.233	0.602	9.016	11.126

Note: Every factor underwent ln transformations. Std. Dev represents standard deviation.

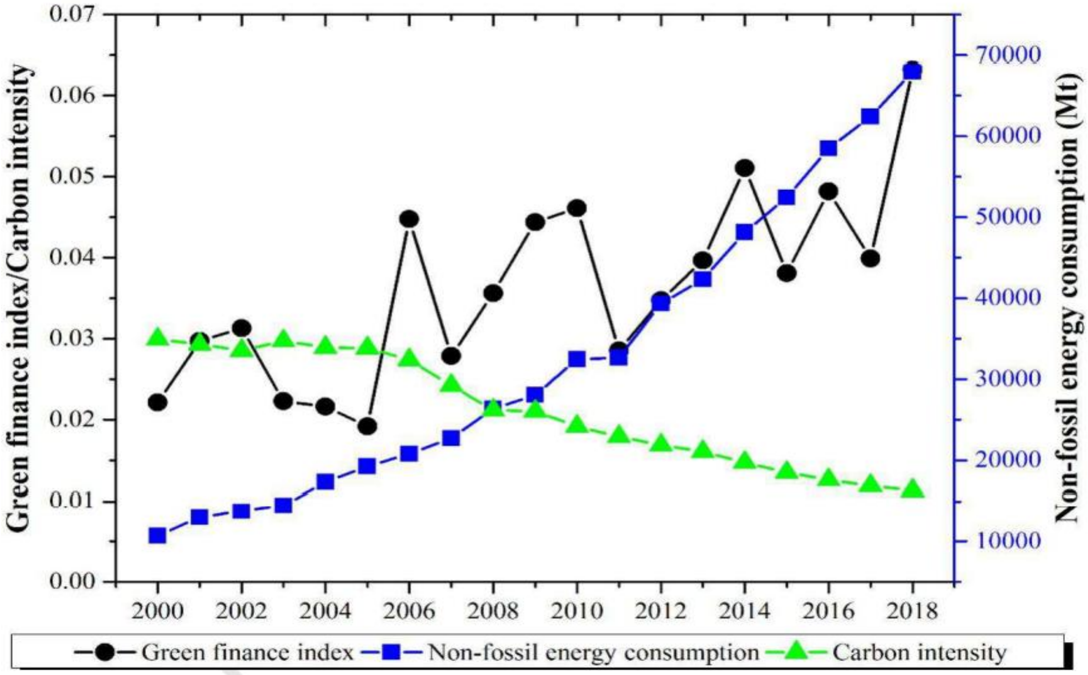

Figure 1. shows Indonesia's non-fossil energy usage (Mt) trends, carbon severity, and green financing index development from 2000 to 2018.

The graph illustrates an increase in the green finance index, which experienced a significant growth of nearly twofold, reaching 0.02214 in 2000 and 0.06321 in 2018. The utilisation of clean energy experienced a significant and consistent increase from 2000 to 2018, exhibiting a more than threefold rise from 10,669.87 Mt to 67,933.13 Mt. There is evidence of progress in the observed reduction in the magnitude of carbon emissions, which exhibited a gradual decline from 0.02995 to 0.01131 between the years 2000 and 2018, surpassing the halfway mark.

EVIDENTIAL RESEARCH

Unit root testing

The outcomes of the unit root check are presented in Table 3. Both the ADF assessment and PP check, which only considered intercept terms, found that neither of the time series indicators passed the tests at a significance level of 10%. Upon considering the temporal trend, it is observed that both the natural logarithm of gross fixed capital formation (lnGF) and the natural logarithm of net foreign exchange (lnNFE) successfully pass the unit root test. However, the natural logarithm of consumer inflation (lnCI) does not meet the criteria. The stability of the first-order difference scores DlnGF, DlnCI, and DlnNFE indicates that the initial sequence appears to have been a singular integral.

Table 3. Shows the results of ADF and unit root checks of PP for the significant indicators of green financing (lnGF), carbon severity (lnCI), but also nonfossil energy usage (lnNFE), as well as first-order difference rankings for each of the three factors (lnGF, lnCI, and lnNFE).

