Impact of Financial Support on Transforming China's Energy Economy

Abstract

This paper aims to study the financial tools and policies the People's Republic of China (PRC) can adopt to support its energy transformation initiatives. Improving the energy sector and expanding renewable energy sources are crucial to China's efforts to reduce its carbon emission by transitioning into a green energy economy. In this regard, finance-related problems are inextricably linked to China's financial growth and are one of the significant obstacles to its energy transitioning initiative. This study establishes a mixed-method approach to investigate its financial capability for the transformation phase and the ramifications to be incurred. A descriptive research design outlines data from the past three decades on its different renewable energy consumption. This research presents convincing proof demonstrating that financial progress is crucially significant and generates a total of 42.42% to the variety of green energy growth via an assessment utilizing macro-level data. Time series-based analysis with the vector autoregressive model (VAR) is used to compare the variables' past and current observations. The study's findings comprehensively demonstrate policy analysis, forecasting, and data describing China's fiscal ability to transform its energy economy through a practical approach such as green finance. The feasibility of equity financing, introducing financial instruments such as Green Bonds, and funding small-scale renewable energy projects is crucial in giving the nation the financial support necessary for the transformation. In particular, the capital sector is the most critical element, followed by foreign investment. Simple comparisons between the EU and US situations show that the EU approach is more pertinent; therefore, Chinese authorities should pay closer attention.

Keywords: renewable energy, financial development, energy economy, green finance

1. Introduction

1.1. Background

Today, the topic of energy consumption and energy efficiency is of global interest, as worldwide nations seek to conform to climate change initiatives and greenhouse gas (GHG) emissions policies to reduce the adverse impacts of global warming. With energy consumption levels at the centre stage of climate change, China emits about 27% of the global GHG, a third of the global emissions. In an initiative to control this, the country has installed hydro, wind, and solar power to generate energy. Still, it generates 26% of its electricity from renewable energy sources from fossil fuels, accounting for approximately 90% of the nation's energy use (Ali et al., 2018).

Burning fossil fuels, primarily coal, causes a lot of pollution in the atmosphere and is the primary contributor to China's greenhouse gas (GHG) emissions. According to data from the World Resource Institute, China and the US are the two countries that generate the most greenhouse gases globally. Together, these nations account for over 30% of all global GHG emissions. On November 12, 2014, the heads of state of these nations signed a landmark agreement to work together to decrease emission levels in response to mounting pressure brought on by the possibility of global climate change. China has committed to reaching its peak carbon dioxide emissions in 2030 and increasing the proportion of energy derived from alternatives to fossil fuels to about 20% by that time. However, it is still uncertain whether or not the policies and measures will be able to attain such a lofty objective without having an impact on economic performance.

China's economy is highly dependent on the global energy market, particularly the global crude oil market, which accounts for over half of its total consumption, yet another related

concern. The economic performance of China may be significantly impacted by instability in the global oil market, particularly recent price changes and wars in the Middle East. For Chinese policymakers, energy safety and the contribution of energy to sustained economic expansion have taken on significant importance. Because the energy industry is so strategically important, China's government is under pressure to fulfil the nation's interests in protecting the environment and energy security. As a result, they are thinking about how to modernize the energy generation and consumption framework.

Notably, there appear to have been the following two significant shifts from the standpoint of financial development. First, the financial department supports the development of diverse sectors more directly and efficiently by providing the necessary financial resources. Second, the financial market framework will be substantially streamlined, and the level of direct financing will significantly rise. It is also concerned that resource depletion will occur over time due to the dependence on rapid expansion. Before the "new normal" phase, the Chinese economy grew at a breakneck pace for a considerable period, with energy consumption rising as an essential productive input (Ali et al., 2018). This stage denotes the quick switch from an unsustainable form of economic development. However, the economic development pattern should change from overall progress to intense expansion according to the framework of the new normal. The energy industry's tasks include streamlining the energy use structure and establishing clean, contemporary energy systems as the new norm to meet the demands of intensive expansion. Therefore, increased financial resources should support the monetary system and energy transformations. The development of the old energy business was formerly endorsed more frequently by China's commercial lending institutions than that of the new energy

sector. Therefore, more financial support is anticipated for the new energy sector, essential to improving the energy structure.

1.2. China's Energy Economy and Financial Market Development

A rising worldwide consensus favours the development of alternative energy sources to reduce the worldwide usage of fossil fuels owing to the risk of global warming brought on by GHG emissions. Although the use of renewable energy is expanding and accelerating, it still only accounts for a small portion of worldwide energy consumption. In recent years, numerous scientific research has appeared to model the growth of renewable energies. These research efforts seek to determine the factors that influence the advancement of clean energy sources and the relationships between the establishment of these green energy sources and various fiscal and economic factors, such as energy pricing, emissions, economic expansion, and financial viability (Acheampong et al., 2020). Many scholars and energy experts have previously examined the connection involving economic development and the elements discussed in this research. Compared to this study, their conclusions can show the drivers of economic growth in China and other nations during the same period.

