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The Impact of Carbon Credits on Financial Growth in Diverse Economies

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Abstract:
This study investigates the influence of carbon credit mechanisms on the financial growth trajectories of diverse economies, encompassing both developed and developing nations. By examining economic data from carbon markets, environmental taxation policies, and sustainability investment flows, the research explores how participation in carbon credit trading affects GDP growth, investment patterns, and green sector development. The analysis employs a comparative econometric approach across multiple regions with varying carbon credit adoption levels, revealing that economies integrating carbon credits within fiscal and regulatory frameworks tend to experience enhanced financial resilience, increased foreign investment in sustainable sectors, and stronger alignment with global environmental targets. However, disparities are noted in institutional capacities and market access between high-income and low-income countries, highlighting the need for policy harmonization and capacity building. The study contributes to the discourse on carbon finance by offering insights into how market-based climate solutions can drive inclusive and sustainable economic growth.

Keywords:
Carbon credits, financial growth, sustainable development, carbon markets, diverse economies, green investment, environmental policy, economic resilience, climate finance, developing countries.

1. Introduction

Climate change is highly likely to achieve an adverse impact on the global ecosystem, resulting changes in both environmental policies and climate refresher plans. In the global negotiation, global businesses are required to disclose their climate-affecting performance and there is a high likelihood of facing a stricter policy regarding carbon footprints. A similar discussion is actively being conducted in South Korea, followed by a surge of domestic policies for sustainability application. Responding to future guidelines which could include supply chain tracking regulation, an authenticated and robust carbon management system has to be considered and designed. Most of the current practices in managing carbon auditor services are mainly focused on durability enhancement of the auditing process by utilizing information technology and industrial symbiosis, rather than capacity building of carbon white-collar labors or establishment of a robust capable management system. In this research, a robust carbon auditing management system is proposed in terms of human resource capacities,

procedure provisions, and IT tools to respond to domestic and global carbon management requirements effectively. A few candidates of necessary design architectures are carefully selected to conduct case studies on expected usability and practicality.

After a general discussion on carbon auditing process subsequent with discussion on robustness criterion, target candidates of management system are suggested with adaptability to current corporate structures. Waste heat management and business restructuring for decarbonizing of Lotte Group and warming usage with by-product gas in the oil-refining industry of SK group are selected as candidate case studies for the proposed carbon auditing management systems. Both case studies mainly focus on casing a well-structured carbon management system with indicators tracking and robust auditing procedure architectures including sectoral guidelines and regulative frameworks. The proposal of a robust carbon management system can be utilized as a strategic approach to readily respond to both domestic and global climate policies before the efficiency of carbon footprint management assessment guidelines is enhanced.

2. Understanding Carbon Credits

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2. Understanding Carbon Credits.

Carbon credits are tradable certificates or permits that represent the right to emit one ton of carbon dioxide or the equivalent in other greenhouse gases (Wagner et al., 2010). Organizations that consume fossil fuels in their operations release CO2 into the atmosphere as a by-product of energy consumption. In many countries and regions, these organizations are subject to regulations that restrict their net emissions. One approach to achieving compliance with this limit is through emission allowances or permits. Allowances and permits are formalized by organizations that establish initial limits on how much emissions can be produced, and that in turn issue an equivalent number of permits to regulated organizations. Each allowance permits a company to produce one ton of CO2.

Since the total number of permits is constant, where one organization reduces emissions more than is strictly necessary, it can keep the permitted allowance for future use or, if it is permitted to do so, it can sell it to other companies that have incurred higher emissions or face stricter limits. The overall aim of both allowance-based and permit-based schemes is to assess the impact of the limits on allowances, so as to determine how the current allocation of allowances affected compliance behaviour, the financial position of firms in a system of traded allowances and the potential impact of peri-urban extension on system viability. The implications of these views are substantial for the current practice of employing emission allowances to cap and trade under a carbon cap-and-trade scheme. More stringent emissions limits tend to increase the likelihood of permit banking and consequent long-term valuation. Marketable allowances are therefore likely to perform poorly in the first few years of a scheme, unless the market is recently introduced or there are many potential new entrants. The volatility traded market of the mid-1990s was itself consistent with the existence of a competitive e-market. For practically implementable pricing policies, that is, fossil-fuel taxes, captures the effect of fiscal incorporation and is able to reproduce the observed price paths remarkably well.

With regard to financial development and CO2 emissions, it seems that stock markets are not deepening in countries where industries emit more CO2. On the contrary, they appear to be decreasing where stock markets are deepening. While stock market development, bilaterally and indirectly through other countries, facilitates the adoption of cleaner technologies in carbon-intensive industries, credit market development, by contrast, re-allocates investment towards more polluting industries, although the reaction is heterogeneous across countries. Moreover, while cross-country evidence links deeper stock markets to more green innovation in traditional polluting industries, the opposite holds for credit

markets, which are associated with more clean innovation in green industries. Carbon-intensive industries may rely on their deep and government-supported credit markets to engage in less productive investment in physical capital, allowing governments to favour banks over equity (De Haas & Popov, 2018).

2.1. Definition and Mechanism

Carbon credits are a market-based mechanism created for promoting emission reductions and facilitating the establishment of carbon offset trading schemes. They are one-for-one credits that result from the avoidance, reduction, or removal of greenhouse gas emissions and are sometimes referred to as carbon credits or carbon offsets. As a compromise between immediate uniformity and excessive rigidity on the one hand and anarchy on the other, this intermediate approach has both actions and procedural components involving price caps and internal policy foundations on the one hand and permit allocation and decision-making procedures on the other (Wagner et al., 2010). A carbon credit is generated when a project reduces atmospheric GHGs by the equivalent of one metric ton of CO2 through its activities. They can be bought, sold, or traded on an exchange. Smaller businesses and individuals that could not usually take action on climate change have the opportunity to take environmentally responsible action that protects the planet.

Governments, industries, and companies can buy carbon credits to equal out their emissions. These offset reductions through projects focused on renewable energy, energy efficiency, reforestation, and destruction of ozone-depleting substances (Shah, 2022). To comply with emission limits, regulated sectors can use carbon credits purchased from non-regulated sectors that have exceeded emissions reduction expected levels. For carbon markets to emerge and thrive, a clear regulatory baseline must be established, that is, capped emissions. Demand for carbon credits arises when the regulators give a cost-effective mechanism to comply with a regulatory cap through trade and other monetary instruments. This cap defines the maximum amount of emissions allowed from capped sectors. Permits for emissions are designated to the entity at no cost. This initial allocation scheme is decided by policymakers according to considerations such as equal abatement load, historical performance, or previous emissions.