Indicators	Test of ADF		Test ofPP	
	Just constants	Trends and constants	Just constants	Trends and constants
lnGF	-2.158	-4.104**	-2.121	-4.100***
lnCI	1.479	-3.409**	1.197	-3.566**
lnNFE	-2.091	-12.898***	-2.412	-14.446***
DlnGF	-5.502***	-6.364***	-6.152***	-6.060***
DlnCI	-3.341**	-3.392*	-3.342**	-3.382*
DlnNFE	-12.043***	-10.488***	-17.753***	-16.186***

Notes: Each factor underwent an ln transformation. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. D denotes a difference in the first order. The unit root of presence serves as the null hypothesis for both the ADF and PP checks.

Test of Johansen Cointegration

Prior to conducting the cointegration analysis, lag differences were computed and the resulting values are presented in Table 4. All criteria (LR, AIC, SBIC, and HQIC), with the exception of LL and FPE, indicated that the significance of factors increased notably when a third-order lag was included. Consequently, these three factors have been identified as having a third-order lag.

Table 4. The three key factors, green financing (lnGF), carbon severity (lnCI), and nonfossil energy usage, are in the best lag order (lnNFE).

Lag	LL	LR	df	P	FPE	AIC	HQIC	SBIC
0	25.8341	-	-	-	9.7e-06	-3.045	-3.046	-2.903
1	68.2142	84.77	9	0.000	1.3e-07	-7.495	-7.502	-6.929
2	82.7696	29.112	9	0.001	6.8e-08	-8.236	-8.247	-7.245
3	112.798	60.059*	9	0.000	7.5e-09	-11.040*	-11.055*	-9.626
4	-	-	9	-	-6.1e-26*	-	-	-

Notes: lnGF, lnCI, and lnNFE indicate the endogenous factors; * denotes the optimum lag order. LL stands for Levin Lin, LR stands for Likelihood Ratio, SBIC stands for the criterion of Schwarz Bayesian Information, HQIC stands for the criterion of Hannan-Quinn Information, AIC stands for Akaike Information Criterion, and FPE stands for Final Prediction Error.

The data has been employed in the co-integration analyses to examine the number of co-integration relationships after determining the optimal lag order. The results are presented in Table 5. The presented table indicates that the alternative hypothesis, which posits the existence of at least one cointegration connection, was accepted, while the null hypothesis, which suggests the absence of any cointegration connection, was rejected. The null hypothesis was accepted based on the trace statistic, which tested the hypothesis of "maximum two cointegration connections." The calculated value of 1.1982 was significantly lower than the critical value of 3.76 at a 95 percent confidence level. The results obtained from the Johansen cointegration analysis indicate a significant and persistent cointegration relationship among the three factors. The subsequent model presented is a regression model that incorporates long-term cointegration.

$$\ln CI = \frac{5.0357}{(2.7113)} - \frac{1.0789 \ln GF}{(0.6497)} - \frac{0.5408 \ln NFE}{(0.3752)} \quad (2)$$

In Equation (2), the standard errors are presented within brackets, indicating that the variables lnGF and lnNFE exhibit statistical significance at the 1 percent level. Based on Equation (2), it can be inferred that a 1 percent increase in the index of green financing development is necessary in order to achieve a corresponding reduction of 1.078 percent in carbon emissions of GDP per unit in the long term. When there is a 1% increase in the proportion of nonfossil energy utilisation, there is a corresponding reduction of approximately 0.54% in carbon emissions per unit of GDP. The correlation between the implementation of green financing and the utilisation of nonfossil energy sources has demonstrated a significant and enduring negative relationship with carbon intensity. This empirical evidence provides a solid foundation for the objective of decreasing carbon emissions per unit of gross domestic product (GDP).

Table 5. Outcomes of the Johansen cointegration analysis (lag 3).

Ranks	Eigenvalues	Trace statistics	Critical values
No cointegration connection		75.148	29.69
Maximum one cointegration connection	0.973	16.525	15.42
Maximum two cointegration connections	0.616	1.198*	3.77
Maximum tree cointegration connections	0.072		