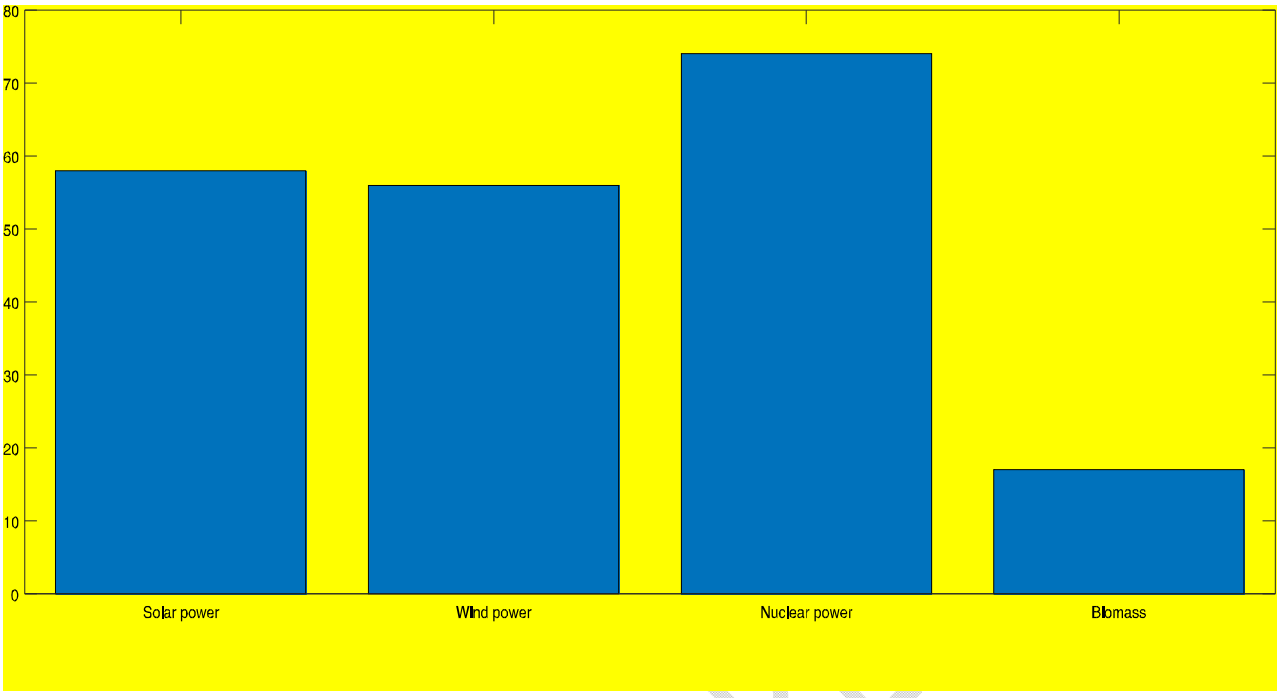


Figure 1: Showing Different Renewable Energy Use in China

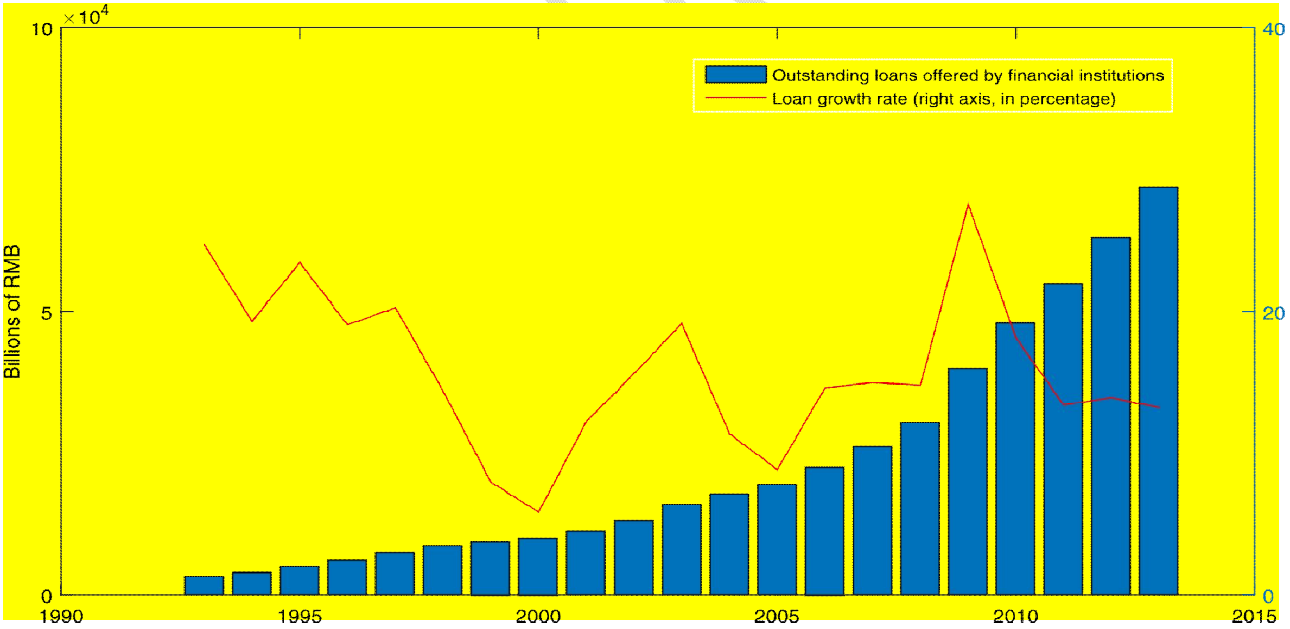


Figure 2: Illustration of the Rise of Domestics Loans by Lending Institutions

The capital market for financing places heavy restrictions on the growth of renewable energies. The cost of finance for the needed architecture substantially impacts financing, even

though investments in renewable energy projects have recently increased. Most recently, this argument has drawn several studies that seek to define the part that financial development plays in the widespread use of renewable energy (Dreher et al., 2021). The significance of the energy sector and environmental issues was emphasized by Creti and Nguyen (2018), who also identified several obvious obstacles to policy in the years following the Paris Agreement. The Paris Agreement's economic effects or financial market implications have been identified as the primary concern amongst other variables. The East Asia Summit territory was a focus of Chang et al. (2016), who also highlighted the importance of fiscal policies in fostering the renewable energy economy. Their project and compilation of relevant studies established unambiguous claims on the policy significance of financing in facilitating the transition to renewable energy (Xie and Zhang, 2023). In this view, the growth of the financial market is essential, and sound policies and system design are required to guarantee an optimal setting for environmentally friendly energy investments.

This paper is structured as follows. An overview of previous research on economic development in factor categorization is presented in the second section. The methodology and data collection methods for quantitative and qualitative information are described in the third part. The econometric techniques for data analysis are introduced in the fourth part. The empirical findings are highlighted and discussed in the fifth part. The last part concludes the paper and suggests relevant policy implications for stakeholders and decision-makers in China.

1.3. Research Questions and Objectives

This study's primary objective is to unravel the effectiveness of pulling financial support to transform China's energy sector and make it more sustainable and efficient now and in the future. Research questions for this paper are outlined below.

