



A Study on Carbon Credits: A Market-Based Financial Instrument for Climate Change Mitigation

Janani R^{1*}

¹Dayananda Sagar Business School

*Corresponding author

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Abstract

The effects of climate change have become an increasing global concern and many nations are adopting market-based mechanisms to reduce greenhouse gas emissions. One of these market-based instruments has been the introduction of carbon credits which allow companies to trade emissions allowances and create financial incentives for companies to become more environmentally friendly.

This research study analyzes carbon credit as a market-based tool for mitigating climate change based on the global carbon market, as well as, the Indian carbon market.

This research study reviews the processes that have occurred over time to develop carbon credit systems from the international level through the Kyoto Protocol to current activity being done under the Paris Agreement. This research utilized the secondary data obtained from organizations like the World Bank, International Energy Agency (IEA) and International Carbon Action Partnership (ICAP). Furthermore, this includes the analysis of carbon price trends, trading volumes and sector specific emissions. Additionally, this research compares mature carbon markets, like the European Union with emerging carbon markets such as China and also evaluates the rapidly developing framework for the carbon market and emission reduction targets for India.

The results of this study indicate that carbon credits have evolved into financial instruments which will impact corporate decision making and generate climate finance, as well as, support emissions reductions. While there are challenges within carbon markets, including price volatility, regulatory differences and measurement issues, there are many opportunities available for sustainable investment and the creation of policy development. The study concludes that with stronger regulation, transparency, and increased participation, carbon credits can play a vital role in achieving climate goals and promoting sustainable economic growth.

Keywords: Carbon Credits; Climate Change Mitigation; Carbon Market; Greenhouse Gas Emissions; Sustainable Economic Growth

CHAPTER 1: INTRODUCTION

1.1 Overview of Carbon Credits

The challenge of Climate Change is the greatest single challenge our planet faces today, as it threatens the stability of the world economy, sustains our environment, and affects the life and well-being of all people. Carbon dioxide (CO₂) is the most significant contributor to global warming through greenhouse gas emissions (GHG) and has resulted in increased intensity of extreme weather events, increasing level of sea levels and imbalance of ecosystems. The growth in the production of carbon dioxide emissions around the globe has led to the development of a greater reliance on market-based mechanisms to manage emissions while continuing to promote economic growth by way of government and international organization support for carbon credits as a means to increase compliance.

Carbon credits provide an innovative solution to this problem by creating an opportunity for individuals and companies to trade carbon credits. A carbon credit provides the purchasing company with an ability to release one metric tonne of CO₂ into the atmosphere as an equivalent to other greenhouse gases (GHGs) that are of the same weight value as carbon dioxide. By placing a monetary value on CO₂ emissions, carbon credits create a market where companies can align their financial interests to support environmental sustainability.

1.2 Historical Background

The story of carbon credits began with the shift from traditional “command-and-control” methods of environmental regulation towards flexible market-based systems that value emissions reduction based upon monetary returns.

1. Conceptual development (1970s – 1990s)

Opportunities existed within the U.S, previous success stories illustrate this:

- 1977 Clean Air Act: Implemented the first tradeable emission offsets, permitting facilities to increase levels of pollution as long as they financed the reduction of pollution by equal or greater quantity at another facility.

- 1990 Acid Rain Program: Created the first successful cap-and-trade system for sulphur dioxide (SO₂) with lower costs than expected and demonstrated that pollutant emissions could be lowered substantially through market mechanisms.
- 1992 Earth Summit (Rio): Adoption of the United Nations Framework Convention on Climate Change (UNFCCC), the launching point for all formal efforts to mitigate climate change.

2. The Kyoto Protocol Era (1997–2012)

The Kyoto Protocol was established in 1997. It created a global system for the trade of 'carbon credits'. The Protocol provided for three types of market-based approaches to the reducing of Carbon-Dioxide (CO₂) emissions from countries around the world:

- Clean Development Mechanism (CDM) — The Clean Development Mechanism (CDM) permits developed countries to obtain credits called 'Certified Emission Reductions' (CERs) for investing in emission-reducing activities in developing countries.
- Joint Implementation (JI) — The Joint Implementation (JI) mechanism allows developed countries to receive credits for financing emission-reducing activities in other developed countries.
- International Emissions Trading (IET) — The International Emissions Trading (IET) as established a worldwide market for carbon emissions. A country that has an excess of carbon emission allowances can sell those allowances to another country that has exceeded its carbon emission quota.
- The Kyoto Protocol became officially operative on February 16, 2005. In conjunction with that, the European Union started its Trading System for Emissions; this was the first time a major carbon trading system had been launched globally.

3. Expansion and Shift to Paris Agreement (2015–Present)

With the forthcoming expiration of the Kyoto Protocol's second commitment period in 2020, there was an emerging transition towards the global framework created by the Paris Agreement of 2015.

- The Paris Agreement represents a "universal participation" agreement; in contrast to the Kyoto Protocol which only required developed nations to commit to reductions, the Paris Agreement imposes a requirement that all countries who sign the Agreement take action against Climate Change by committing themselves to determine their Nationally Determined Contributions (NDCs).
- The IET will govern the new international carbon market with Article 6 providing assurances of two key elements that were missing in the Kyoto Protocol; namely, to ensure that there will be high transparency of all transactions, and to prevent the dual counting of emissions.
- Major Developments from 2024 to 2025: At COP29 in November 2024, an agreement was made by the governments to set rules to develop and trade emission reductions as carbon credits. The markets have developed further into a higher preference for "high-integrity" credits and durable removals maybe versus simple avoidance projects by the year 2025.

1.3 Global Context of Carbon Credits

Carbon Market is divided into Compliance Market and Voluntary Market; each market type has its characteristics. Below is a summary of each market type:

Compliance Market

Regulations applied by government, emissions targets must be met by the company. There are some compliance markets such as:

- EU Emissions Trading System
- Chinese National ETS
- California Cap-and-Trade

As a result of the strict rules imposed on companies, compliance market carbon pricing is generally higher than voluntary market prices.

Voluntary Market

Voluntary markets allow companies to purchase credits as a means of achieving their established sustainability goals or enhancing their brand recognition. There has been an increase in the number of organisations that are embarking on ESG (Environmental, Social & Governance) type strategies; thus, supporting the growth rate of voluntary markets.