Notes: The symbol * denotes the number of optimum cointegration connections

Framework for vector error correction

The cointegration regression framework is supported by the error correction model (ECM), which was put forth by Engle and Granger (1987). The VEC framework may be created as below, per Fan, Hu, Kong, and Zhang (2017) and Shao, Wang, Zhou, and Balogh (2019):

$$\Delta lnCI_{it} = \alpha_1 + \sum_{p=1}^{r} \beta_{11p}\, \Delta lnCI_{i(t-p)} + \sum_{p=1}^{r} \beta_{12p}\, \Delta lnGF_{i(t-p)} + \sum_{p=1}^{r} \beta_{13p}\, \Delta lnNFE_{i(t-p)} + \lambda_I ECT_{i(t-1)} + \varepsilon_{it} \quad (3)$$

$$\Delta lnGF_{it} = \alpha_2 + \sum_{p=1}^{r} \beta_{21p}\, \Delta lnGF_{i(t-p)} + \sum_{p=1}^{r} \beta_{22p}\, \Delta lnCI_{i(t-p)} + \sum_{p=1}^{r} \beta_{23p}\, \Delta lnNFE_{i(t-p)} + \lambda_2 ECT_{i(t-1)} + \varepsilon_{it} \quad (4)$$

$$\Delta lnNFE_{it} = \alpha_2 + \sum_{p=1}^{r} \beta_{31p}\, \Delta lnNFE_{i(t-p)} + \sum_{p=1}^{r} \beta_{32p}\, \Delta lnCI_{i(t-p)} + \sum_{p=1}^{r} \beta_{33p}\, \Delta lnGF_{i(t-p)} + \lambda_3 ECT_{i(t-1)} + \varepsilon_{it} \quad (5)$$

The initial discrepancies in the aforementioned equations are represented by ΔlnCI_it, ΔlnGF_it, and ΔlnNFE_it, which serve as indicators of transient variations in the three components. The variable "p" denotes the number of lag orders, while the symbol "β" represents the coefficient used to evaluate the impact of independent factors on the dependent variable over a shorter time period. On the other hand, the symbol "λ" represents the correction coefficient, which determines the speed at which a system transitions from a state of non-equilibrium to long-term equilibrium. The term ECT_(i(t-1)) appears to represent the error correction term, which represents the residual component derived from the co-integrating equation. The regression results are presented in Table 6.

The degree of fit for the Vector Error Correction Model (VECM) exceeds 0.75, indicating a strong level of agreement. Specifically, the values of 0.9374, 0.9763, and 0.9573 demonstrate a favourable match between the model and the observed data.

Table 6. Shows the models' outcomes for vector error correction

	1	2	3
	DlnGF	DlnCI	DlnNFE
EC(t-1)	–2.008*** (0.445)	0.021 (0.057)	–0.192 (0.118)
DlnGF(-1)	0.667* (0.395)	–0.062 (0.051)	–0.127 (0.105)
DlnGF(-2)	0.495** (0.245)	–0.085*** (0.032)	–0.087 (0.065)
DlnCI(-1)	–0.257 (1.05)	0.112 (0.135)	0.101 (0.277)
DlnCI(-2)	–4.506*** (0.937)	0.017 (0.120)	-0.286 (0.247)
DlnNFE(-1)	1.056 (1.155)	0.348** (0.149)	–0.590* (0.304)
DlnNFE(-2)	1.223** (0.540)	0.174** (0.069)	–0.320** (0.143)
Cons.	–0.013 (0.317)	–0.179*** (0.042)	–0.107 (0.084)
R^2	0.938	0.977	0.957
Chi^2	104.884	288.008	157.009

The framework's error correction coefficient (1) exhibits a statistically significant value of 2.008, indicating significance at the 1 percent level. This implies that the rapid expansion of green finance may lead to an economic adjustment that ultimately achieves long-term equilibrium. Although the framework coefficient (2) violates the downward correction rule, its statistical insignificance is evident with a coefficient value of 0.021. Framework 3 exhibits a coefficient of -0.192, which is deemed statistically insignificant, similar to Framework 2.

For all relevant independent factors, the first and second lag periods of DlnGF in equation 1 are statistically significant at the 10% and 5% levels, respectively. The negative correlation between the second lag of the change in the index (DlnCI) and the dependent variable, which is statistically significant at the 1% level, shows that a significant decrease in the green financial development index would result in immediate and significant changes in carbon intensity. Furthermore, the coefficient of this correlation is more significant than those of other variables in the model (1). The aforementioned outcome occurred within the framework of a notable increase in carbon intensity, which signifies the swift expansion of energy-intensive enterprises that typically possess substantial assets and require significant capital investment to thrive. The provision of financial resources to these types of enterprises may experience a decline as they secure additional funding, potentially leading to a decrease in the green financing development index.