- What is China's energy economy, and what are the main factors that make it need transformation?
- How can the Chinese government mobilize local and global financial partners for their economic and capital support for the country's energy transition?
- What financial resources are currently available to support China's energy transformation efforts, and to what extent are they sufficient to meet the needs of this energy transition?
- Which forms of financial investments are essential, and how much can they help foster the growth of renewable energy?
- What are the potential economic and environmental benefits of transitioning to a more sustainable energy economy in China, and how can these benefits be maximized?
- What are the key government policies and incentives in place to promote the transition to a sustainable energy economy in China, and to what extent are they effective in achieving this goal?

On the other hand, the following research objectives are answered in-depth in the rest of the paper.

- To investigate the current state of China's energy economy and the factors that make it ripe for transformation.
- To evaluate options through which the country can mobilize local and global financial partners to obtain financial resources for the country's energy transition.
- To identify the financial resources currently available to support China's energy transformation efforts and assess their adequacy.
- To find out the forms of financial investments that are important and the amount required to help foster the growth of renewable energy.

- To explore the potential benefits of transitioning to a more sustainable energy economy in China in terms of economic growth and environmental sustainability.
- To examine the role of government policies and incentives in promoting the transition to a more sustainable energy economy in China and assess their effectiveness.

1.4. The Rationale for a Mixed-Method Approach

For this study, a mixed-method approach is a logical choice for several reasons. First and foremost, the mixed-method system enables the fusion of both qualitative and quantitative information to offer a more thorough and complex knowledge about the challenging problem of China's changing energy economy. With only one approach, this strategy may make spotting patterns, trends, and complex relationships easier. Additionally, by gathering data from many sources, the mixed-method technique can help to improve the accuracy and legitimacy of the study's outcomes. This is crucial when researching a subject as intricate and multifaceted as China's changing energy economy, which calls for various viewpoints and data kinds. By integrating quantitative data with qualitative stakeholder perspectives, which can then be studied jointly, combining these methods can offer a more comprehensive knowledge of the problems at hand. This method can assist in identifying potential conflicts or disparities between stakeholder opinions and quantitative data, which can subsequently be handled and resolved.

2. Literature Review

2.1. Previous Studies

Various research has determined that financial development causes and positively influences economic growth. Generalized moment method (GMM) analysis by Chiu & Zhang (2023) of dynamic panel data from 71 nations between 1960 and 1995 stated that financial development favoured economic growth. Another study by Chang et al. (2016) included 74

countries and confirmed the contribution of financial development to economic growth. However, the study by Chang et al. (2016) failed to demonstrate how financial product contributes to economic growth despite using 19 periodic figures from 19 OPEC nations and China. On the contrary, national research on economic growth has recently increased.

A nationwide investigation makes it simpler to choose variables based on the characteristics of the banking sector and indicates the amount of financial development than a cross-country study does. The significance of establishing a solid and reliable economic base that influences transformations in China's energy consumption structure is a contemporary issue for discussion. For instance, Chiu & Zhang (2023) demonstrated how China could enhance its energy consumption structure by reducing incentives for coal or oil using a Computable General Equilibrium (CGE) model. According to their modelling results, reducing coal subsidies by 3% resulted in a 1.76% rise in the percentage of non-fossil fuel energy relative to the baseline scenario. Doytch and Narayan et al. (2016) looked at the long-term relationship between economic growth, funding, commerce, and energy consumption in China using many financial stability measures, including foreign direct investment (FDI) inflow, stock market enhancements, and the banking sector. According to their empirical findings, economic development was expected to increase the energy demand, contributing to increased emissions and fossil fuel reliance. Long-term, China ought to invest more money in green energy sources to improve the country's overall efficiency in energy production (Zhou et al., 2020).

From the investigations mentioned earlier, China has come to a different result. Preliminary research was done on the Granger causation involving economic growth and development in China. Chiu & Zhang (2023) utilized data from 286 Chinese towns between 2001 and 2006 and discovered a favourable relationship between financial development and

economic growth. Another research by Ernst & Young (2016) used the GMM approach to analyze provincial panel data for China from 1985 to 1999 and discovered that intermediary financial services in China increased savings among homeowners and state budget replacements and stimulated economic growth. However, it is believed that the ineffective loan dispersion by China's financial institutions is why the rise in loans failed to spur economic growth (China Securities Regulatory Commission, 2016). Jian et al. (2019) discovered that the loans had a detrimental effect on per capita GDP. Kim & Park (2016) analyzed China's provincial panel data from 1989 to 2003 and concluded that the amount influenced by capital financing boosts economic growth while the degree of government interference in financing has a detrimental effect on economic growth. The GMM approach was used by Hao et al. (2020) to evaluate the province panel statistics from 1995 to 2012 and discover the adverse impact of financial development on economic expansion. As was already established, some empirical studies supported China's financial development's contribution to economic growth. Conversely, several studies have concluded that due to China's inadequate financial distribution, the financial product has little effect on the country's economy and might hurt it.

Jian et al. (2019) investigated the factors that influence the usage of green energy in six significant growing economies, particularly China. Their empirical findings imply that wealth and pollution levels are the key variables affecting renewable energy use in China and that there is a short-term bidirectional relationship between them (Wang & Wang, 2021). These conclusions are based both on panel-data models and time-series models. Their analysis of the available research revealed that when researching this topic, academics typically adopt either the supply-side or demand-side techniques (Ji and Zhang, 2019). From the evaluation, while the

demand-side analysis used carbon dioxide emissions, energy costs, and income, the supply-side studies employed manufacturing capacity and technological advancements.

For instance, to determine the direct cause-and-effect relationship between green energy consumption and economic growth in Organization for Economic Cooperation and Development (OECD) member states and a broader sample of 80 countries, He et al. (2019) used panel time-series simulations. Chen et al., 2019 extension of their earlier model for the panel integration approach to support a nonlinear, seamless transition technique. According to empirical findings generated from annual data for seven Central American nations from 1980 to 2010, economic growth, energy prices, and emissions had substantial longer-term effects on energy consumption from renewable sources (Kimura et al., 2016). In their analysis of 20 OECD nations from 1990 to 2008, CAIT (2017) discovered a unidirectional causal association between the production of renewable power and an increase in the country's gross domestic product (GDP). Still, the strength of the link varied depending on the energy source.