Carbon Pricing Revenue Globally has now exceeded US\$100bn per annum; which has shown how important Carbon Markets are in the provision of Climate Finance. The volume of carbon pricing instruments worldwide has increased from five in 2005 to approximately eighty in 2025. This rapid increase demonstrates the rate of growth for Carbon Pricing Instruments.

1.4 Indian Context of Carbon Credits

Since the adoption of the Kyoto Protocol, India has been involved with the Global Carbon Market mainly with the Clean Development Mechanism (CDM) under the United Nations Framework Convention on Climate Change (UNFCCC). Given that carbon markets were an important means of achieving international climate change targets, India introduced the Carbon Trading and Credit System (CTCS) as part of the amended Energy Conservation Act in 2023.

Other climate change mitigation goals for India include:

- Net zero emissions by 2070.
- A 45% reduction in emission intensity per unit of GDP by 2030.
- Expanding renewable energy.

The Indian carbon market is still developing and has considerable growth potential, particularly with respect to high emissions from sectors such as power, steel and cement.

1.5 Working Mechanism of Carbon Credits

Carbon credit systems generally operate under a **cap-and-trade model**:

1. Government sets an emission cap.
2. Firms receive emission allowances.
3. Firms emitting less can sell credits.
4. Firms emitting more must buy credits.
5. Trading occurs in carbon markets.

This system ensures that emissions are reduced at the lowest economic cost while providing flexibility to firms.

1.6 Current Trends

- Rapid growth of global carbon markets
- Integration with ESG investing
- Entry of financial institutions
- Digital carbon trading platforms
- Expansion of voluntary markets

1.7 Significance of the Study

This research is of importance to analyse carbon credits through an economic lens; many researchers are studying the environmental implications but there are significantly less studies that assess how carbon credits can function as an investment tool and affect the way people invest and how they invest in the market.

All groups that will be impacted by the research need to understand carbon markets. These include:

- Policy-makers
- Investors
- Businesses

- Financial institutions

CHAPTER 2: LITERATURE REVIEW

Literature Review

1. Labatt & White (2011) – Carbon Finance

This foundational work explains how climate change risks are translated into financial decision-making. Carbon credits are presented as risk management and hedging tools for firms. The book establishes the financial logic behind carbon markets. It provides a conceptual base but does not focus on empirical market behaviour.

2. Gosnell et al. (2011) – Market-Based Mitigation in Agriculture

This study examines the role of carbon markets in encouraging climate-friendly practices among ranchers. Financial incentives motivate participation, but complex verification processes limit adoption. The study highlights the importance of policy and institutional support. It mainly focuses on agriculture rather than broader financial markets.

3. Mol (2012) – Carbon Flows and Financial Markets

Mol discusses how carbon emissions are converted into tradable financial assets. The study highlights the growing link between environmental governance and global finance. Carbon markets are shown to influence capital allocation and investment behaviour. Governance and regulatory challenges are identified as major concerns.

4. Moarif & Rastogi (2012) – Emerging Economies

This paper evaluates market-based climate policies in emerging economies. It finds carbon markets to be cost-effective tools for emission reduction. However, weak administrative capacity limits effectiveness. The study stresses gradual policy implementation.

5. Mehling & Mielke (2012) – Brazil's Experience

This research analyses Brazil's early experiments with market-based instruments. While pilot mechanisms showed promise, political uncertainty restricted expansion. The study emphasises learning from international carbon markets. Institutional readiness is highlighted as crucial.

6. Melo et al. (2014) – Multiple Benefits of Carbon Markets

This study explores carbon certification schemes that combine climate, biodiversity, and community benefits. Such co-benefits increase social acceptance of carbon projects. However, higher costs reduce participation. The balance between impact and affordability remains challenging.

7. Ervine (2014) – Carbon Market Crisis

Ervine critically examines the instability in global carbon markets. Price volatility and oversupply weakened market confidence. The paper questions excessive dependence on market mechanisms alone. It calls for stronger regulatory intervention.

8. Vanderklift et al. (2019) – Blue Carbon

This study focuses on carbon finance for marine ecosystems. Mangroves and seagrass offer significant carbon sequestration potential. However, market-based finance in this area is still underdeveloped. Policy support is required for scaling.

9. Zhou et al. (2020) – China’s Emission Trading Schemes

This comparative study examines China’s pilot ETS programmes. Market-based mechanisms contributed to emission reduction. However, effectiveness varied across regions. Institutional coordination is identified as a key factor.

10. Badgery et al. (2020) – Soil Carbon Credits

This research analyses soil carbon sequestration as a source of carbon credits. Financial incentives encourage farmers to improve soil health. Verification and monitoring costs remain high. Scalability is a concern.

11. Michaelowa et al. (2021) – World Bank’s Role

This study highlights the role of international institutions in developing carbon markets. Public–private partnerships improve credibility and investor confidence. The World Bank acts as a market enabler. Scaling carbon markets remains a challenge.

12. Espelage et al. (2022) – Carbon Markets in Climate Finance

This study positions carbon markets as a core component of climate finance. Carbon credits mobilise both public and private capital. International cooperation under the Paris Agreement is emphasised. Uneven participation reduces effectiveness.

13. Belianska et al. (2022) – IMF Climate Note

This IMF report evaluates carbon credits within broader climate finance instruments. Developing economies are seen as major beneficiaries. Market volatility and governance risks are highlighted. Institutional strength is essential.

14. Belianska et al. (2022) – Sub-Saharan Africa

This study focuses on carbon markets in Africa. Natural resource availability offers high potential. Financial and institutional limitations restrict participation. Capacity building is necessary.

15. Espa & Ahmad (2022) – Paris Agreement & Trade Law

This paper analyses Article 6 of the Paris Agreement. It highlights legal and trade-related challenges in carbon markets. Coordination between climate policy and trade law is critical. Regulatory clarity remains unresolved.

16. Bajaj (2022) – Carbon Credit–Climate Nexus

This study discusses carbon credits from social and scientific perspectives. It links climate action with economic instruments. Carbon credits are seen as tools for sustainable development. Stronger policy alignment is recommended.