Furthermore, there appears to be a significant and positive correlation between the initial hysteresis coefficients of DlnNFE and DlnGF. The observation that the coefficients of DlnGF are consistently lower than those of DlnNFE suggests that intermittent energy sources play a significant role in influencing short-term fluctuations in green financing. In Framework 2, there is a significant inverse relationship between the change in CI (DlnCI) and the lagged change in GF (DlnGF) at a statistically significant level of one percent. This relationship suggests that an increase in green financing can have a substantial impact on reducing CO_2 emissions per unit of GDP when carbon intensity deviates from its long-term equilibrium position in the short term. The coefficient of the second lag period is higher than that of the primary lag period, indicating a notable and enduring inhibitory effect of green finance. The lag coefficients of the first and second difference of the natural logarithm of non-fossil energy (DlnNFE) exhibit statistical significance and positive values at a 5 percent significance level. This suggests that the utilisation of non-fossil energy displays a strong persistence effect and is relatively easy to enhance in the short term. However, reducing non-fossil energy usage poses a significant challenge.

The statistically significant negative impact of the first or second lags of the change in non-fossil energy (DlnNFE) within the third framework, at a significance level of 1 percent, suggests that the growing opposition to fossil fuels is having a noticeable effect. When comparing the coefficients of the factors in the three frameworks, it is observed that the coefficients in Framework 2 are generally lower than those in the other two frameworks. This suggests that the other variables have limited influence on carbon severity. Promoting a rapid reduction in carbon intensity continues to be a complex endeavour.

VECM endurance testing

A stabilisation test was conducted on the VEC modelling framework in order to examine the effects of impulse responsiveness. The outcomes of a typical root test are illustrated in Figure 2. With the exception of the dual-unit roots suggested by the vector error correction model (VECM), all eigenvalues of the entirely adjoint matrix are located within the unit circle. Consequently, the framework can be deemed sustainable, enabling the continuation of the research for an impulse response assessment.

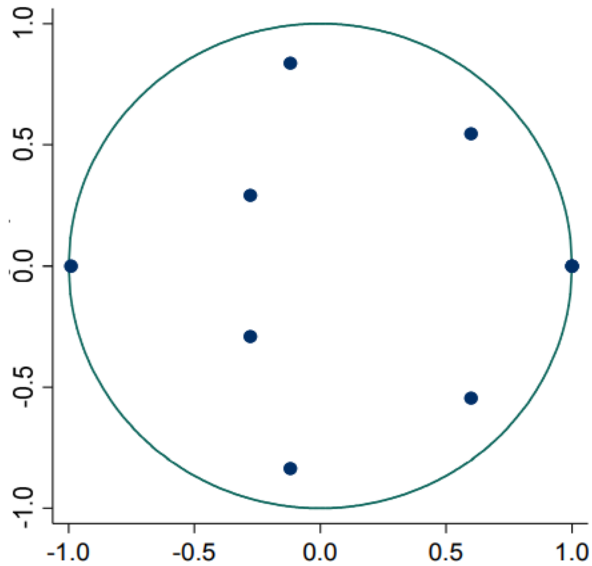

Figure 2. Shows the vector error correction framework's discrimination graph for stability analysis.

Evaluation of impulse responses

Therefore, by manipulating the three crucial factors, stability can be achieved in both the variance decomposition and the impulse response. The impulse response time was divided into ten stages. The ten stages correspond to a duration of 10 years, as the unit of measurement for the variable is in years. Additionally, the impulse response has been analysed within the factor directives of lnCI, lnGF, and lnNFE. The first column in Figure 3 illustrates the impact of these factors on the natural logarithm of GF. The response of the green financing development index to carbon severity exhibits a marginal variation of approximately zero, suggesting that the impact of carbon severity on green financing appears to be negligible. With the exception of stages 1, 5, and 9, the peak value exhibits a variation of approximately 5 percent. Furthermore, the influence of lnGF in isolation seems to have an overall positive effect. This observation suggests that the logarithm of green financing (lnGF) appears to be the primary determinant of its growth. The relationship between the natural logarithm of net foreign assets (lnNFE) and the natural logarithm of gross domestic product (lnGDP) exhibits a slight inverse correlation.