2.2. Research Gaps

The available literature generally demonstrates the growing interest in advancing the exploration of renewable energy. The impact of financial growth has been established, although mainly in a few nations. Consequently, this research, to start with, are not unique to China. China is the frontrunner regarding investments in renewable energy, as mentioned. China's leadership stresses the need for continued advancement in renewable energy to create a green financial system. Which forms of financing are more critical, and how much can they help foster the growth of renewable energy? These are the challenges facing policymakers. There are no clear answers to these queries in the extant literature.

These cross-country studies offer essential data on the factors that influence the progress of renewable energy, but they are not tailored to China's circumstances. Furthermore, most existing studies fail to simulate all markets as a system and instead concentrate on the supply or demand side. In practice, all the factors interact. The present research uses a systemic approach pertinent to China's need to enhance its energy structure over the time frame studied. An open system considers all the factors discussed in the research, encompassing the supply and demand sides. By doing this, we can fill a gap in the literature and offer crucial knowledge to China's policymakers.

3. Methodology

3.1. Research Design

This study employed a mixed-method research approach. To comprehensively address the key objectives, both the qualitative and quantitative methods and the secondary sources were used to give a more thorough investigation of the subject of the study. In this study, most of the analysis triangulates the descriptive research design by investigative statistical data for many years. The first part of the study used a qualitative approach entailing in-depth semi-structured interviews and a sampling strategy with key stakeholders in China. In contrast, the quantitative part entails a review of available financial data and statistical analysis.

The second part of the study constitutes the vector autoregressive model (VAR), which has since been shown to be a very effective tool for examining relationships in a macroeconomic system. The VAR model offers a straightforward yet efficient method to explicitly define how economic components are linked or interact by enabling every variable to be inherent and integrating them into a structure. Yet, it can be challenging to interpret a VAR model. A VAR model contains far too many coefficients to be adequately explained. On the contrary, the model

is frequently interpreted using a variance analysis and impulse response function. These two approaches are forward-looking. The variance decomposition technique offers details concerning how parameters in the system can understand the variation in a single factor derived from the prediction error. At the same time, the impulse response function illustrates how the entire framework reacts to specific disturbances.

3.2. Data Collection

This paper gathered the quantitative data by looking at secondary sources, such as academic articles, government reports, and other appropriate publications. A comprehensive assessment of the origins of data access is part of the sampling approach that helped to establish accurate and timely data to assist in answering our key objectives. Also, the data gathered included an in-depth examination of pertinent databases utilizing keywords or phrases about China's energy sector and the financial backing for environmentally friendly energy transitions from 1990 to 2021. Statistical techniques such as descriptive statistics have been used to examine the information obtained to find patterns and trends of energy transitioning to green energy.

On the other side, in-depth interviews with significant players in China's energy operations have been utilized to gather the qualitative data for this study. Purposive sampling was effected to randomly select individuals based on their knowledge and experience in the energy and financial sector. Key participants for this study include government representatives, business executives, and academics with expertise in China's energy sector, and the funding needed to alter it will be among the participants. Semi-structured discussions with the chosen participants were conducted as part of the procedures for gathering information to evaluate their viewpoints on the issues being investigated. This approach was documented in

audio and verbatim translated for further assessment, where a translator familiar with the Mandarin language was employed.

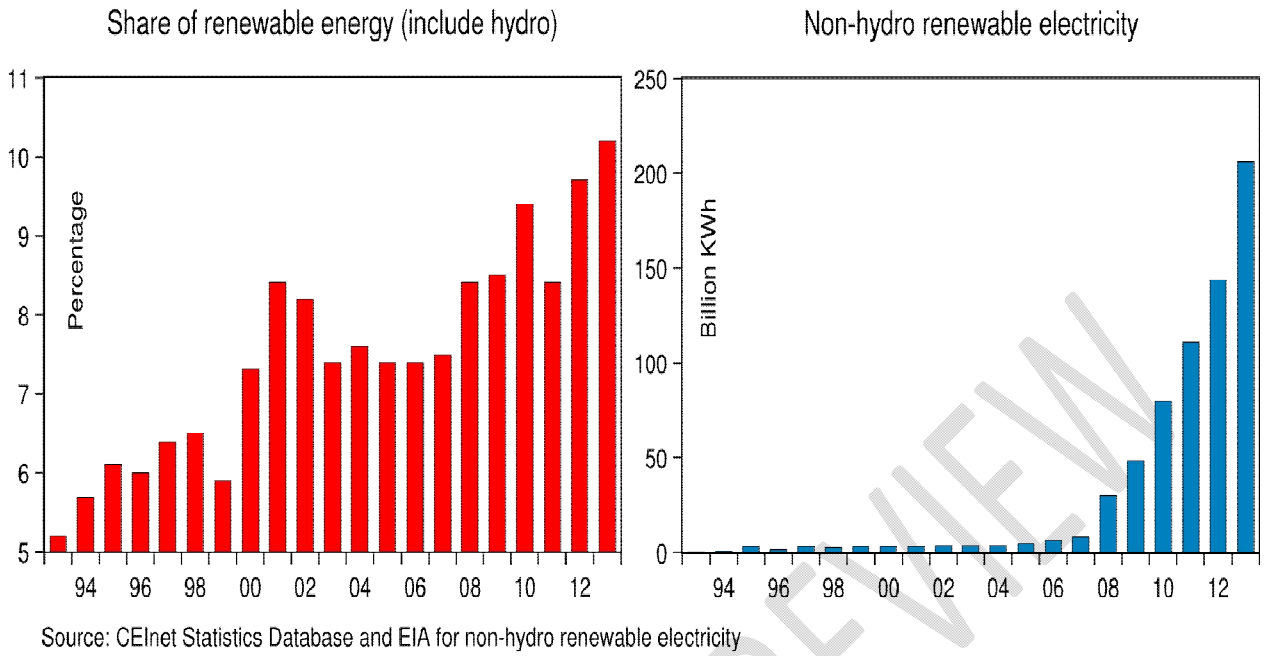
The goals of issuing interview questions for this investigation was to gather information about the participants' opinions of the present condition of the energy economy in modern China, financial resources readily accessible for promoting the process of energy transformation, the potential benefits of an environmentally green energy economy, China's mobilization of local, regional, and global financial partners towards the energy economy, the difficulties and obstacles in accomplishing a sustainable energy transition, and the strategies that can be used to overcome them. Furthermore, data was gathered using thematic analysis by locating significant patterns and trends in China's energy consumption of renewable and non-renewable energy sources, compared to countries such as the US and EU with high energy consumption rates. Data Analysis

The accessibility of information on stock markets in China helped determine the yearly distribution of data utilized in this section that spans 1992 to 2013. Before 1992, there were no publicly accessible stock market data available. The variables used for this study were selected for the empirical model based on the literature. In addition, data from the National Bureau of Statistics in China and the CEInet Statistics Database have been used as macroeconomic indicators for measuring financial development. It also incorporated data on GHG emissions from CAIT (2017) and helped track environmental demands for using energy from renewable sources.