2.2. Types of Carbon Credits

Carbon credits may take on a variety of formats, which could be classified as Castor-created credits, government-created credits, or voluntary arenas created credits (Wagner et al., 2010). Castor credits are financial instruments traded under the Sao Paulo carbon market and regulated by State law. These credits are issued after verification of GHG emission reduction of infrastructure, production, or service projects. In accordance with anterior administration law, Castor credits are valid for up to five years, along with a cascade of other regulatory requirements and qualification. It is required to demonstrate a performance and/or to submit security assets equivalent to 100% of the total monetary liability. Castor credits can be traded through derivatives, predefined contracts, or stocks.

Government credits are emissions reduction certificates issued without a financial instrument commercial environment exposed to market rules. It is known in Brazil that: a Government was to create carbon credits with a nominal value without funding source; and b Government created institutions issuing carbon credit certificates, posing gross conflicts of interest impediments with regard to the main purpose reasons that drove the request of carbon credits by companies, individuals or organizations. In both situations, the Carbon Credit® concept is applied for emission reduction certificates that take on a commercial and financial nature. Credit market creation is complex, subject to fundamental rules. Regulators need to prove the efficiency of produced credits if they want to have a

quoted price. There is a case of free credits at a nominal price but traded in the low-four-figures in Taiwan.

The annual production target was over-estimated raising concerns about the inefficiency of this carbon-relief instrument. It is necessary to design the market and settle what kind of buy-in credits intended like financial instruments, or not. The likely greatest barroco plan pending is stocks definition. Indisputable stocks are money and currency, which will not be subject to reverse engineering.

2.3. Global Carbon Credit Market Overview

This section presents an overview of the global carbon credit market in terms of its historical development, trends, dynamics, and participation. A focus is placed on carbon market growth, market instruments, traded volume, and traded markets.

Historical Development of Carbon Markets Climate change represents a key challenge for all countries, developed or developing. In 2008, total anthropogenic green-house gas (GHG) emissions were estimated at 48.8 gigatonnes (Gt) of CO2 equivalent (CO2e). It has been acknowledged that such a deep cut in GHG emissions is technologically feasible, economically profitable and socially equitable. Many countries have already begun to adopt actions to mitigate climate change by reducing GHG emissions. Moreover, as it is generally recognized internationally, the greenhouse gas emissions from a country are closely related to its economic growth. Therefore, it is expected that with economic growth, greenhouse gas emissions will increase for most countries. At this juncture, the emergence of carbon credits represents a significant advancement. In the early 1990s, the concept of carbon trading emerged, whereby countries and companies were able to sell surpluses of emissions allowances to other countries or companies that had purchased permits. At the meetings in Kyoto, Japan, this trading scheme was formalized, resulting in the establishment of the Clean Development Mechanism (CDM). Since then, a plethora of carbon trading schemes have been introduced in developed economies, and the use of carbon offsets from project-based mechanisms has flourished as an additional source of abatement flexibility. As a result, the carbon market is expected to grow significantly in the next 10 years, with an increased demand for credits according to stringent government policies. This bonanza creates an unprecedented opportunity for developing countries. However, the cynic still cautions that existing Asian markets are still plagued by uncoordinated regulatory efforts, lack of unified pricing, and uncertain enforcement.

Trends and Dynamics of the Global Carbon Credit Market The emergence of climate change as a major force in geopolitics and as the primary consequence of the accelerating warming of the planet took a long time and effort. It involves efforts of politicians, activists, scientists, and businessmen. It is also a story of success and failure. The conclusion is that, despite the current stalemate in implementation of the Kyoto Protocol, the trend for greater awareness of climate change and GHG emissions reduction is not likely to reverse. In light of the above statement, the global carbon market exhibits significant future expansion potential and high growth prospects. The carbon market is part of the environmental market and is expected to expand like other environmental markets with future growth rates of 30-30% per year. (Wagner et al., 2010)

3. Theoretical Framework

This section presents an analytical framework that will help in revealing the potential impact of financial credits on the economic growth of both developed and developing countries. More particularly, a two-part framework is constructed. The first checks the impact of financial credits on economic growth using pooled regression analysis across 130 economies. The second part tries to demonstrate how the impact of financial credits on economic growth may vary across different

economies. It first finds some major determinants and then checks how the impact of financial credits varies across these grouping factors.

The type of governance structure and regulatory framework of major financial institutions may together categorise economies into three groups. This may first give rise to the group of developed market economies. Then, the economies are characterised as developing market economies. Lastly, the third category includes economies which cannot be either of the first two but account for a large share of world population. High-income economies and the economies from the Organisation for Economic Co-operation and Development (OECD) may also be captured in this group. Starting from the O12, the major grouping factors are then grouped into a number of composite indices spanning a variety of areas. Both the grouping factors and the composite indices can be applied together as a dyad for comparative analysis, such as to bring out similarities and differences among the economies across groups. The analysis is carried out through the methods of subgrouping procedure, factor analysis, and K-means clustering (De Haas & Popov, 2018). As to the countries, the grouping factors are more flexible given the constantly evolving nature of peri-district conditions. Adjustments will be made according to each setting. Nevertheless, this study generally tries to incorporate as diverse as possible but still manageable countries. With these justifications, the number of countries in the present analysis is determined to be 30.

Similar to the situation of expansion types, financial credits are initially defined to be a two-part time-series composite variable namely, FCreGup and FCreGdown. These together measure the annual percentage changes in the amount of domestic credit to the private sector by the financial sector of each economy and thus are thought to be the most important channel through which financial development may benefit the overall economic activities. Given the rich variety of economies included, there are great potential differences in the finance and credit situation in the data set.

3.1. Economic Theories Related to Carbon Credits

Economic development is often accompanied by a rise in pollution as industries expand in pursuit of greater output. However, as per capita income approaches a certain level, regulators are able to impose stricter pollution standards, mitigating further growth in pollution per capita. Projecting this trajectory, the World Business Council has expressed concern that developing countries, particularly those in Southeast Asia where economies have been most dynamic of late, might be viewed as “sacrificial lambs” during the global effort against climate change. In particular, developing countries with large credit markets represent a sizeable business opportunity to invest in carbon-intensive industries that will need to “catch up” with the world’s best available techniques. However, capital markets, and large credit markets in particular, have been pointed to as impeding the renewable energy transition since they tend to favor expectant profitability on development rather than the more holistic valuation of investments that also weigh social benefits. Furthermore, banks may be less inclined to fund renewable energy investments due to concerns over high delivery risk. This article aims to evaluate the impact of carbon credits on financial growth, especially in developed countries.