The initial column demonstrates the impact of lnCI, lnNFE, or lnGF on lnCI, while noting that lnGF's influence continues to be negative. Phase two represents the period during which the impact reaches its maximum level. Subsequently, a modification occurs in the seventh stage, resulting in a consistent impact of less than 1 percent. The aforementioned findings suggest that the continued development of green financing is of utmost importance in achieving a sustained reduction in the severity of CO2 emissions. Conversely, the impact of lnNFE on the fluctuation of lnCI is minimal. Therefore, it can be inferred that Indonesia's efforts to expand its non-fossil energy sources are insufficient, and there is still a need to expedite the process of structural energy adjustment.

The third column displays the standard deviation of the lnCI, lnNFE single-unit, and lnGF instinct responses to lnNFE. The amplitudes of the three pulse reactions are substantial. Both the natural logarithm of confidence interval (lnCI) and the natural logarithm of growth factor (lnGF) have a negative impact on the response of the natural logarithm of non-fatal events (lnNFE). The results indicate that variations in carbon intensity and the availability of green financing have a significant impact on the utilisation of non-fossil energy sources. While the variable lnNFE exhibits a positive effect in isolation, its magnitude is notably smaller compared to the other two factors. This suggests that lnNFE possesses limited intrinsic potency and primarily relies on external stimuli for its influence.