To measure the financial development of a country, we observed three main measures: the stock market, the financial market, and overseas investment as a proportion of GDP, which have been employed in the existing literature. The prerequisites for both equity and debt funding have also been represented. The third metric, overseas investment, clearly shows how foreign

investment has affected the economy. In addition, the framework of energy utilization has been defined by the percentage of renewable energy in the overall final energy consumption. The stability of this simulation has been evaluated using non-hydro energy-producing net output.

The left-hand panel of Fig. 3 below shows the overall proportions of distinct renewable energy sources in energy consumption and the net power produced from non-hydro renewable sources located on the right panel. From the illustration, the ratio of renewable energy in China's overall energy consumption has grown, almost doubling from 5.2% in 1993 to 10.2% in 2013 (Hao et al., 2020). The most significant percentage and the biggest difference from other renewable energy sources is hydropower. When hydropower is excluded, the patterns of net power production from clean energy sources vary. After 2008, when non-hydro power generation saw a strong surge, the illustration exhibits a distinct transition in structure. One must consider this, so we utilize developments in non-hydro renewable power net production as another factor for China's progress in renewable energy sources and its energy infrastructure to assess how reliable the statistical results are (Wang et al., 2021).



Source: CEInet Statistics Database and EIA for non-hydro renewable electricity

Fig 3: A Comparison of China's Renewable and Non-Renewable Energy Share

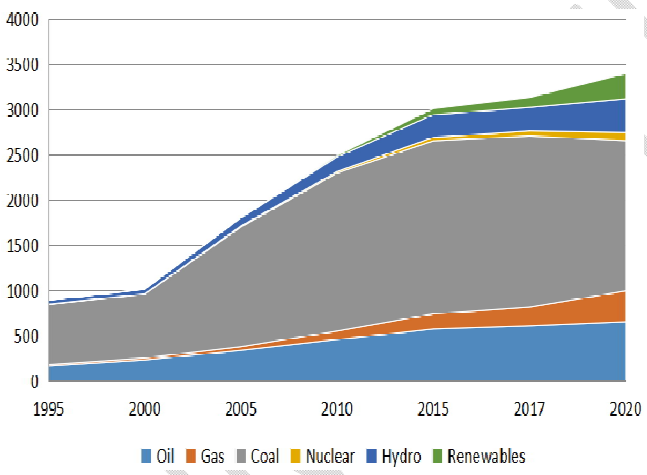


Figure 4: Sharp Increase in China's consumption of energy from 1995 to 2020

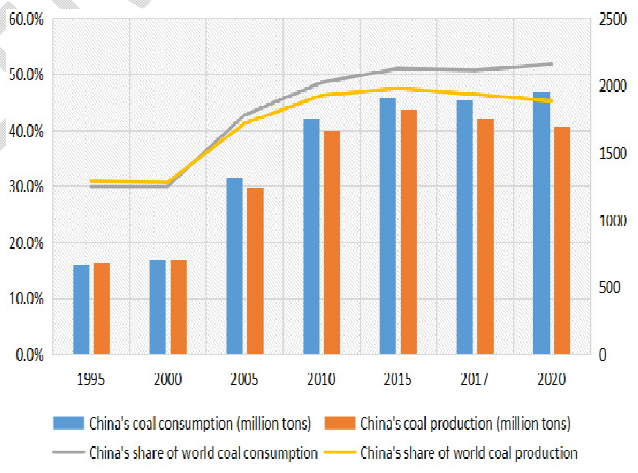


Figure 5: China's coal production and Consumption from 1995 to 2020

4. Results

4.1. Financial Development on Share Value

This section explores various suggestions and suitable policies acquired from journal and research articles published within the last 5 years, constituting both qualitative and quantitative data. According to the study, the Peoples's Republic of China (PRC) requires well-structured financial policies to develop its renewable energy technologies, such as advanced solar PV, wind energy, and liquid hydrogen power supply, to expedite its clean energy development. As established by Economic Research Institute for ASEAN and East Asia (ERIA), both public and private/commercial financial tools play a significant role in addressing China's pressing issue of renewable energy investment (Kimura et al., 2016). First, conventional financing tools constitute equity and debt, and development banks should be used in financing green energy sources like wind, solar, and hydrogen. In the context of China, the following support mechanisms should be underscored:

a) The viability of equity and debt financing from investment funds, joint ventures, and venture capital
b) Funding small-scale renewable energy sources located in rural and urban environments
c) Expand the market for new financial instruments like Green Bonds to increase the country's access to financial assistance by creating a need for Green Bonds as a renewable energy investment. In addition, the foreign exchange hedge tool for renewable energy finance is an additional cutting-edge helpful tool to lower the cost of borrowing.

Figure 6: Factors Facilitating the Need for Financing Renewable Energy

Figure 6 outlines the financial designs, the monetary processes, and the layout of favourable policies as the centrepieces that connect each of these five facets of financing green energy.

The energy framework in China is approximated using a seven-variable VAR model employing renewable energy as a percentage of overall energy consumption. When plotting a relationship in this system, pairwise comparative contributions among any two variables can be used. The graph demonstrates that the stock market's growth plays a crucial role in the overall framework and is the major contributor. Nevertheless, the most considerable net benefit from the system is economic expansion, which also gains compared to what it does to all the remaining variables. The stock exchange and the lending market constitute net contributions to the percentage of renewable energy, one of the critical financial growth metrics. Variations in oil

costs are another net factor affecting China's energy system. A different account of the system's operation has been provided. It details the extent to which one variable benefits from the framework alongside how much it impacts it. The net measure applies to where a stock makes the overall system's most significant net contribution (39.48%), and growth receives the technique's most significant net benefit (70.10%) (Chen et al., 2019). We established that the unpredictable changes in today's global energy sector and unrest in other countries political structures could also render it harder for China and other heavily import-dependent nations to accomplish their country's goals or considerably raise the price of their energy imports.