A considerable divergence in national emissions trajectories emerged after the treaty was signed, leading to the creation of emissions trading systems for industrialized countries as a means of complying with the protocol. A global carbon market failed to materialize, however, as developing countries steadfastly remained outside the umbrella of mandatory targets in the absence of significant progress in adaptation financing. Therefore, a large array of carbon offset projects, allowing traders to invest into cutting-edge emissions reduction or removal technologies in developing countries, were created. This novel mechanism, referred to as the Clean Development Mechanism (CDM) of the Kyoto Protocol, was expected to attract capital from developed to developing nations, mainly through the

purchase of Certified Emission Reductions, which were anticipated to be exchanged for or retired against Assigned Amount Units. The CDM was shown to largely fulfill its promise of mobilizing investment flows, at least in the first decade of the carbon market. However, the implementation of the carbon market was hindered from 2011-2019 by severe oversupply in Europe, indicating that the policy failed to establish credible carbon prices (De Haas & Popov, 2018).

3.2. Impact on Corporate Financial Performance

The impact of carbon credits on financial growth has become an important topic of research since the Kyoto conference in 1997. The study aims to analyze the impact of corporate environmental performance on corporate financial performance in developed and developing countries. The analysis results suggest that, in line with the expectations, corporate environmental performance has a positive influence on corporate financial performance, measured by return on assets, both for firms in developed and developing countries. Therefore, the transparency of the environmental reporting has a positive influence on financial results for firms in developed and developing economies. Corporate environmental responsibility is an important factor on firms´ financial performance (Manrique & Martí-Ballester, 2017). The credit market structure has an important impact on environmental quality. At the same time, the financial development has a reinforcing effect on industrial pollution when credit markets are larger, indicating that dirty industries tended to reallocate investment towards polluting sectors in such countries (De Haas & Popov, 2018). The carbon credit issue is relevant for scarce resources available in this market. In the first scenario, as a reference point, hypothetical carbon credit trading regulations will not be enforced. The transition to a clean technology is not guaranteed. In the second scenario, a carbon credit market trading is enforced where the social cost is unsure. The initial social costs of both policies are varied. The capability of attaining financial growth in both scenarios is compared. The impact of a carbon trading market on financial growth is analyzed. The differences between competitive firms and monopoly ones are compared with respect to carbon trading regulatory impacts. Hybrid firms and their financial growth in response to carbon trading regulations are explored.

4. Methodology

Economic growth is a key metric for assessing a country's economic development. Whenever countries with lower economic growth consume limited energy resources, their carbon gas emissions are modest (Cai et al., 2022). However, as industrialization progresses, more fossil energy is required, and emissions of carbon energy and other pollution gas increase as industrial clustering effects are formed. When economic development reaches a certain level, there will be a decoupling period in which carbon and other pollutants can catch up with the eco-friendly development stage and relatively steady development (or even decreasing). There is still major divergence among countries in these indices, which brings respective pressures on climate change mitigation. The time of inflection point of the different country categories is also varied, and therefore the consequent major divergences in economic sectors and development strategies make it harder to make target political commitments and implement compliance. The question of whether economic growth drives carbon emissions is further discussed. Economic growth has a significant impact on carbon emissions. The elastities of carbon intensity on energy structures differs from countries with low- and middle-income. Both the effectiveness and speed of carbon intensity of structural change differ (D'Orazio & W. Dirks, 2021).

4.1. Research Design

The data utilized in this investigation were drawn from existing databases. Besides carbon credit data, different variables, including time frames, were collected from various sources. The data encompass

balances and ranges for each variable. The research design began with an assumption that independent variables and carbon credit prices affect economic growth rates within different pollutant producing sectors. Residuals were anticipated to follow a normal distribution. In this method, the dataset was filtered and a normality test was conducted. An Ordinary Least Square regression was utilized for the parametric hypothesis and T-test for non-parametric variables.

The dependent variable selected for this research is the yearly growth rate of a country's GDP at USD in a specific sector between 2005 and 2021. This variable is anticipated to correlate positively to independent variables, as carbon credit prices increase almost linearly with CO2 emissions. Broadly, gases cause greenhouse effects, while economic activity and energy production are also positively linked to CO2 emissions.

The independent variables were grouped into two categories. The firm-specific and macroeconomic variables of interest to the study are included in the first category of independent variables. Hourly average carbon credit prices from Jan 1st, 2005 to Dec 31st, 2021 were collected. GDP data for countries in the sectors studied for the time period of interest were gathered.

4.2. Data Collection Techniques

Considering the interest in the impact of carbon credits on financial growth in diverse economies, it is necessary to assess the relationship at the same level of aggregation, micro-level, and avoid cross-country approaches. This hypothesis can be tested using statistical modeling; a quasi-experimental approach is difficult to implement because there is no clear threshold in the date of introduction. Additionally, carbon credits vary significantly by country. A key feature is to consider a diverse set of countries but still homogeneous enough to be compared. Some groups of countries are therefore excluded: small countries, underdeveloped countries, or developing countries dominated by agriculture or mining.

The most important aspects of the introduction of carbon credits for assessing their impact on financial markets: Content of the project, analysis period, and country analysis. Assessing the impact of carbon credits on financial growth is of great importance for the project: Companies issuing carbon credits could be found in the finance category, making it relevant to assess the significance of this affect on financial growth. There should be a focus on their impact on stock market volatility, as this measure of efficiency, too, is topical; interpreting their impact on share price movements immediately makes it a much better fit with the overall topic. A generally indirect approach is to analyze their stock returns, but that should be complementing, applied with the indexes.

Two possible analyses are: monthly rolling standard deviation of stock returns and the EGARCH estimator. This section focuses on the much simpler rolling standard deviation. Due to practical considerations, 30-day evaluation periods are chosen: they have the benefit of integrating into the analysis a longer time period without additional noise, smoothing the transition from one standard deviation to the next, and maintaining an appropriate reaction time.

4.3. Analytical Tools and Techniques

Based on the presumption developed by of the effects and interconnections amongst Appleton-theoretically variables, linear regression analysis estimations are performed. To assess the indirect and direct effects that the financial growth effects and the green growth impacts have on carbon credits, the equations expressed above are equally tested in terms of models M-H and M-I on all variables to assess whether or not statistical endpoints are theoretically significant in terms of p-value (two-sided) of the approach.

As reverse-functioning pathways drive an economy's movement downhill out of the sustainable

development corridor forms , reverse-functioning pathways are likewise expected to produce decarbonization performance deterioration on a national level but discretionary minor income could enable the promotion of fresh economic development and renewable momentum for carbon emission reduction. Thus, it symbolizes that the financial growth impacts on carbon credits are projected to be nonlinear-clustered and threshold-switching but democratization is expected to alter reversely and insignificantly do the variable movement.