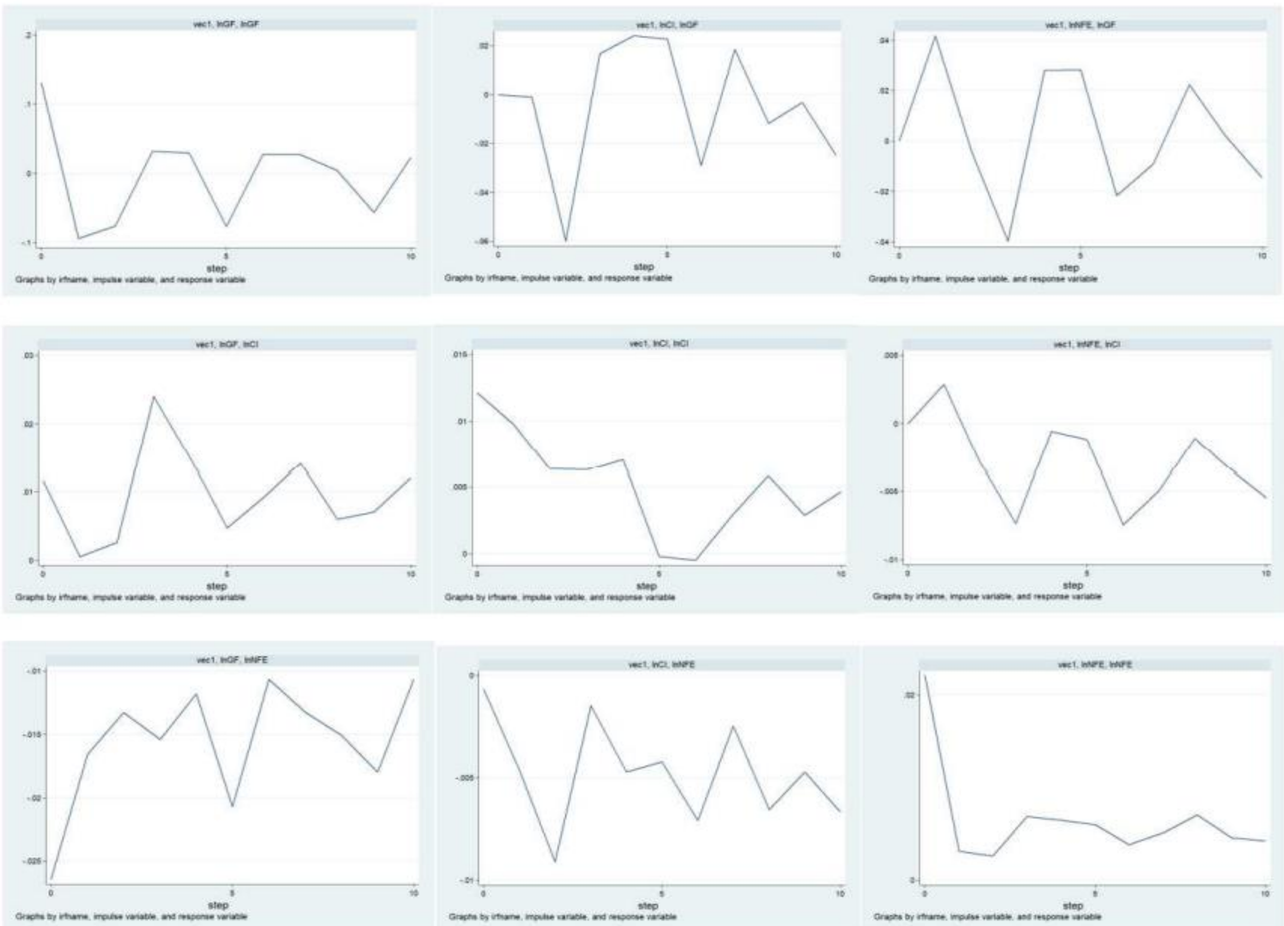

Figure 3. Shows the correlations among the percentage of non-fossil energy consumption, the green financing development index, and carbon severity.

Variance decomposition

The variance decomposition follows a similar sequence and lags order as the impulse response. lnGF, lnCI, and lnNFE's variance decompositions are shown in Figures 4, 5, and 6. Table 7 displays how much variance decomposition affected the average number of variables in their first, fifth, and tenth stages. Compared to alternative elements, green finance has been determined to be most affected by itself (Fig. 4). In Figure 5, the variance decomposition of lnCI has been displayed. Beginning with the primary stage, the impact of green financing on carbon severity upsurges quickly and alleviates at or near 60% by the fourth stage. At time 3, carbon severity reaches a maximum addition to the variance decomposition, stabilizing at slightly higher than 20%. The variance decomposition of nonfossil energy partakes a negligible influence.

Accordingly, structural energy modification has little impact on lowering carbon severity, but green finance has a significant impact. These findings are consistent with the findings of the impulse response evaluation. Figure 6 depicts the variance breakdown of the lnNFE. Within the first stage, the share of green finance's variance decomposition rises quickly and stabilizes at about 60 to 70 percent. The use of non-fossil energy increases during the first stage before gradually declining to less than 20%. Carbon severity has the most negligible influence but has steadily risen to around 10% over time.

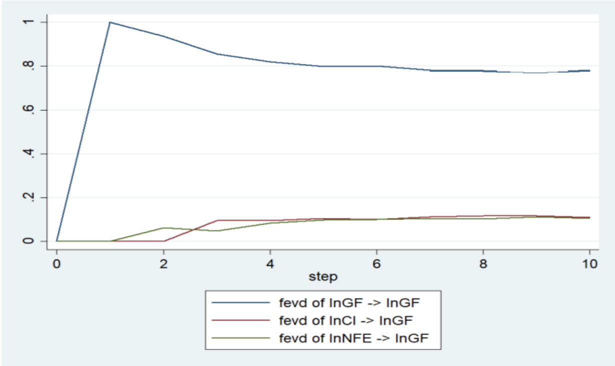

Figure 4. Shows the lnGF variance decomposition.

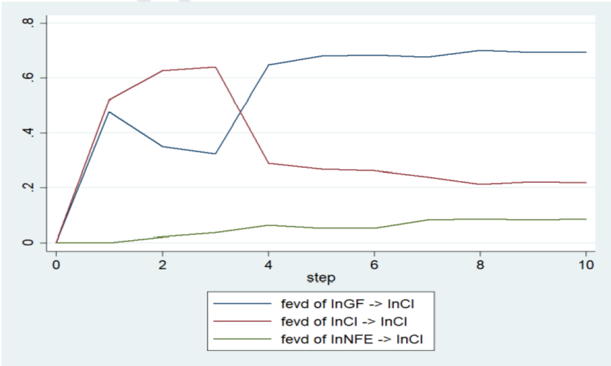

Figure 5. Illustrates the lnCI variance decomposition.