17. Shen et al. (2023) – Institutional Role in Forest Carbon Markets

This systematic review highlights the importance of institutional quality. Transparent governance improves carbon market credibility. Weak institutions reduce investor confidence. Institutional reforms are crucial.

18. Martielli (2024) – Carbon Credits and Financial Performance

This study links carbon credit usage with improved corporate financial performance. Benefits include cost efficiency, risk management, and ESG appeal. Carbon credits support long-term value creation. However, empirical evidence is limited.

19. Manjunatha & Kumar (2024) – India Context

This study analyses carbon credit trading in India. It highlights regulatory progress and future potential. Alignment with India's climate goals is emphasised. Market infrastructure is still developing.

20. Chawla & Chawla (2025) – Capital Markets and Climate Mitigation

This study examines carbon credits alongside green bonds and sustainable ETFs. Carbon credits complement traditional capital market instruments. Investor interest in diversified green portfolios is rising. Regulatory clarity is essential.

21. Chen et al. (2025) – Carbon Regulation and Innovation

This paper links carbon pricing with green innovation. Market-based instruments encourage clean technology investment. Regulatory inconsistency weakens incentives. Stable policies are needed.

22. Chaturvedi et al. (2025) – Carbon Credits and Agriculture

This study highlights carbon credits in sustainable agriculture. Farmers gain income diversification. Soil carbon and emission reduction potential are discussed. Measurement challenges remain.

23. Damoah & Yeboah (2025) – U.S. Climate Finance

This research explores innovative climate finance instruments in the US. Carbon credits support emission reduction efforts. Private sector leadership is strong. Policy uncertainty persists.

24. Karousakis – Deforestation and Carbon Credits

The study focuses on reducing deforestation through carbon markets. It highlights benefits for developing countries. Implementation challenges include land rights and governance. Financial incentives show strong potential.

25. Nweke-Eze – Kenya's Renewable Market

This paper explores UNFCCC interventions in Kenya. It highlights carbon credits in renewable energy projects. International mechanisms support investment inflows. Local regulatory capacity is a constraint.

Research Gaps

1. **Limited India-Specific Financial Evidence**

Most studies focus on global or developed markets, while India-specific empirical research on carbon credit pricing, trading behaviour, and financial impact remains limited.

2. **Carbon Credits as a Financial Asset Class**

Existing literature treats carbon credits mainly as policy tools rather than **investable financial assets**, with limited analysis of returns, volatility, and portfolio integration.

3. **Long-Term Corporate Financial Impact**

There is insufficient research measuring the long-term effect of carbon credit participation on firm profitability, valuation, and shareholder value.

4. **Integration with Capital Markets**

Few studies examine the interaction between carbon markets and traditional capital markets such as equity, debt, and derivatives.

5. **Regulatory and Measurement Uncertainty**

Measurement, verification, and regulatory consistency issues are frequently mentioned but rarely analysed in depth from a financial risk perspective.

CHAPTER 3: DATA AND METHODOLOGY

3.1 Introduction

The purpose of this chapter is to document the research methodology enabled the investigation into credits for carbon, as a market-oriented financial instrument for the purposes of reducing climate change impacts. In doing so, the chapter describes how the project was designed, what data sources were used, which variables were examined and analysed statistically, establishes the scope and limitations of the research, and supports collegial collaboration with external researchers as well as other communities working toward similar goals.

The methodology provides an organized way of linking the four objectives of the research with the set of data and methods of analysis. Providing a systematic method of doing so will increase the credibility and significance of study findings as they relate to the financial and economic aspects of carbon credits.

3.2 Nature of the Research

This study employs a combination of descriptive and analytical methodologies.

Descriptive Component

Descriptive parts of the research will be focused on:

- The development of carbon market
- The features of carbon credit schemes
- An overview of the frameworks for both global and Indian carbon markets
- The function played by carbon credits as instruments to finance climate change projects

This allows for clear conceptual definitions, as well as background for the analysis.

Analytical Component

- The analytical portions of the research will focus on:
- Patterns in carbon pricing
- Patterns in trading volumes of carbon credits
- Patterns of emissions by sector
- Change in the size of the carbon market

The analysis is intended to provide an assessment of carbon credits as financial instruments, and to provide an understanding of how carbon credits function in the marketplace.

3.3 Research Design

The research utilizes a secondary data research design as carbon market data can be found at publicly available national and international websites through global institutions, so no primary survey or fieldwork has been conducted.

The research utilizes a comparative analysis and time series design to compare:

- Carbon markets globally to the India Carbon Market,
- EU Experience to Chinese Experience with the EU Emission Trading Scheme vs China's Emission Trading System,
- Segmenting the Emission Sources in India which supports the identification of patterns, trends, and supporting relationships in the behaviour of carbon markets.

Objectives of the Study

1. To study how Carbon Credit has developed as a financial instrument through market, both in India and globally.
2. To analyse Global and Indian Carbon Markets by examining price trends, trade volumes and sectoral emission levels.
3. To assess the contribution of Carbon credit to Climate Financing and sustainable development.
4. To identify major challenges and future opportunities within carbon credit markets.

3.5 Scope of the Study

The scope of this research encompasses:

- Worldwide carbon markets (EU and China emissions trading schemes)
- The structure of India's carbon credit
- Trends in carbon pricing
- Trading volumes
- Emission analysis by sector
- The contribution of climate financing

Date Range Covered - 2005-2025.

2005 is an important point of reference because:

- The Kyoto Protocol became active, allowing for an international agreement on emission reductions.
- The first trades occurred in the EU ETS.
- Carbon credits were established as viable financial products.

3.6 Sources of Data

The research is principally based on existing data obtained from trustworthy sources.

Global Sources:

- World Bank - Carbon Pricing Dashboard
- World Bank - State of Carbon Pricing
- ICAP - International Carbon Action Partnership
- IEA - International Energy Agency
- United Nations Framework Convention on Climate Change
- International Monetary Fund Climate Notes

Indian Sources

- Economic Survey of India
- Ministry of Environment, Forest and Climate Change
- Bureau of Energy Efficiency
- RBI Report on Climate Risks.