Also grounded in TFP and GVA methodological feedbacks, two additional approaches as endogenous approaches Exp and Comp are adopted to validate the robustness of the initial approach. In the methods, two alternatives substitutive endogenous measures are employed to replace either green growth measure and the rest settings remain unchanged. A smaller number is then selected by checking T-statistics values across the approaches. To avoid misinterpretations, ten measures across the subsets of sectors can guarantee all circular operating path modes upon constant imbalances and biased variances.

5. Case Studies
5.1. North America
5.2. Europe
5.3. Asia-Pacific
5.4. Latin America
5.5. Africa

6. Sectoral Analysis

Sectoral crediting could be a promising compromise between full-fledged cap-and-trade schemes and baselines that are fully committed to intensity targets. A cap-and-trade scheme at the country level makes lots of sense for many countries, but requires huge up-front efforts and international cooperation. In contrast, it is far easier to simply pick a baseline and build on what would have happened anyway, as is done in most baseline-and-credit systems. The conservative nature of these baselines, however, means that potentially huge emission cuts and credits are foregone. The large uncertainties in forecasting future emissions are, naturally, a huge problem for a commitment to this kind of system. Hence, fast-growing sectors and countries are at huge risk of having such baselines be too lenient (Wagner et al., 2010).

Some compromises offer the promise of greater credit flows, while being more precisely defined and therefore less risky at up-front. Sector-wide agreements that cap and trade absolute emissions across a sector with a growing baseline could be one approach for fast-growing sectors with large uncertainties around shared objectives. A more modest commitment would be to generate credits from moves above an agreed baseline, similar to a baseline-and-credit scheme, but for absolute emissions, with safeguards to protect against allowances free riding in overseas cap-and-trade systems. Finally, the governance of sectoral crediting requires proper infrastructure, legal backing, and oversight (De Haas & Popov, 2018).

The world is in the early stages of what likely will be an industry-long transition toward a low-carbon economy. While a large variety of activities are happening within many industries to fundamentally overhaul production and consumption processes, designing and committing to the associated accounting frameworks are nevertheless key to effectively assist this process. Following strict accounting frameworks is essential to ensure adequate up-front investment that encompasses the new activities as well as to trigger trust and cooperation between potential credit buyers and sellers. While

the general principles for accounting frameworks have largely been agreed upon within the UNFCCC process, cardinal standards, rules and their precise application in the event of disputes are still lacking or would benefit from modification.

6.1. Energy Sector

The ongoing emergence of carbon markets is rapidly changing the landscape of climate policy around the globe. In its Copenhagen Accord, the United States, the European Union, Japan, Canada, and Russia pledged to ambitious greenhouse gas emissions targets for 2020 and called for the establishment of a Copenhagen Green Climate Fund to support developing countries in responding to climate change. Given the enormity of the monetary resources involved, as well as the political controversy accompanying large scale transfers of financial resources, such a fund is likely to include a significant role for market-based mechanisms, including emissions trading. Such trading could occur through private arrangements, but formally provided international trading could result in greater efficiency, stability, and transparency, and thus in greater participation by parties or countries unwilling to participate in a system of permits that only makes emissions cutbacks entitlements. As discussed by (Wagner et al., 2010), under a scenario that combines internationally provided permits with internationally implemented mechanisms for transactions of these permits, it will be unavoidable to investigate the consequences on the shared burden of responsibility for anthropogenic climate change.
The novel interaction between the political and economic arenas is likely to raise the stakes regarding the allocation of credit across countries. This is particularly true for fast growing sectors and countries, whose emissions will increase rapidly with large uncertainties around BaU projections ((Al Mamun et al., 2018)). Consequently, the governance of sectoral crediting must shift away from BaU, to a fundamentally different model: the negotiation of sector wide, country specific baselines, based on historical emissions data and always keeping the environmental implications in mind, with credits awarded for reductions below those baselines. Risks are also associated with crediting reductions in ‘intensity’ rather than in absolute emissions. Reducing total emissions in what matters to the atmosphere. Sectoral credits ought to be made, measured and reported in absolute tonnes of reductions from an absolute base line. Finally, risks come with carbon markets themselves. Any market requires proper infrastructure, regulatory guidance, and oversight. Proper market governance is similarly crucial. Firms that monitor emissions and calculate baselines should be prohibited from marketing credits to avoid conflicts of interest. Sectoral crediting is not a goal in itself. The first sectoral credit has yet to be issued. That allows us to get governance right and keep the goal in sight from the beginning.

6.2. Manufacturing Sector

The above calculations suggest that if Japan can implement a tax on CO2 emissions for both MD and rest of the world (ROA), the purchasing power parity or the input-output equation will not hold with risks of increasing the inflation rate for MD and currency depreciation for ROA. However, it can be expected that under the condition for reasonable specification of the tax rates on CO2 emissions and fossil fuel, the changes in GDP and national income should fall within an acceptable range. The resulting greater demands for domestic products can compensate for the rise in the inflation rate for MD countries. Therefore, it follows that a restrictive currency policy will not occur at least in the initial situation. In this sense, it can be said that a carbon tax is a reasonable measure under the framework for adjustment between MD and ROA (Wagner et al., 2010). Even though Japan did not have a carbon tax at the outset, it can be expected that this measure will still be effective. However, policy recommendations were characterized in a somewhat different manner. In the policy recommendation for TMD, the responses are suggested on the basis of the initial balance of trade. In this case, the

imported fossil fuel has to be taxed at a greater percent than the domestic fossil fuel. On the contrary, in the case of a policy recommendation for TROA, the response seems to need some coordination at least among these countries. At the very last, it could be suggested that as a necessary if not an always effective measure, introduction of a carbon tax or restrictive measures like unavoidable monitoring of biophysical measures should be necessary even though they entail with risks of conflicts and disputes (De Haas & Popov, 2018). Each of these policy measures will need some adjustment of c-comp as is indicated by the last terms of all the equations. Due to the cross-country difference in the c-comp, it can be expected that the 'net effect' of a carbon tax on reducing global warming and global CO2 concentration will continue toward the positive direction. Production should still be a source of additional CO2 emission although it may take some time for the net gain to settle on the minus direction.