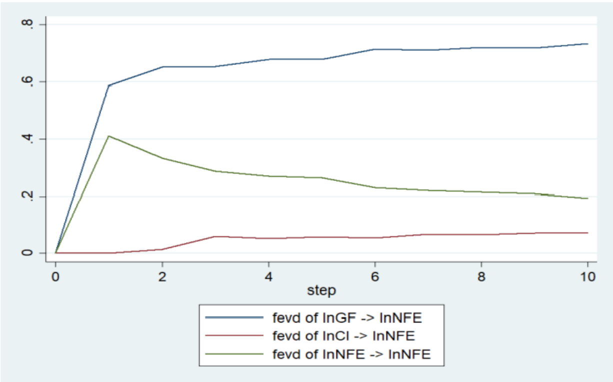

Figure 6. Represents the lnNFE variance decomposition.

Table 7. Indicates the Variance decomposition's addition to lnGF, lnCI, and lnNFE

Phases	Retort factors	Percentage variance decomposition contribution		
		lnGF	lnCI	lnNFE
1	lnGF	99.9	46.84	59.85
5		78.75	69.07	68.85
10		77.29	68.46	74.45
Average		87.02	62.79	65.72
1	lnCI	0	54.18	0.05
5		11.53	25.82	6.76
10		12.15	22.94	8.08
Average		7.23	34.65	3.30
1	lnNFE	0	0	42.14
5		8.75	5.14	27.41
10		9.57	7.63	20.50
Average		7.78	5.59	28.02

Granger cause analysis

The Granger causality analysis has been employed for examining Granger causality, which defines a causal link dependent on "prediction" between economic indicators. The three factors, DlnCI, DlnGF, and DlnNFE, have all been autocorrelated and statistically robust at 10 percent within the first difference. Following the initial difference from every factor, the Granger causality check has been performed. Thus, the findings are displayed in Table 9. At the 1% significance level, there appears to be clear evidence of two-way causation between DlnCI and DlnGF, as well as DlnCI and DlnNFE. The Granger causality analysis for DlnGF and DlnNFE has a p-value of 0.094, but at a 10% significance level, there is two-way causation between DlnGF and DlnNFE. Consequently, it seems clear that green financing does not significantly contribute to promoting new energy.

Table 8. Granger causality check's outcomes including DlnCI, DlnNFE, and DlnGF

Equations	excluded	Chi^2	df	Prob value>Chi^2
DlnCI	DlnGF	69.582	3	0.000
DlnCI	DlnNFE	12.278	3	0.010
DlnCI	All	141.45	6	0.000
DlnGF	DlnCI	19.093	3	0.000
DlnGF	DlnNFE	7.395	3	0.094
DlnGF	All	37.89	6	0.000
DlnNFE	DlnCI	27.27	3	0.000
DlnNFE	DlnGF	9.39	3	0.016
DlnNFE	All	30.47	6	0.000

RESULTS, POLICY RAMIFICATIONS, AND RECOMMENDATIONS FOR FURTHER STUDY

Results

A VECM has been employed throughout the research to statistically assess how nonfossil energy usage and green financing conduce to a decrease in carbon severity in Indonesia between 2000 and 2020. Using four factors from the 2016 Guidelines on Constructing a Green Financial Network, green credit, green sanctuaries, green insurance, and green investment, a green financial development index has been created to more accurately depict green financing. We came to the following findings. Initially, it had been discovered that there was indeed a significant long equilibrium association between carbon severity, green finance, and nonfossil energy usage, with a decrease in carbon severity correlated with a rise in the index of green financial development and a higher ratio of nonenergy usage.

Secondly, a rise in carbon severity hampered the growth of non-fossil energy and decreased green financial investment, which caused the green financial development index to fall. Thirdly, while the growth of non-fossil energy lacked the self-driving capability and almost always depended on governmental assistance, it remained principally influenced by green financing and carbon severity over the long and short term. Fourth, Indonesia's green financing strategy significantly impacted carbon reduction, but its results were inconsistent and invariably short-lived. Finally, Indonesia's carbon severity varies little over time; as a result, lowering it quickly seems to be a difficult challenge.

Forthcoming Prospects for Study and Policy Ramifications

The first strategic inference concerns the requirement for bigger green finance policy sustainability and consistency. As revealed by the research provided, significant variations in green financing have a detrimental impact on carbon severity and the non-fossil energy sector. Thus, a critical factor in promoting the mitigation of emissions is the constancy and longevity of the green finance strategy. Indonesia's green finance policy framework has to be enhanced; moreover, widespread green financing may guarantee the advancement of conserving energy. Additionally, the 13th Five-Year Program marks the earliest to include financing and asks for the creation of a green financial framework and green development funds.