The above-listed sources provide credible and current information on carbon pricing, emissions and associated market activity.

3.7 Variables Used in the Study

To achieve the objectives, the following variables are analysed:

Global Market Variables

- Number of carbon pricing instruments
- Global carbon pricing revenue
- Carbon credit trading volume
- Carbon prices (EU ETS, China ETS)

Indian Market Variables

- Sector-wise emissions (MtCO₂)
- Power sector emissions
- Industrial emissions

Financial Variables

- Carbon price volatility
- Market growth rate
- Revenue trends

3.8 Analytical Tools Used

The study uses basic statistical and analytical tools suitable for secondary data.

1. Trend Analysis

Used to study:

- Growth in carbon markets
- Revenue trends
- Price movements

2. Comparative Analysis

Used to compare:

- EU vs China carbon prices
- Global vs Indian markets

3. Descriptive Statistics

Used to calculate:

- Mean
- Percentage
- Growth rate

4. Ratio Analysis

Used to examine:

- Sector contribution to emissions
- Market growth indicators

5. Graphical Analysis

Charts used:

- Bar charts
- Line graphs
- Pie charts

3.9 Limitations of the Study

Despite careful analysis, the study has certain limitations:

1. Dependence on secondary data
2. Limited India-specific trading data
3. Carbon markets still evolving
4. Price volatility affects comparison
5. Some global data available only for recent years
6. Data differences across sources

These limitations do not affect the overall findings but should be considered while interpreting results.

CHAPTER 4: DATA ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter provides the evaluation and the interpretation of the data collected from the study. The analysis of the data focuses on the four objectives for carbon credits as market based financial instruments, by examining the global and Indian carbon markets, price trends, trading volumes and emission trends.

The analysis of data was obtained from credible secondary sources, such as the World Bank, IEA (International Energy Agency) and ICAP (International Carbon Action Partnership). The results of the data will be interpreted using descriptive statistics, trend analysis and comparative analysis.

OBJECTIVE 1: To examine the evolution of carbon credits as a market-based financial instrument

Carbon pricing instruments worldwide

The World Bank's report "State and Trends of Carbon Pricing 2025" explains that globally there were only five operational carbon pricing instruments in 2005, but that number has increased to 80 by 2025. These instruments consist of 43 carbon taxes and 37 ETSs accounting for around 28% of total global GHG emissions. The large increase in the number of instruments is indicative of greater uptake of carbon pricing mechanisms in many places around the world. For example, India, Brazil and Türkiye are now working on establishing new carbon pricing mechanisms and these countries expect to raise more than \$100 billion in public revenue during 2024 through these mechanisms.

Key Figures & Trends (2005-2025)

- **2005:** 5 operational instruments.
- **2025:** 80 operational instruments (43 taxes, 37 ETSs).
- **Coverage:** Approximately 28% of global Green House Gas emissions are now covered by carbon pricing.

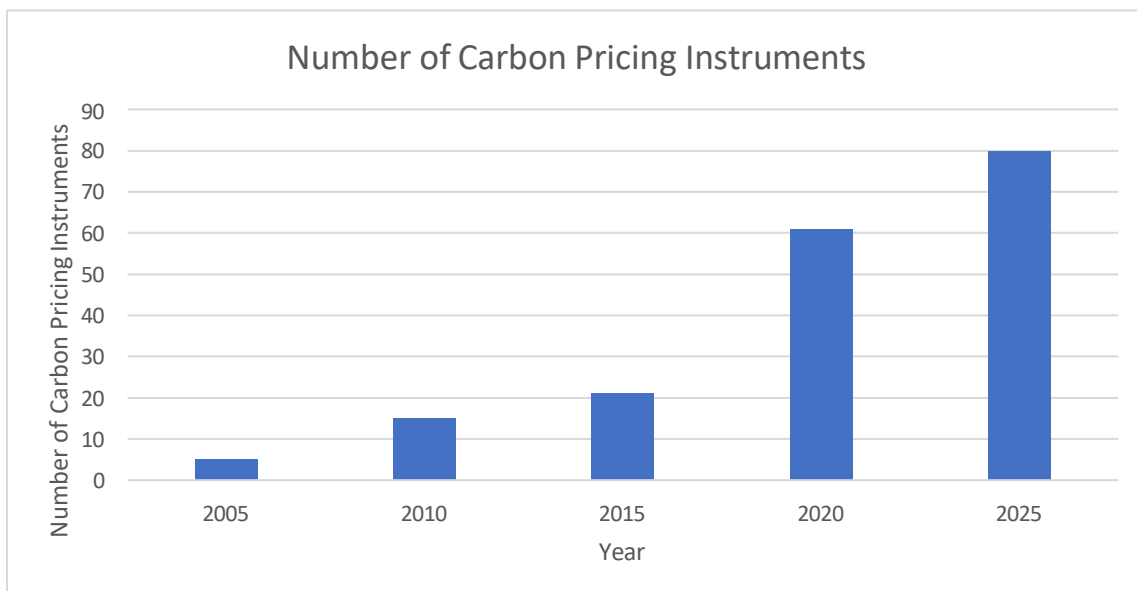
- **Revenue:** Generated over \$100 billion in public revenue in 2024.

Growth Drivers

- **New Entrants:** Countries like India, Brazil, and Türkiye are developing national carbon pricing systems.
- **ETS Expansion:** China's ETS is expanding, and other regions are seeing growth in both taxes and ETSSs.
- **Policy Focus:** Instruments are designed to cut emissions, raise revenue, and drive green growth.