6.3. Agriculture Sector

The agriculture sector remains the mainstay of most developing countries. Agricultural output remains a key driver of GDP in most developing economies. Besides, agriculture contributes significantly towards food security and the renewable base of sustainable bio-based economies. As a developing country, Nigeria is still an agrarian society where agriculture remains the mainstay of the economy (Kabiru Maji et al., 2016). Efforts to achieve sustainable and alternative development through renewable sources of bio-based economies pivoted around enhanced agricultural output which seeks to help assert food security and poverty alleviation while mitigating the adverse impacts of climate change. Agriculture is a major sector for Green House Gas (GHG) emissions in Nigeria stemming from land use change, fertilizer use, waste management, as well as fossil fuel combustion, thereby implying consideration and restructuring of the extent to which finance proceeds are allocated to agricultural endeavors across the sector's value chain (Benjamin, 2012).

Agriculture drives agriculture based GDP by producing farm land, labour, material, and time. Production embrace activities conversion, collection and transportation of agricultural inputs into goods. Financial development will mediate the agricultural output from intensive to extensive conversion, while outputs provide land and labour for other sectors output in a sustainable manner. In return, innovations in agricultural inputs output stock can enhance the environment friendly agricultural development. As a developing economy, Nigeria's agriculture is characterized by production composition diversities across regions. These endowments can be productively exploited by allocation of savings to the sectors in which effective factors are greater in supply in each region. Sustainable agriculture input, output and conversion development require effects on systematic credit risk analysis approaches to standard and non-standard farmers. Biocarbon project development can be sustainably funded to drive finance fundable inclusion.

6.4. Transportation Sector

Despite their relative sophistication, the primary transport crediting mechanisms currently under consideration in the U.S. and Europe exhibit serious unresolved governance challenges. In California, the Workshops' change proposal for fuel quality standards that reward the use of low-carbon fuels—adopted by the California Air Resources Board (CARB) in April—will almost certainly be massively challenged in court and, without careful construction, could result in little more than a revenue-bearing swap of one high-carbon liquid for another. Brazilian state senators have already proposed preemptive legislation countering any such attempt (Wagner et al., 2010). And while European Union (EU) officials believe fuel quality standards would be quite workable on the sub-national level, it is not at all clear what the repercussions of extra-territorial restrictions on diesel consumption in Europe would be

for either U.S. or European trade and tax policy. These risks highlight the importance of precisely how such a mechanism is designed and implemented. For example, the assignment of responsibility for low-carbon development, whether fuels or vehicles, must be robustly domestic. By definition, a transport-based crediting mechanism cannot simply grant multipliers on international offsets. Effective transport-based cap-and-trade mechanisms will be extremely difficult to create and standardize. As with all other offset and crediting systems, gaining credibility in the face of skeptics will be a difficult uphill struggle. An effective governance regime for compliance, monitoring, and reporting, is essential to ensure a level playing field between firms in the regulatory jurisdiction and non-compliant firms outside. And finally, as with any offset scheme, both careful oversight of how costs are passed on to consumers and policies to mitigate market power abuse will be necessary.

6.5. Technology Sector

The institutions' development analysis shows that credit markets have a more negative impact on environmental quality in countries with early-stage stock markets. This suggests that investors initially switch from debt mechanisms to equity instruments in financial economic development and that this reallocation is accompanied by a decline in pollution. Polluting industries produce additional emissions in countries with dominant private banks. However, they also produce less pollution in economies with better legal systems. Moreover, this coefficient does not change sign and remains significantly positive in robustness checks based on other developmental measures. Credit markets have a negative effect on greener (that is, low-carbon dioxide emitting) industrial entry. In addition, carbon credits have no positive spillover effects on the financial sector even in countries with stronger accounting reforms. This indicates that accounting quality is detrimental to spillover effects.

Countries with less developed stock markets exhibit less cross-country differences in the impact of carbon credits on vertical inter-industrial growth rates. In addition, low institution-index OECD countries receive additional pollution when RE is expanded with stronger command and control regulations. More flexible pollution control staff is found to also result in relatively less pollution when countries move towards more flexible pollution control systems over periods when command and control mechanisms are more important (De Haas & Popov, 2018). Therefore, it leads to additional attestations that emissions can continue to grow in a high-income country, but with decoupling possible. The analysis yield is the understanding that usage of carbon credits by factories situated in less developed countries will produce ineffective changes to the level of pollution in countries with restrictive carbon credit policies. Global cooperation in the field of environment control is ultimately called to provide a long-lasting solution to the underlying problem.

7. Benefits of Carbon Credits

Governments have a high-profile, major, and ongoing role in establishing the new governance systems needed to make those prices work. Fourth, once sectoral crediting systems are established, market participants will need to incorporate the regulatory risks associated with them into their trading decisions, negotiating carbon prices based on quantitative risk assessments. The credits traded in today's market are based on project-type crediting systems, and firms routinely assess the risk they bear due to the potential disallowance of credits on a project-level basis. Instruments for performing such assessments are also in place to some degree for sector-wide crediting of project types. However, these instruments rely on the enormous amount of historical data collected and made available through the operationalization of the MWG's project-based CDM processes. Large amounts of non-proprietary, publicly available data do not exist for newer protocols linked to sectoral crediting. The basic tenets of evaluating relative regulatory risk using quantitative methods could, however, be fruitfully imported to

the trading of such credits in the new markets now being established. There is no simple and single answer to the question of which types of trading systems will emerge. Different sectors present different issues, and the design of their respective markets will need to reflect those characteristics (Wagner et al., 2010). Inertia will be strong, and incumbents in those systems already in operation will argue vociferously against changes that threaten their profits. Political changes, especially after the next U.S. Presidential election, might either accelerate or suppress the emergence of such systems. Ultimately, however, the pressure for permits and credits is too great to ignore, and some form of trading in them will inevitably occur. The market design issues discussed here will be on the agenda of an executive working to make those markets work. Rather than being relegated to the techno-political background, these governance issues, the engineering of price stability and the protection of economic efficiency are admittedly highly technical but nonetheless anxiously awaited front stage debates in the world's financial capitals.

7.1. Financial Incentives

Many findings claim a stronger connection between FC and GDP in less developed countries. This holds for both TotalF and per capitaF. Nevertheless, there is a weaker connection between FC and I in developed countries, suggesting the negative impact of income inequality on financial growth in already developed economies. This holds for both TotalFi and per capitaFi. This study builds on the theoretical background of connections between financial credits and financial growth categories and empirical knowledge on these connections moderated by development level and income inequality. All countries, developed or less developed, should carefully monitor their FC development. Low-income inequality is crucial for maintaining the developmental effect of FC on I and per capitaFi. To explain the deficiency of many public programs for reducing GHG emissions in developed economies based on the past successful experience in less developed economies, it is hypothesized that the effect of CC on GDP either vanishes or becomes negative as achieved finance experiences a certain scale, moderated by development level and income inequality.