4.2. Demonstration of Tables and Graphs

The illustrations in this section present the statistics of varying renewable energy sources and their consumption levels in the country. Furthermore, the framework shown in Fig 7 demonstrates how the seven components rely on one another.

Table 1 Data statistics results

Statistics	Renew01	Renew02	Stock	Credit	FDI	GHG	Oil	Growth
Mean	0.25	44.78	1.73	1.24	− 0.13	5.85	8.22	9.29
Median	0.20	25.33	− 1.26	1.52	− 0.23	6.22	10.59	9.00
Maximum	1.40	273.34	80.32	19.54	2.40	13.08	47.07	13.60
Minimum	− 1.00	− 69.31	− 83.07	− 10.19	− 1.19	− 1.51	− 45.12	6.70
Std. Dev.	0.64	74.31	28.38	6.71	0.80	4.00	24.36	1.95
KPSS Test	0.07	0.17	0.11	0.08	0.22	0.14	0.12	0.09

Looking at Table 1, some generic empirical information on the variables that are employed in the economic model is presented. Every variable shows favourable mean growth rates during the study period aside from foreign direct investment (FDI) inflows. Given that FDI inflow rates are compared to the gross domestic product (GDP), a negative result might indicate that GDP is expanding faster than the amount of FDI coming in. The expansion of the green energy economy is measured differently, which is also supported by Fig. 7.

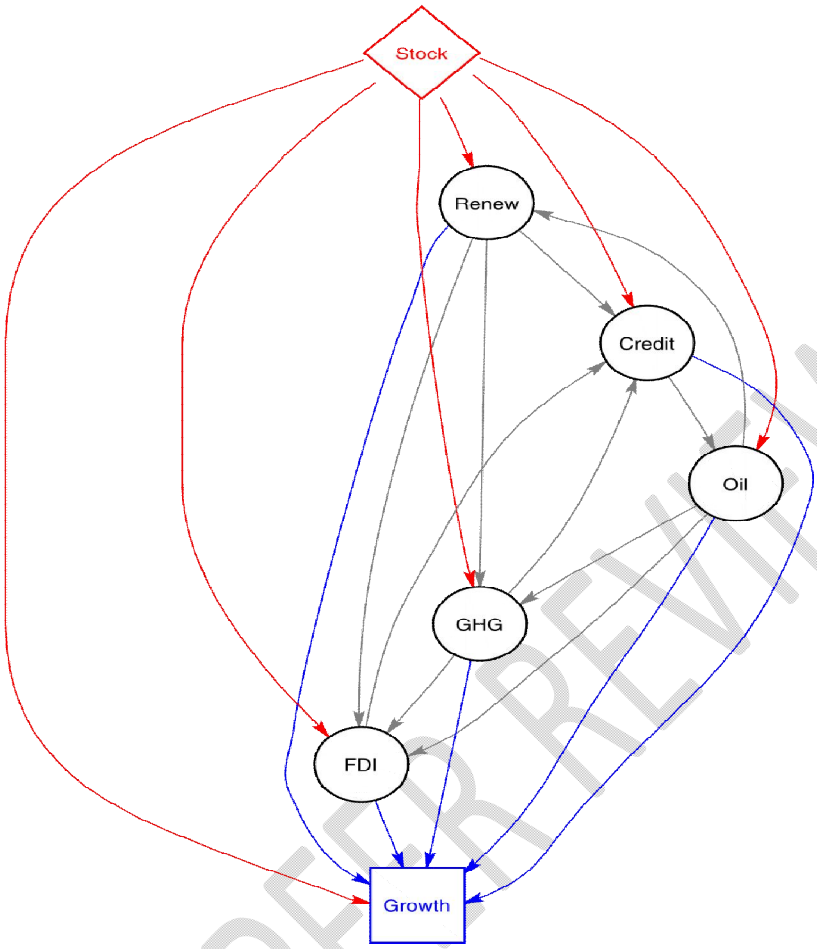


Figure 7: An Illustration of a Pairwise Interaction in the Energy Framework

China's energy consumption framework is approximated by incorporating a seven-variable VAR framework implementing renewable energy as a percentage of overall energy consumption. As shown in Figure 7, the relationship between these elements can be portrayed through the pairwise relative contributions made by each variable. About 55% of China's overall energy consumption in 2019 comprised production, and 59.6% of the energy used in this sector was coal (Shang & Liu, 2020). As illustrated in Figures 4 and 5, China's consumption of coal has seen an upsurge over the last decade, which calls for urgency to transition into green energy.

Despite efforts for China to rely on additional sources of green energy, a large portion of China's energy consumption originates in overseas countries in politically dangerous zones. It

needs to navigate through narrow waterways to arrive there. For China to continue to develop and expand, securing unhindered entry to foreign energy sources is essential.

4.3. The Case of China

China is in great need of a quick energy transformation to go green and to produce and consume more sustainable renewable energy sources. The government's Dual Control strategy will impede such expansion, so keep that in mind. The Dual Control strategy, adopted in 2016, aims to increase environmental sustainability by limiting the rise in the utilization of energy and its intensity (Kimura et al., 2016).

The need for sustainable development is growing as the impact of climate change grows more apparent. China has pledged to implement the Dual Control Policy and is committing to achieve zero net emissions by 2060. As a result, companies will unavoidably need to go through a transitional period, which could have conflicting implications for the energy industry. As China National Offshore Oil Company enters the wind energy market, Sinopec puts substantial resources into hydrogen-based fuel (Kimura et al., 2016). China's strategic move has pulled more foreign partners amid its energy transition initiative. The Middle East is one vital partner that provides China's energy security since over 50% of China's oil imports come from the region. In addition, China's increasing investments in African states cement its oil security strategy since the continent possesses 9% of the world's petroleum reserves.