4.2 Growth of Carbon Pricing Instruments (2005–2025)

Year	Number of Carbon Pricing Instruments
2005	5
2010	15
2015	21
2020	61
2025	80



Source: World Bank – State and Trends of Carbon Pricing
<https://www.worldbank.org/en/publication/state-and-trends-of-carbon-pricing>

Interpretation

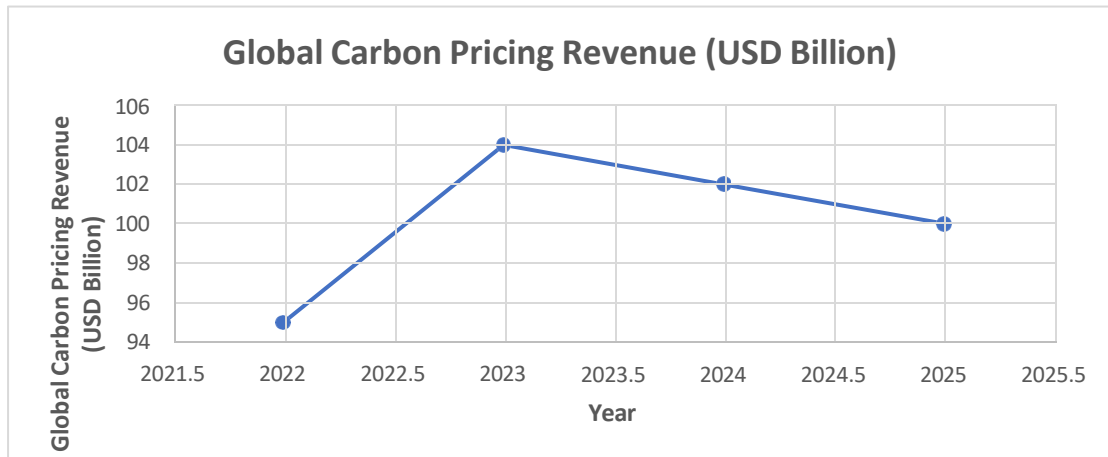
In 2005, there were only five regions/areas in the world that had implemented carbon pricing instruments (e.g., carbon taxes or cap-and-trade systems), but by 2025 there are expected to be at least 80. This growth demonstrates both an increasing level of global acceptance of carbon pricing as a policy tool and an increasing level of global acceptance that carbon pricing is a viable way of financing climate action.

More recently, the rise of carbon markets has illustrated that carbon credits are no longer merely environmental instruments; they are also financial instruments that can produce revenues for businesses and individuals and affect investment decisions on a global basis. For example, the increasing participation of countries like India, Brazil, and China only helps to reinforce the importance of carbon credits in the global financial marketplace (in relation to the increasing role of carbon credits within the international economy).

4.2 Global Carbon Pricing Revenue Trend

As reported by the 2025 World Bank report titled "State and Trends in Carbon Pricing", carbon pricing collected at least \$100 billion in amazon for public finance in 2024; a number that reflects similar levels to last year's report. The amount of carbon pricing mechanisms has significantly increased from five in 2005 to eighty in 2025 covering about 28% of all worldwide carbon emissions. While precise figures about each year (2005-2024) are not included here, analysis shows there has been an exponential increase in the number of carbon pricing instruments which generate substantial revenue with more than half being reinvested towards environmental and development initiatives.

Year	Global Carbon Pricing Revenue (USD Billion)
2022	95
2023	104
2024	102
2025	100



Source: World Bank Carbon Pricing Dashboard
<https://carbonpricingdashboard.worldbank.org/>

Mean Revenue

$$= (95 + 104 + 102 + 100) / 4$$

$$= 100.25 \text{ billion USD}$$

Interpretation

Carbon credits are now more stable and therefore make a more reliable contribution to public finances over time by providing government funding for projects aimed at reducing greenhouse gas emissions. The consistency of revenue from these credits demonstrates that the carbon market has matured as a climate finance source.

OBJECTIVE 2: To analyse global and Indian carbon markets using price trends and trading volumes

4.4 Carbon Price Comparison: EU ETS vs China ETS

Market	Carbon Price
EU ETS	€64.74
China ETS	\$13.33

Source: International Carbon Action Partnership (ICAP)
<https://icapcarbonaction.com/en/ets-prices>

Interpretation

The carbon prices in the EU emissions trading system (ETS) are considerably greater than those in China's emissions trading system (ETS). The European market's greater sophistication and more stringent emissions regulations account for this difference. With their higher carbon prices, there are greater incentives for businesses to reduce their carbon emissions.

China has experienced lower carbon prices because it has had a phased-in approach to its implementation, but as its market develops, its carbon prices will increase and will be consistent with the rest of the world.

The analysis illustrates that market behaviours and carbon pricing are strongly influenced by regulations.

4.5 Global Carbon Credit Trading Volume

Year	Credits Traded (Million)
2020	188
2021	362

Source: World Bank Carbon Markets Report
<https://www.ecosystemmarketplace.com/>

$$\text{Growth Rate} = \frac{362-188}{188} \times 100 = 92\%$$

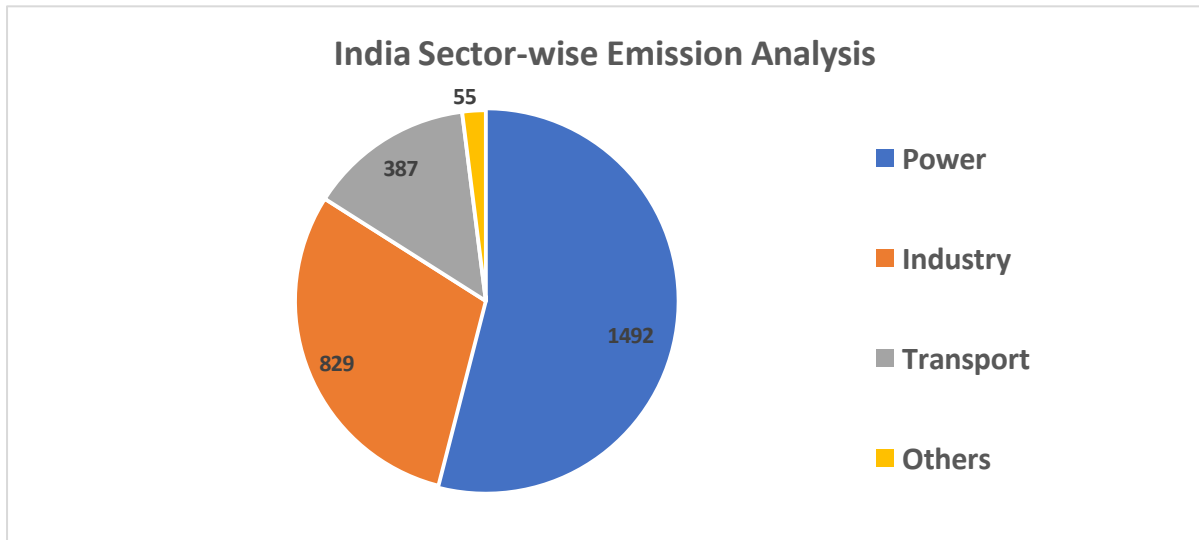
Interpretation

In the timeframe of 2020 to 2021, the amount of carbon credits traded experienced an increase of 92%. The rise in volume shows that there are now more companies involved in this market and there is more demand for carbon offsets than ever before. Companies are trying to achieve sustainability goals and improve their ESG performance through the purchase of carbon credits.