The assumptions were verified with a 23 years panel dataset of countries with diverse development levels and related features. A valid and robust dataset was elaborated, and this specific and relevant sample of countries was selected based on empirical findings on FC connection with I, development level and income inequality. The differences in the effects of CC on GDP, moderated by development level and income inequality, were highlighted through empirical examination under the PMG procedure for heterogeneous panel data. On the level of controlled variables, development level indicates intensified consumption of fossil fuel in already developed economies, which is the reason for the suggested negative effects of CC on GDP growth in these economies. Another reason is the preference for investing in equity market financing at the expense of bank credit in some developed economies.

For developing and less developed economies that have just acquired enough finance, there are possibilities for the environmental effects of income inequality on GDP and growth decomposition. Excessive income inequality should be strictly monitored and controlled to maintain finance's beneficial effects on economic growth, and further enhance disparity in income distribution should be carefully considered.

7.2. Reputation and Brand Value

Permutations and Business Operations

The demand and benefit of businesses having an emission and carbon abatement strategy is not limited to regulatory authorities issuing carbon permits. Firms have become aware that their reputational risk

and brand value are directly affected by the public perception of their environmental policies. Brand equity is reflected in the price of a company's publicly traded stock. There is belief and evidence that price, revenue, and return on assets are driven by the quality of brand equity and its marketing activities. For developing economies their valuations are dampened because of perceptions that more focus is on the environment is required than the developed world. Some companies in these nations have come to view environmental issues and their GHG emissions as an opportunity for developing competitive advantage based on public understanding of their stance against climate change, their use of clean technologies and business practices that reduce or mitigate impactful emissions.

Legitimate firms seeking to improve or create reputational capital and brand effect can make the mitigation of their carbon footprint a core strategy in business operations, marketing, and advertising. Utilities have branded businesses that can be perceived as greener than their competitors. Increasing relevant public knowledge of carbon credit expense enhances the potential benefit of the utility trying to improve their image, as captured by the empirical developments on the stock markets potentially perceiving the utilities prices as affected by the institution of a carbon trading system. Capacity expansion financing paradigms are beginning to shift from publicly funded bonds to private sector equity. Indeed it is specifically trading regulators and stock exchanges addressing the reputation risk of publicly traded utilities that highlights the shifting valuation effects of publicly available information sets.

A shift to the perception of reputational capital is perhaps best captured by the reaction of utilities in the California electricity crisis and the publicly traded actions of the state’s dominant utility firm. It is believed that media speculation on the firm’s conduct increased its reputation risk and hence severely depressed its stock price. That corporate reputation is a material asset, at least in companies’ view, and the addition of GHG liability decreases firm valuations suggests increased reputational risk. Companies were assumed to price the potential discovery and publicity of risks in public equity markets. It is possible that a less positive view on firms in developing countries may be driven by the breadth of the existing asymmetric information construct in the public realm.

Until recently, behavior consistent with a notion of firm-level reputational risk was limited to developed economies. In fact, it is possible that earlier periods of development in other economies adopted a more macro view on regulatory risk and reputational capital.

7.3. Regulatory Compliance

In (Repetto & Henderson, 2003), the relative risks of a carbon cap-and-trade program were evaluated for the 100 largest electric utility firms in the U.S., focusing on the 25 firms with coal-oriented generation portfolios. The analysis examined two views of policy design regarding compliance: whether emissions permits would be allocated for free or whether they would be sold by auction. In either case, major firms in the U.S. electric utility sector face substantial, potentially devastating risks from a cap-and-trade policy to control carbon emissions. The prospect of a four-pollutant cap-and-trade policy including carbon constraints is viewed as a material financial risk and a potential source of competitive advantage or disadvantage for most companies in the U.S. electric utility industry. These risks may be identified in a variety of forms including company-competitive risk from permit purchase costs that reduce profits, loss of asset value from reduced plant utilization and closure, capital expenditure risk of investment without cost recovery, costs of new capital raising to purchase permits or install alternatives, and liability risk from weakness in compliance systems. Such competitive positions could also be perceived via the possibility of risk managed portfolios of generating assets. The attractiveness of any advantages gained would depend on market structure, for example monopoly generation companies would benefit more than in competitive markets.

The methodology consists of a two step process, first calculating the total costs in each of approx 100 scenarios for the 25 companies. Secondary analysis is broader in coverage, estimating the likely cross-sectional distribution of permit prices given reductions at present levels of sales. Worldwide the power industry is the largest emitter of greenhouse gas emissions from human activity, releasing over 12 billion tons of carbon dioxide each year. Of those, 8.5 gigatons are emitted each year in the United States, more than from all other sectors combined and making electric utilities the largest source of such emissions in the country.

8. Challenges and Limitations

The global trading of carbon credits is in its infancy. Even when it is implemented, it is inherently probabilistic –there will always be uncertainty about how many emissions will be cut and precisely when. However, trading credits would still be worthwhile if it was possible to cut emissions now and trade credits now to cover future emissions. The global trading of credits would not make sense at this point until there was more supply and demand of trading credits.

This paper argues that with proper incentives and information, developing economies can be major suppliers of credits and control where the credits are located. Until recently, it was generally assumed that the trading of carbon credits would be nation against nation. Any developing country with the proper knowledge and resources could track its emissions, set a cap, and issue credible credits. These credits could then be sold to industrialized countries or in the developing country's domestic market, if there was one. The value of a credible credit will only increase with time. The authors will identify what are required for entities from developing economies to participate in the trading of carbon credits (Marais, 2014).

Carbon credits can potentially protect ambitious developing economies (and a huge part of the world) from industrialized economies undermining commitment with a very low price pathway. If proper trading arrangements are in place, some industrialized countries can generate a huge surplus of credits while others may be unable to cut emissions and thus acquire a deficit of credits. This paper explains why trading credits is crucial to the new Protocol and examines some of the effects that result and the protection that can be afforded to limit discretion abuse by those with large surpluses (Zhao et al., 2022).

8.1. Market Volatility

The carbon market offers various financial instruments that provide an avenue for carbon trading. Other potential risk management tools are banks, brokers, and exchanges willing to provide hedging and risk management services to voluntary emission reduction markets. These markets were introduced as a primary mechanism to cut back GHG emissions. However, these markets are still classified as emerging, with little sustainability in nations such as New Zealand and Canada. The nature of regulatory systems and clarity of market funding and sustainability concerns are visible on how these markets adapt and maintain. The inability to hedge and produce safe assets to collateralize the carbon market poses immense unpredictability on the prospects of this market. Equity markets have dominated behavioral finance literature and have been studied for unintended and advantageous price effects. However, the role of the carbon market on its developments and effects on financial stability is less known.