The three key financial measures, stock, FDI, and credit, can be viewed as the supply-side variables in the growth of clean energy in China if both oil and GHG represent the demand aspect of doing so (Chen et al., 2019). The stock marketplace, which consequently makes up the most significant portion, accounts for 16.25% of the volatility in energy growth from renewable sources. The second factor is foreign capital investment. The empirical approach demonstrates

that developing China's capital markets accounts for 42.42% of the country's energy efficiency progress over the last two decades (Paramati et al., 2016).

The clear takeaway from these empirical findings is that Chinese policymakers support financial development and implement additional favourable financing regulations for renewable energy. Our results offer solid statistical support for recent efforts in China to advance the development of a green finance system (GFT Force, 2015). We utilize a different measure to depict the modifications in China's energy system to test the validity of the empirical results presented in the preceding section. In this instance, the expansion rate of renewable non-hydro electrical power generation is utilized. The largest source of clean, renewable energy is hydropower. Its evolution nevertheless possesses particular features that set it apart from other renewable energy sources. It has an uneven geographical distribution, with the greatest concentration in southwest China. Its expensive electricity distribution from these areas to eastern China also comes with increased development costs in those power-rich areas. Then, hydro projects are frequently substantial and call for significant public funding. Additionally, the authorization process is drawn out and might encompass numerous government departments. Even if it resolves some environmental issues, it may create new ones.

Because of the unique qualities of hydropower, non-hydro power is a more crucial area for energy structure reform. In actuality, non-hydro-renewable development already plays a more significant part. Since 2008, the non-hydro portion of renewable energy has significantly expanded. We must figure out how well our econometric system functions without hydropower. The rate of increase of non-hydro energy sources is estimated instead of the proportion of growth in renewable energy employing the VAR technique.

5. Discussion

5.1. Interpretation

For the five aspects illustrated in Figure 5 in the previous section, five recommended actions can be employed. The first policy category focuses on building markets and includes initiatives like the Renewable Portfolio Standard (RPS). The next set of guidelines aims to lower investment risk surrounding clean energy sources by ensuring China has stable institutions, laws, and policies. The third suggestion relates to the supply of Power Purchase Agreements (PPA), the use of net metering, and financial incentives to increase the economic feasibility of deploying more renewable energies. Also, addressing technological barriers through contemporary innovations such as R&D and grid connection is heavily resourceful in this initiative. Furthermore, diversifying financial avenues by reaching local, regional, and global partners would lessen the overall expenditure toward clean energy transformation.

The US and EU are global leaders in both the implementation of and funding of green energy. Thus, it is essential to analyze what transpired in both economies. He et al. (2019) used data from the World Bank, which covers both of them from 1991 and 2012, which is almost a similar time frame as for China. When the previous empirical results were compared to nations such as the United States and Europe, the outcomes were quite distinct from those in China (He et al., 2019). Only 22.57% of the US share of renewable energy was attributable to financial development, compared to 33.78% for oil fluctuation in prices alone. It is illustrated by Liu et al. (2019) that economic reasons weigh far more significantly in the EU market, where its contribution to the sustainable energy market totalled 56.02%. We find this percentage comparable to that of China, although credit, not the stock marketplace, is the primary driver in the EU market. The contrasting significance of economic development is a further difference

between the EU and China. While development makes a negligible contribution to sustainable energy growth within China, it makes up about 16.76% of it in Europe.

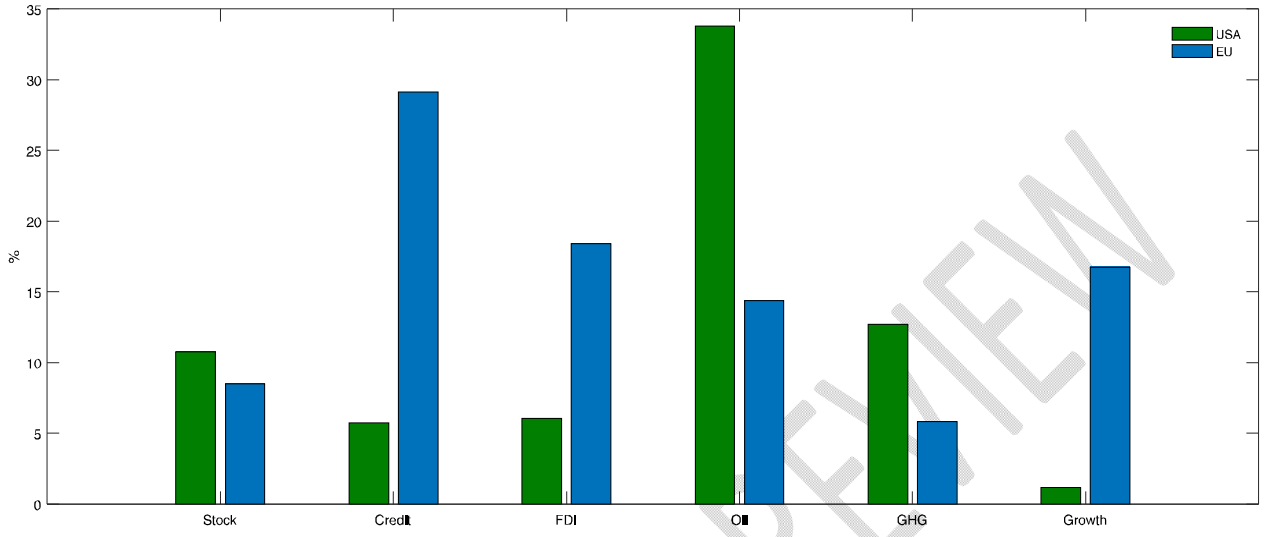


Figure 5: The US and EU Share Value of Renewable Energies

From the diagram in Figure 5, the credit sector in China appears to be playing a minor role (about 14%) compared to the EU, which is about 30%. On the other hand, the share of the US credit sector is valued at 6%. This variable alone shows the discrepancies between the US and E.U. Bai et al. (2019) conclude that despite the goal of creating a green banking system and some significant banks' actions have rendered a message to the market, and it is uncertain how the framework may benefit SMEs. Regarding the significance to financial development, China and the EU are somewhat comparable, although China and the US tend to be distinct. Given that China and the EU share more basic traits than the US, the EU route might prove more applicable to China.