As evidenced by the rapid increase in trading volume, carbon credits are now a form of actively traded financial assets.

4.6 India Sector-wise Emission Analysis

Sector	Emissions (MtCO ₂)	Percentage Contribution
Power	1492	54%
Industry	829	30%
Transport	387	14%
Others	55	2%
Total	2763	100%



Source: International Energy Agency (IEA) India emissions
<https://www.iea.org/countries/india/emissions>

Interpretation

Over 50% of India's emissions come from the power sector. Therefore, carbon markets in India should focus primarily on high emitting industries (i.e., power, steel, and cement). Emission reduction potential will be greatest from these three sectors.

This analysis indicates that large emitting sectors create an opportunity for carbon trading; therefore, there is significant opportunity for carbon credits in the Indian market.

OBJECTIVE 3: To evaluate the role of carbon credits in climate finance

4.7 Contribution to Climate Finance

Carbon pricing on a global scale raises more than \$100 billion dollars in revenue each year.

Much of this revenue is reinvested into:

- Renewable energy
- Green infrastructure
- Projects focused on adapting to climate change.

Interpretation

Carbon markets can be an important tool for providing financing to address climate issues. They facilitate the mobilisation of both public and private sector investment to support sustainability efforts around the world and to help developing countries achieve their climate change commitments.

The combination of generating revenue from carbon markets and also reducing emissions highlights the economic and environmental benefits of carbon markets.

4.8 Role in Corporate Financial Strategy

Firms use carbon credits for:

- To offset carbon emissions into the environment
- Manage regulatory risk
- Increase their good environmental, social and governance (ESG) rating
- Attract new investors

Interpretation

Carbon credits drive corporate finance decisions. If a company invests in reducing its carbon emissions, it generates a financial return on the investment by selling carbon credits. This creates an incentive to encourage the implementation of socially sustainable business practices. The use of carbon credits improves the company's reputation with investors and increases confidence in corporate sustainability.

OBJECTIVE 4: To identify challenges and future opportunities

4.9 Carbon Price Volatility

Carbon prices fluctuate due to:

- Policy changes
- Market demand
- Economic conditions

Interpretation

Price volatility creates uncertainty for firms and investors. Stable regulatory frameworks are needed to ensure long-term market growth.

4.10 Market challenges in carbon credit systems

Because of the changing technologies, regulation, and increased competition in the marketplace for carbon credits, large potential exists to provide solutions to the problem of climate change by creating an efficient financial system whereby carbon credits can be bought. Nevertheless, carbon markets are still subject to major challenges such as structural, financial, and regulatory issues. All of these factors affect the overall credibility, stability, and long-term efficacy of the marketplace for carbon credits. Therefore, it is important to have an understanding of these issues to properly assess the potential value of carbon credits as financial instruments.

I. Carbon Price Fluctuations

Carbon market price fluctuation poses a major challenge to many traders. Variations occur often because of changing policies, economic cycles, and market demand for carbon credits. The EUETS is an example of a carbon market that has seen significant price increases and decreases over its lifespan.

A firm faces a number of challenges arising from carbon price volatility, including:

- Investment Planning Costs
- Compliance Cost Uncertainty
- Long-Term Green Investment Discouragement

Companies are reluctant to invest in emission reduction technologies when there is so much price volatility on carbon credits. Investing in carbon credits can be very difficult for investors when prices are so unpredictable. Thus, developing a stable carbon pricing mechanism is very important to maintain confidence in the market.

II. Uncertainty in Regulation

The development of Carbon Markets is heavily reliant upon government regulations and international agreements. Therefore, changes in regulations could have major effects on carbon prices and trading volumes of carbon. The structure of carbon markets within many countries continues to evolve, creates uncertainty within the investor community as well as within the companies involved in carbon trading.

Examples include:

- Different countries have different rules regarding the functioning of Carbon Markets
- No Global Standard Framework Exists
- Implementation of Policy Takes Longer Than Anticipated

Market growth and investor confidence will stagnate due to the uncertainty created by regulatory issues. Therefore, there is the likelihood that companies will wait for clarity of regulations before participating in carbon markets.

III. Measurement Issues for Verification

Credibility of Carbon Credits relates to obtaining accurate measurements of the amount of emissions that were reduced due to project implementation. However, accurately measuring the amount of GHG emitted and verifying the amount of GHG emitted as a result of implementing a project can be very complex and expensive.

In ascension, to the complexities of measuring and verifying, there are many challenges facing Huven and Carbon Credit issuers such as:

- Difficulties associated with measuring emission reductions associated with Agricultural and Forestry Projects

- Risk of overestimation of Carbon Savings

- High Cost of Verification

If the amount reduced is misstated, low quality Carbon Credits are being issued which will negatively affect the investor confidence and success of Carbon Markets.

IV. The idea of Greenwashing

Greenwashing refers to companies that have created products with an apparent "green" profile but do not truly reduce emissions. Many companies choose to buy carbon credits as opposed to reducing their own emissions, therefore having no intention of actually reducing their emissions. The primary purpose of these credits is to sell "green" image to consumers, not to offset emissions.

This raises problems such as:

- Loss of credibility of carbon markets
- Misleading sustainability claims
- Lack of transparency

Without proper regulation, greenwashing will continue to erode public confidence and invalidate carbon markets from achieving their intended purpose.