As a result, there are three ways that green finance policy might be enhanced. 1) The formal oversight of developing a green financing system has to be enhanced; thus, the appropriate rules and policies need to be implemented. A complete finance service network that consists of green investments, loans, bonds, and securities must be created inside this structure. 2) A grading system for green bonds and securities suitable for Indonesia's circumstances must be devised. An authorized third party must confirm that the stocks and bonds are green before issuing them. They must also conduct a scientific study and verify the programs' environmental advantages. Additionally, a panel of professionals that comprehend the importance of green investments and may examine as well as keep track of the particular features of such funds utilized to assist the green business should be put together. 3) Guidelines, processes, and practices relating to "green credit" should also be enhanced. Ordinary people should consistently be recognized and given special mortgages, as well as promoting excellent and appropriate business networks to facilitate green landscaping under energy-saving requirements along with the acquisition of green housing in addition to the latest energy automobiles following national energy-saving credentials for construction.

The following strategy supposition involves the prerequisite for improved assistance for green financing in non-fossil energy companies. The cost per unit of non-fossil energy is considerably greater than that of fossil energy, which may be the leading source of the inadequate progress of this kind of energy. As per the long-run co-integration model, the employment of nonfossil choices, like nuclear energy, wind, and solar could successfully cut CO_2 emissions. Non-fossil energy vigors typically comprise substantial investments and protracted payback periods. To embrace green financing goods and services in the growth of nonfossil energy businesses, multipurpose and speckled operating plans need to be established.

Mainly: 1) To alleviate the financial needs of investigation and authorization and reduce the duration of approvals, assistance for green credit for nonfossil energy schemes must stand reinforced by the supply of low-interest lending. Equivalent to this, practical approaches for non-fossil businesses should consistently be executed. Examples include fiscal discount interest, tax cuts, furthermore, exclusions, pretax provisions, and voluntarily lousy debt write-offs. 2) The importance of the financial market should indeed be highlighted. There ought to be a considerable number of green businesses developed with non-fossil energy as their primary business to endorse low - and medium-board platforms and over-the-counter marketplaces, including sci-tech innovative panel marketplaces for nonfossil energy firms. 3) The entry barrier for something like the non-fossil energy sector into Indonesia's financial market has to be decreased. Lowering the project income criteria may apply to reviewing and authorizing a corporate securities issue. Limitations on the quantity and percentage of the money collected to replenish cash flow or pay off bank debts must be slightly reduced once green companies become registered.

The third strategic conclusion would be that the carbon market's position regarding green financing approval should be loosened. Utilizing financial derivatives to reduce carbon dioxide and other greenhouse gas emissions seems to be how carbon pricing is implemented in the financial sector. Currently, Indonesia's carbon market is also not operating at its full potential, and there are misconceptions regarding CO_2 emission permits and their financial benefits for sectors and businesses. Financial policymakers should be leading in establishing a national carbon marketplace. The vigorous growth of a carbon spot market will indeed be facilitated by the efficient financialization of the carbon market. A carbon investment account geared toward the carbon finance market must be developed to strengthen the financial viability of emission-depletion initiatives.

Throughout the initial stages of carbon financing, financial institutions may give a more significant security proportion well within the parameters of controlled risks and be urged to incorporate carbon emission obligations in the area of pledging to lend. A green route seeking special permission can also be developed, and financial commodities connected to carbon emission obligations should be developed. Carbon securitization solutions should indeed be innovated. Carbon assets must be revitalized as well as used more effectively. Moreover, carbon exchangers should always be pushed towards developing a full suite of low-carbon derivative financial products for something like a minimal-carbon index framework. Minimal-carbon funds and finance leases may be progressively enhanced on the premise of all this.

The following are potential subjects for further investigation. 1) The methodology shown in this article to create the green financing index might be modified. Few researchers in the field have already created an index like this; that also seems to be a challenging and novel issue. A well-built green financial index might increase the precision of future investigations. 2) More in-depth analysis of the relationship among factors can be assisted by using cutting-edge techniques and instruments. The threshold framework, for instance, might be employed to determine the nexus's breaking points. 3) The area of focus could include a cross-national examination of economies, particularly those with advanced green finance structures. By adopting this, the benefits, as well as challenges of other nations, might be contrasted.

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