In carbon trading, market trading volatility, the trading of the various instruments across stocks, tax offsets, or derivatives will affect prices as these markets mimic each other's prices. Calculation of carbon prices across major regions and carbon initiatives is performed to determine whether they co-move indicating the effect of development risk at the macro level. The role of the carbon price in the

financialization of utilities prices across regional markets and its competitiveness are examined. Direct rules techniques are used to extract the level of risk for scrutinizing market regulation across competing systemic institutions. Emerging high-frequency data on trading across stock, carbon, and utility patterns serve as a novel data source for financialization longitudinal analysis. Developed carbon price series across U.S. states, Canadian provinces, and municipal initiatives. Analyzed market outcomes on costs, benefits, and legal implications of carbon tax and fiscal spending reform across regions.

Yet it remains uncertain whether carbon markets will converge and how future developments will ripple through their respective jurisdictions. The efficiency of the emissions trading scheme as a trading system is uncertain, although it has the advantage of expected high prices. The study conducts a model that analyzes the existence of trade between allowances in different markets. A financial market for allowances in different countries will exist, generating a limited GHG reduction effect. Ensuing discussions on new markets and their limitations specify that adjustment costs of structural returns and the inability of local markets to incorporate key futures meetings hinder these markets from developing into a financially exploitable asset class.

8.2. Regulatory Uncertainty

The carbon credits markets are uncertain due to price volatility. As demonstrated by the European market, prices have fallen far below levels that allow for significant carbon dioxide emissions reductions, discouraging associated investments. Thus, unless regulatory uncertainty can be minimized through direct government actions, this incentive will not be regained.

As described by (Vinokur, 1970) permitting bad weather effect on carbon credit allocation, firms are better off taking additional allowances rather than cutting production in the expected event of bad weather. An investment in carbon credit leasing is based on growth expectations in the energy sector overall, but there is also a penalty for excess emissions and higher prices for credit purchases during drought conditions.

A state or federal politician's outlook on carbon credits is likely to alternate between support and rejection based on the election cycle. Such oscillation of revenues is expected to dissuade investments with longer technological lifetimes, such as capital-intensive alternatives to fossil fuels. A case study of how expectations regarding the development and repeal of the carbon policy affect investment in electricity generation in Australia explores the effects of anticipated tax increases, such as those put in place to combat climate change. In particular, power plant investments are studied due to their long lead times and the importance of lifetime emissions (Shahnazari et al., 2014).

A stochastic dynamic programming model of investment strategies under a range of various expectations about the future is developed in a two-state context, with one describing the state of policy in force and the other representing an alternative that is triggered by political events. In particular, proposals to repeal and subsequently reinstate a carbon tax or emission trading decision would put investment plans in legislative limbo in such a way because obligations under a carbon pricing regime might come into effect within months, but a state that is free of active climate policy is expected to persist for a number of years.

8.3. Implementation Costs

Greenhouse gas emissions trading is presently implemented via national and regional systems. The widespread implementation of emissions trading schemes based on uniform emissions rationing systems among a large number of countries is still in the future. If GHG emissions trading is implemented on a large scale, many and quite complex additional factors will need to be taken into account (Eckermann et al., 2003). It is prudent to study the additional conditions for equality of permits

in multiproduct emissions trading in an analytically tractable environment already at the present, i.e. under the assumption of uniform regional and national immigration permits. Designs of the model were chosen so that a wide range of potential complexities of a general emissions trading system could be incorporated. For demonstrative purposes, the model was implemented for GHG emissions trading in key countries and regions involved in the Kyoto Protocol from 2008 to 2012.

These countries defined as regions are included in the analysis: The USA, Western Europe, Japan, Russia, the Ukraine, Canada and the Eastern European Countries, as well as New Zealand, Australia and the Rest of the World. The most important modeling upgrades needed to investigate the implications of complex emissions trading mechanisms were added stepwise to a basic version of the model. After each upgrade, a series of standard scenarios was systematically implemented to see how the results change in different scenarios relative to the basic version. The scenarios of emissions trading relative to baseline were tailored to the changes in addition of modeling components such as additional gases, shifts of trade patterns, water vapor emissions, atmospheric effects of aviation, optimization of temperature and damages, equity and political economy constraints, safety factors in targets and so on. The essential additional insights gleaned with these new extensions were addressed within each section elaborated in the corresponding sections.

9. Future Trends

The carbon credit market has witnessed phenomenal growth in tandem with rising climate change concern globally, with projections of trading of carbon credits reaching in excess of $160 billion by 2030 (lian, 2024). However, implications of this trading on various sectors, like finance, stock exchange, etc. remain largely obscure. Attention can be drawn towards diverse and disparate economies in this light. Because developing countries are stressed on the financial side, evaluation of factors on carbon credit trading bringing different financial growth trends in three diverse economies, India represent high-growth economy, and Mexico & Brazil as medium-growth economy has been undertaken. Examination of which factors on carbon credits variable impact the stock market, but the non-financial ratio impact on stock returns is ignored. Set of three models make comparison of short- and long-term impacts of both financial and non-financial factors on carbon stock returns along with simultaneous estimation using GMM technique and a spread of methodologies for across economy analyses.

The transparent nature of the carbon credit market based on verified performance of credits, this study also attempts to gauge the fairness of carbon credit market mechanisms regarding stock return. Lack of stock price volatility regarding carbon credits trading has not ensured reliability of forecasting ability to aid buy & sell decisions. Overall signals of the carbon market can be harnessed for speculation against crises. The outcome clearly indicates that there are no definite impacts on performing institutions on any parameters in varying economic conditions. The insights may assist monetary authorities and governing bodies to structure trading mechanisms that enable fair play and bring out their longer-term capacity on third world economic growth in various domains, specifically carbon credits and guidelines.

Scope for future work persists towards analyzing events to explore short-run behavior, integration analysis to avoid arbitrage trading, employing cross-correlation analysis to uncover lag duration, and using market and government interventions recommendations to frame better conduction of financial dealings.

9.1. Technological Innovations

Technological innovations are the developments that can produce a new product or method that will

come up with the improved and better solution to the existing problem. This is one of the short-run features that help the greenhouse gases to mitigate. The automobile industry has come up with electric cars that have still not captured a big point in the whole market, it would be better to give a thorough review of the existing industries that cause carbon emissions to spread in the economy (Thi Quy et al., 2024). This feature is mostly expensive. Technologies take time to absorb into most of the fossil fuel power plants.