V. Low Participation from Developing Nations

Developed nations have created carbon markets; this is not true in all Of developing countries, as many of these nations are still in early development assistance stages. There are several factors that affect the ability of developing countries to participate in carbon markets, such as;

- Limited ability to develop policies and programs
- Limited ability to obtain knowledge about the market
- Limited access to financial resources

The combined effect of the above will cause excessive participation and limit the ultimate impact that the carbon markets could have.

VI. Market Fragmentation

The carbon market is characterized by its fragmentation; there exist many independent carbon markets operating throughout multiple regions (e.g. EU ETS, China ETS, voluntary markets), each of which has different pricing mechanisms/rules and various standards of operation. As a result, the lack of coordination creates barriers to trade and inhibits global market efficiencies.

4.11 Market Opportunities in Carbon Credit Systems

The carbon market presents great opportunities for businesses and governments regardless of the challenges they face; as the demand for carbon credits grows due to tighter global climate regulations, there will be many additional opportunities created by international markets expanding over the next several years.

I. Expansion of Carbon Markets

Carbon markets have grown exponentially since their first introduction (in terms of number) – moving from 4 in 2005 to nearly 80 at present, with announcements from an increasing number of nations planning on establishing carbon markets within their countries (e.g., India, etc.).

As carbon markets continue to expand in the future they will:

- Increase trade volumes in carbon credit transactions
- Increase liquidity throughout the market
- Provide additional investment opportunities.

As carbon credits become a major player in the future of global financial markets.

The growing trend of treating carbon credits more like financial assets will result in an increasing number of financial organizations/investors entering the market to obtain diversity in their portfolios as well as to manage their exposure to climate change.

II. Integration with Financial Markets

The future development of carbon markets includes:

- The creation of carbon credit-based derivatives.
- Creation of carbon-linked bond products.
- Establishing the ability for trading of carbon futures on established stock exchanges (i.e., NYSE, NASDAQ, etc.)

Thereby improving both the depth of the carbon market as well as the overall liquidity of the carbon market.

III. Growth of Climate Finance

Significant revenues from carbon markets can be utilized for Climate change mitigation and adaptation projects. The government uses carbon pricing revenue to finance renewable energy projects, develop green infrastructure, and execute sustainability initiatives.

This will create a positive feedback loop:

Carbon Markets -----> Revenue Generation -----> Investment in Green Projects ----- >

Decrease in Greenhouse Gas Emissions As the demand for Climate change financing rises, the relevance of Carbon Markets will also increase.

IV. Corporate Sustainability and ESG Investing

Many firms are now implementing Environmental, Social and Governance (ESG) strategies. As a means of obtaining carbon neutrality, companies gain carbon credits through their sustainability efforts to improve their ESG rating.

The benefits to companies for securing carbon credits are:

- Brand Image Improvement

- Attraction of Investors

- Compliance with Regulation Requirements

The majority of the demand for carbon credits will increase due to the growth of ESG Investing.

V. Technological Advancements

Blockchain and digital monitoring systems are technological innovations that have increased transparency within the carbon market. They assist with:

- Accurately tracking emission reductions
- Eliminating fraud
- Improving verification

Therefore, technology will bring a level of credibility and efficiency not seen before to carbon markets.

VI. Opportunities for India

Potential for developing carbon markets is high in India, due to:

- High emissions from the power and industrial sectors
- Expansive growth in renewable energy
- Continued government support of policy

The implementation of the Carbon Credit Trading Scheme will create opportunities for:

- Indian companies
- Investors
- Renewable energy projects

India could potentially become a major supplier of globally traded carbon credits.

Overall Evaluation

There are various challenges that carbon marketing encounters in relation to issues of volatility, regulations, and credibility; however, there are also more opportunities available than challenges at this time. Strengthened regulations, enhanced technologies, and broader participation in the marketplace will allow for carbon markets to stabilize into viable financial systems.

The key drivers for the growth of carbon credit markets are the following:

- Regulatory clarity
- Transparency in the marketplace
- International cooperation
- Technological support

Carbon credits will likely see widespread usage as a financial instrument over the next couple of decades.

CHAPTER 5: CONCLUSION, FINDINGS AND RECOMMENDATIONS

5.1 Summary of the Study

The research evaluated whether carbon credits are being used as an innovative market-based financial tool for mitigation efforts related to climate change. Carbon credits provide a mechanism to attribute a 'value' to 'greenhouse' gas (GHG) emissions and allow businesses and other organizations to 'trade' their allowances in order to connect environmental responsibility with the 'financial' decisions of businesses. Global efforts, such as the Kyoto Protocol and the Paris Agreement, have contributed to the development of carbon markets and lead to many countries implementing carbon pricing systems.

The evaluation of the state of global carbon markets indicates that there is a growing number of businesses using carbon credits as financial instruments, influencing their business behaviour, and revenues that can support climate-related initiatives. Mature carbon markets, such as the European Union, tend to have higher carbon prices due to more stringent regulations; in contrast, developing or emerging carbon markets are evolving over time. However, the increase in both trading volume and revenue from carbon credits suggests that businesses have a growing interest in and are becoming increasingly reliant on carbon credits for climate finance.

According to this study carried out in India, there is great opportunity for creating carbon markets, especially in industries that have high emissions such as power and manufacturing. India has made long term commitments to reduce their emissions and also announced their plans to develop a domestic carbon credits system, both of which should lead to greater market growth.

In general, this report found that carbon credits have become very important financial instruments supporting emission reductions and sustainable development. Carbon markets are expected to play a growing role in both international and national climate strategies despite factors that cause price fluctuation and differences in regulations.

5.3 Major Findings of the Study

I. Evolution of Carbon Markets

According to the study's findings, more than 20 years ago there were almost no carbon pricing instruments available; however, the growth of carbon pricing instruments around the world since then indicates more organizations have begun exploring market-based mechanisms for reducing emissions over the last twenty years.

The operational implementation of the Kyoto Protocol in 2005 allowed widespread use of international carbon trading. Since then, participation in international carbon markets has greatly increased, as have implemented cap-and-trade programs and carbon tax programs in many countries. As can be seen from this information, as the number of available carbon pricing mechanisms rises, there is a corresponding rise in the perceived value of carbon credits as a form of financial instrument.