China will approach these two developed markets gradually. The findings presented unmistakably show that the Chinese path is more similar to the EU model than the US history. This is not altogether unexpected because the US has maintained the biggest and most advanced

financial sector for over a century. In contrast to China and the EU, whose economies depend significantly on the world's energy market and experience more significant energy limitations, it additionally possesses a wealth of natural assets.

5.2. Policy Implications

The empirical findings have several obvious policy ramifications. First, our results demonstrate that China has a market mechanism to assist the green transition. Like other industries, renewable energy production may greatly benefit from expanding financial markets. With improved efficiency and reasonable financing options, stock market growth and credit system reform can indirectly help the development of renewable energy sources. International investment in the field of renewable energy should additionally be supported. Second, there is a need for explicit policy actions, particularly for the lending market. In China, the credit industry continues to perform a minor role compared to the European Union.

The concept of creating an environmentally friendly financial system and the actions taken by a few large banks have provided an unmistakable signal to the market. However, it is uncertain whether the framework could help small and medium Enterprises (SMEs) that are the most dynamic and significant forces for sustainable growth. Third, China looks like it differs significantly from the US but exhibits some parallels with the EU regarding the significance of its economic growth.

Given that China and the EU share broader traits than the US, the EU route might be more applicable to China. Regarding the data's availability, the amount of data we have is relatively modest overall; as a result, the numerical findings shouldn't be overanalyzed because they could be subject to any significant discrepancy in the variables. The overarching message should, however, not change. This in-depth investigation of past information in China has a clear

message for policymakers: they ought to reinforce the significance of the financial sector and create laws that support the renewable energy industry more. It further provides evidence of support for the demand for China to create an environmentally sustainable finance system.

A more significant overhaul of the financial system is required to make it simpler for non-state-owned businesses to get loans. Government should refrain from interfering with commercial banks to misallocate financial resources and disburse loans to companies that are not productive. Therefore, it is essential to continue enhancing the financial system's functionality and the market's. Also, think about the relationship between real GDP, consumption of energy, and capital stocks. China's economy is currently facing the transition to a future industrial phase. The strong relationship between GDP, energy use, and the amount of capital needs to be considered when the nation develops its energy consumption strategy. For instance, the decline in energy consumption directly impacts economic development and a secondary effect via lowering capital stocks. In the meantime, securing energy availability, its advancement, and using new energy technologies is essential.

5.3. Limitations and Future Research

The distinction between the duties of the federal and local governments is difficult in the energy industry's reformation process. While the federal government has lost the capacity to enact rules and make policy decisions, China's provincial authorities have progressively strengthened their control over energy businesses. Local governments typically hire regulatory workers at the local level, but they do so to carry out rules set by the national government. There is a lack of clarity on the legislative and administrative responsibilities of the State Council's numerous commissions and local government organizations (Secretariat, 2018). Some people find it difficult to relinquish their duties and battle over resources. The ineffective execution of

safety standards and removing unlicensed mines due to concerns between local and federal governments are two clear examples. The Chinese government must therefore establish an explicit set of regulations for the energy industry. It has been suggested that China adopt the federal system used in the US and Canada, where local agencies and the federal government's local regulatory rules, such as those governing security requirements and interprovincial matters, have been clearly stated and upheld. It may also be thought about creating a single regulatory body to oversee all energy-related issues at the national and provincial levels.

At the corporate and commercial levels, the structure of governance issues is challenging. Considering the current restructuring of the energy sector, it is unclear how free state-owned energy businesses are to compete domestically and abroad. For instance, it is unclear whether local oil corporations can use acquisitions and mergers to expand into the regions of other businesses. Additionally, domestic oil corporations lack clear governmental direction regarding purchasing overseas assets. Energy executives may behave most beneficially to the detriment of the public interest due to the lack of established anti-monopoly rules and regulations for mergers and acquisitions. It is feasible for both domestic and foreign competitors to collude or work together. Monopoly power can readily arise without a defined institutional structure that clearly defines the ability of regulatory authorities to control competitiveness in the renewable energy market.

The associated implications that we discovered are as follows. Firstly, governments should establish tax reductions and financial incentives to encourage a more significant share of green power in overall energy use to reduce CO2 emissions and protect the environment (Tian et al., 2022). Secondly, distinct financial development factors have varying impacts on CO2 emissions. Whereas governments should support the growth of the banking industry and stock

market to encourage economic expansion, they ought to establish suitable financial market policies, which include enabling more funding to adopt green innovations, which could lower energy use and carbon dioxide emissions. Thirdly, countries should focus more on increasing the share of green energy while supporting financial growth associated with decreasing emissions, as differing degrees of economic growth may impact the contribution of renewable energy sources to CO2 emissions (Li et al., 2022).

6. Conclusion

6.1. Key Findings

China's thirteenth Five-Year Plan (FYP) reiterated improving the energy sector's infrastructure as a potentially significant growth direction. Specific goals and actions have been developed to enhance the share of energy from renewable sources and encourage the production of clean energy. They represent the Chinese government's objective of lowering emissions and pursuing a sustainable and healthy course for economic expansion. Despite intense financial pressure, significant progress has been accomplished in the previous two FYP years concerning attaining ambitious carbon reduction targets.

Renewable energy development is frequently dangerous and expensive, particularly at first. Legislative support is required to foster an atmosphere that will help this industry grow. The economic environment is one of the most crucial pillars. The present research employs time-series information as well as a recently established systemic approach to examine how much the financial sector has played in the expansion of clean energy in China across the past 20 years, complying with the current research and China's recent developments on setting up an environmentally friendly financial system, that asserts that economic growth plays a crucial role for promoting renewable energy.

6.2. Significant Contributions

The study's empirical findings demonstrate that the banking industry dramatically contributes to changing the framework of the energy sector in China, employing the expansion of the stock market, the growth of the credit market, and the growth of foreign investment as indices of financial development. More than 40 per cent of the disparity in the variations in the percentage of renewable energy is often explained by the development of the financial sector. The continued growth of the stock market as a whole is the most significant of these economic drivers. It is compatible with the nature of an emerging sector's development, which is frequently risky and necessitates equity funding more than debt financing. We corroborate our findings and demonstrate the robustness of the results by utilizing the increasing rate for non-hydro hydroelectric net production as an alternate measure.

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