Therefore, most of the developing nations might come up with this feature as a later stage advanced technology that can capture the emissions as well as the firm already come up with such industries would benefit from the carbon credits scheme in the long run. Some of the existing technologies for capturing emissions are the following. These chemicals are heated to more than 900 degrees Celsius when used as feed and undergo a series of complex chemical reaction to produce ash and a gas with a composition similar to that of CO2. As a result, finished ash is blue-green in appearance and is usually combined into slurry with water for pumping. In practice, the necessary feed is either dolomitic lime by the combination of CaO and MgO or quicklime combined with limestone or dolomite as pH-control agent in the dairy farm.

Another example of capturing emissions is Bone Char that is made from animal bones, and then attached with charcoal. The chemical properties of this biomaterial are relatively high surface areas, lower bulk density, many hydroxyl groups attached with the surface, high adsorption capability of pollutants in water especially Fluorine. They physically use natural materials to adsorb/regulate the CO2 emissions. These technologies are not other technological solutions to reduce the carbon emissions into the air.

9.2. Evolving Regulatory Frameworks

A likely factor is that stock markets have been found to exert better oversight on firms, rendering them less capable of postponing necessary but costly abatement. mortgage-backed securities help lessen the time inconsistency of climate policy, which would bolster the case for risk-sharing credit markets. Risk-sharing measures which lessen the impact of such a time-inconsistent outcome could in principle alleviate this concern. But it may be much harder to change the focus of existing credit markets than it would be to pursue risk-sharing policy in major economies. A governance regime which abates in a cost-effective manner is more likely to have other markets which operate in a manner perceived to be economically rational. Moreover, bringing the carbon market within the stricter and more universally applied regulatory regimes governing credit markets could increase confidence that costs are being kept closer to the lowest level. It might also weaken the legitimacy of abatement measures which, while economically inefficient, could have strong distributional appeal even if perceived to be potentially less effective. There are some lessons to be learned for networks covering multiple sectors and sectors within a jurisdiction as they relate to horizontal compatibility. Countries that are party to treaties in which aspects of implementation are delegated to associations of firms might represent a good source of inspiration here. This is especially true for fast-growing sectors and countries, whose emissions will increase rapidly with large uncertainties around BaU projections. Consequently, the governance of sectoral crediting must shift away from BaU to a fundamentally different model: the negotiation of sector-wide, country-specific baselines based on historical emissions data and always keeping the environmental implications in mind with credits awarded for reductions below those baselines (Wagner et al., 2010). Risks are also associated with crediting reductions in ‘intensity’ rather than in absolute emissions. Reducing total emissions is what matters to the atmosphere. Sectoral credits ought to be made, measured, and reported in absolute tonnes of reductions from an absolute baseline. Finally, risks come with carbon markets themselves. Any market requires proper infrastructure, regulatory guidance,

and oversight. Proper market governance is similarly crucial. Firms that monitor emissions and calculate baselines should be prohibited from marketing credits to avoid conflicts of interest. Sectoral crediting is not a goal in itself. The first sectoral credit has yet to be issued.

9.3. Increasing Corporate Responsibility

Countries today are recording an increase in health concerns resulting from climate change and emissions of harmful substances, such as carbon dioxide, sulphur oxide, and nitrogen oxides from energy generation plants and vehicles. Governments around the world have joined forces to tackle climate change and to facilitate carbon reduction through the publication of international agreements, laws, and enactments. There is a need to develop an effective tool that creates a favourable environment for developing direct-clean energy systems while maintaining and developing existing systems for carbon intensity reduction (Chen, 2023).

Emerging economies such as China and India, despite the high carbon intensity levels, are embracing and developing carbon liability systems. China's carbon asset market is under infiltration in both a macro and micro sense. Important aspects of China's carbon price and how it influences GDP growth levels, total export levels, and individual financial firm growth levels are considered. The parameters of a two-part model are estimated by a mixture and smooth transition regression approach to account for the macro and micro trends.

Motivated by the urgent need to mitigate climate change and carbon emissions, this study provides micro- and macro-level evidence on the growth effect of carbon trading systems. This impact differs from economy to economy, and user guidance is provided. The findings indicate that asset managers are not just impacted but extensively disrupted by the introduction of a carbon trading system. A close examination of the clear advantage offered by credence goods enables policymakers to mitigate the unintended consequences of carbon enforcement.

It has been found that Corporate Social Responsibility and corporate carbon intensity are closely related to the corporate life cycle, divided into 5 stages: first is the introduction stage, second is the growth stage, third is the mature stage, fourth is shake out stage, and finally, the decline stage. The impact of CSR on carbon intensity is negative at all stages. Looking at an extensive dataset covering 1745 listed Chinese firms between 2009 and 2019, it is found that for firms at the introduction stage, CSR is −0.0014 on CCI; at the growth stage, CSR is −0.0007 on CCI; at the mature stage, CSR is −0.0010 on CCI; at the shake-out stage, CSR is −0.0024 on CCI; at the decline stage, CSR is −0.0045 on CCI; and a greater impact on carbon emissions of PE, HTE, and SOE.

10. Conclusion

This paper is motivated to assess the impact of carbon credits on financial growth in different economies using the newly constructed time-varying-factor Global TURF on a panel of 45 countries between 2004 and 2022. The paper finds that carbon credits have statistically significant positive effects on financial growth in both developed and developing economies. The impacts of carbon credits on financial growth are sustained for developing economies, while they are mixed for developed economies. In addition, it finds that environmental sustainability, economic uncertainty, economic openness, trade globalisation, geopolitical risk, and income inequality play important roles in determining financial growth in different economies. Finally, possible short- and long-term policy implications are discussed. The findings highlight the effectiveness of carbon market policies to combat climate change and the importance of policy coordination between carbon market development and economic growth.

Many countries and regions have implemented or plan to implement carbon trading markets to combat

climate change and achieve carbon neutrality. As the main market instrument for carbon pricing, carbon credits have received increasing attention from government and academic circles. Previous research mainly focuses on how carbon credit markets affect companies' behaviour, the economy, and the climate. However, few studies examine how the development of carbon credits, as an innovative financial instrument, affects a country's financial sector. This research gap is addressed by using a sample of 45 countries to investigate the impact of carbon credits on financial growth.

Financial markets have significant impacts on economic growth. A well-functioning financial market system can improve resource distribution efficiency, speed up capital accumulation, promote technological innovations, and catalyse economic development. The development of a carbon credit market can promote growth in capital and human resources, especially with the continued decline in bilateral economic cooperation between the US and China. On the one hand, carbon credits can partially replace the national treasury bonds as high-RRBS instruments, increasing the net fund flow into local and foreign climate-friendly firms. On the other hand, energy-efficient technologies can be successfully diffused from developed economies to emerging economies, which yields new growth opportunities for financial institutions.

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