II. Carbon Credits as Financial Instruments

The data demonstrates that carbon credits have changed from simply being used as environmental policy mechanisms to now being treated as financial resources. These types of assets can be traded in a marketplace, and are impacted by the forces of supply and demand, as well as experiencing price variations like other commodities and financial securities.

The creation of revenue through carbon credits for government entities, private-sector business entities, and the resulting influence that they have on corporate investment decisions allows for new ways for potential participants to gain access to financial markets. Therefore, carbon credit's entry into financial markets reinforces the conclusion that they have become viable new means for financing.

III. Global Market Trends

Global carbon pricing revenues have now exceeded an estimated \$100 billion a year and while this demonstrates that carbon markets have an increasing role to play in financing climate change, there is considerable variability of carbon prices across the different global carbon markets.

For instance, established markets, such as the EU Emissions Trading System (ETS) have

relatively high carbon prices because of stricter regulations and because of their maturity as a

market while less established markets, such as China's, have lower prices but are likely to grow in the future. Moreover, the volume of carbon credits traded continues to grow because of the need from companies to achieve their sustainability targets and comply with regulations.

IV. Indian Carbon Market Potential

High emissions in the steel, cement and power industries put India at tremendous risk for development in carbon markets. The introduction of carbon emissions trading in India is an important first step on its way towards developing a national carbon market. The analysis of emissions within sectors shows that the power industry accounts for over half of the country's total emissions, indicating that if all high emission sectors can be targeted through trading carbon credits, there will be a significant reduction in emissions in those sectors.

Due to India's support of worldwide carbon markets and its promise to reach an overall net-zero emission target by 2070, carbon markets in India will have an opportunity to grow and expand based on their development through investment.

V. Role in Climate Finance

The revenue generated by carbon markets creates significant resources for funding climate adaptation/mitigation projects. Renewable energy, sustainable infrastructure, and environmental protection can utilize these resources.

In addition to generating substantial funds for sustainability-related projects, carbon credits stimulate private sector investment in low-carbon technologies and emissions reduction projects. Carbon markets provide financial incentives for sustainability, which are an important source of climate finance.

VI. Market Challenges

There are a number of challenges facing the development of carbon markets as they have considerable potential to help reduce carbon pollution. Unpredictable prices create significant uncertainty consistently for firms and investors, while regulatory inconsistency across countries leads to fragmented carbon markets. There are issues with respect to measurement and verification of carbon credits, which was raised as a credible concern with respect to integrity. Additionally, the risk of companies greenwashing, or misrepresenting their

environmental sustainability, creates uncertainty regarding whether a carbon credit is legitimately a real environmental offset.

Developing countries and the awareness of firms about carbon markets have been limited, which is restricting the market from growing. If these issues can be addressed, the effectiveness of carbon markets will be improved.

VII. Future Opportunities

According to the study, carbon markets are likely to grow significantly due to three major factors: growth into developing countries, increased linking of carbon markets and financial markets, and improved efficiency of the market through technology.

With an increased focus on ESG investing and sustainable practices, demand will continue to increase for the purchase of carbon credits. In addition to that, this may ultimately create a new financial product: the issuance and trade of carbon credits within the financial markets, such as carbon derivatives and futures contracts.

Overall Conclusion

The market-based mechanism of carbon credits has proven to be a viable means for combatting climate change because these incentives will encourage companies to cut their emissions yet still maintain flexibility with respect to their operations. As evidenced by the growing size of carbon markets, they are becoming increasingly relevant within the global and national financial systems.

Carbon credits are behaving like traditional financial instruments that affect how companies make their investment decisions, create revenue, and support climate finance. The global carbon market mature while India's carbon market is in its infancy, however, there is significant potential for this market to grow.

Carbon markets can be important if they are properly regulated, transparent and have adequate participation. Carbon credits are an example of the interrelationship between environmental policy and financial innovation, which makes them an integral part of sustainable development.

5.2 Recommendations

I. Strengthening Regulatory Framework

Clear Regulations set by Governments will provide certainty in the Carbon Market - this will encourage companies to participate and create a global market through the standardisation of rules among many nations.

II. Carbon Market Transparency

The establishment of transparent methods of reporting and monitoring the Carbon Market is necessary for the market to maintain credibility. Improved verification methods/tools will provide more accurate information about Carbon Credits and reduce the risk of Greenwashing.

III. Incentivising Corporate Participation

Companies need to be provided with incentives and awareness of their participation in the Carbon Market in order to enhance trading volumes and to increase liquidity within the Carbon Market.

IV. Financial Institutions Should Create Carbon Based Financial Products

Financial Institutions need to create products such as Carbon futures and Derivatives in order to provide for additional trade, greater liquidity, and more capital available to invest in the Carbon Market.

V. Technical and Financial Support for Developing Nations

Developing Nations should receive funding in order to establish their respective Carbon Markets and to increase participation in the Global Market by developing capacity and infrastructure.

VI. Technology to improve Carbon Market Transparency and Efficiency

The adoption of digital technology (e.g. blockchain) will greatly improve transparency and efficiency in Carbon Markets, while also improving the processes of monitoring/verification.

VII. Focus on High Emissions Industries (Example - India)

India should concentrate their Carbon Market on the Electricity, Steel and Cement sectors to maximise the amount of Emission Reductions and the amount of Carbon Credits to be issued in India.

5.3 Implications of the Study

This research has implications for:

- **Policy-makers** - This will give them guidance on how to create successful carbon market initiatives through their policy design process.
- **Corporations** - The importance to corporate strategy (i.e., financial) for carbon credits is highlighted in this research.
- **Investors** - Carbon markets provide new avenues for investments for emerging investors in these markets.
- **Researchers** - This research provides additional foundation for future research looking at carbon credits as financial instruments.

5.4 Scope for Future Research

Future research may focus on:

- Empirical analysis of carbon price volatility
- Impact of carbon markets on firm performance
- Integration of carbon credits with stock markets
- Behavioural aspects of carbon trading

5.5 Final Statement

Carbon credits are one of the most innovative developments at the intersection of environmental policy and finance. The global movement to combat climate change has resulted in the expansion and continued evolution of carbon markets. With sufficient regulation and development of the carbon credit market, these credits can potentially provide a substantial

contribution to sustainable economic development and environmental stewardship.

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