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Analysis of the Characteristics of Price Volatility in Carbon Emission Rights Market Trading

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Abstract

Market-driven policies to address the externality of climate change include carbon taxes and emissions trading systems. The relationship between these carbon pricing instruments' designs and variations in the business cycle is the main topic of this essay. One pressing policy issue is specifically whether and how these tools ought to react to business cycles. In order to respond, the paper compiles pertinent theoretical and empirical findings from scholarly works. It concludes that by including responsiveness into the architecture of carbon pricing instruments, the regulatory burden can be lessened over time and distributed more fairly. This can be accomplished specifically by easing the cap during economic expansions and tightening it during recessions in contrast to a fixed cap emissions trading scheme. In a similar vein, a carbon tax regime that is less responsive to cycles and levies a higher tax during expansions and a lower tax during recessions is probably going to enhance welfare. It is difficult to implement a process that makes carbon pricing devices in the real world responsive. The paper focuses on the major groups of mechanisms that have been studied in the literature, giving a general overview of the trade-offs involved. When selecting a responsiveness-inducing mechanism, it is important to take into account the unique features of the nation, including its institutional background, any pertinent political economy issues, and the peculiarities of variations in its GDP and emissions.

JEL classification numbers: G12, G17, G18.
Keywords: Carbon emission trading market, GARCH model, VaR.

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1. Introduction

After the financial crisis, the economy slowed down. As it recovered, there was interest in the relationship between measures addressing climate change and cyclical economic activity, sometimes known as business cycles, expansion and recession, or boom and bust cycles. The design and functioning of two carbon pricing instruments—the carbon tax and the emissions trading system (ETS)—that are intended to lower emissions are given particular consideration. Through the quantitative mechanism of the emissions trading system, the government caps overall emissions and issues permits equivalent to the cap, which regulated enterprises are required to turn over to the government in order to offset their emissions.

Most notably, the price of the licence is set by the business trading activity in the licence market, not by the emissions trading scheme. In contrast, regulated enterprises are required to pay a defined price per unit of carbon emissions under a carbon tax, which is a pricing technique; however, the overall amount of emissions is not predetermined. The operational efficiency of these two methods will be impacted by the business cycle. The most significant emissions trading mechanism in the world, the EU Emissions Trading Scheme (EU ETS) serves as a crucial benchmark for environmental protection on a worldwide scale. the world's largest ETS by some margin. EU ETS observers have suggested that the collapse and continuing low level of the carbon price since 2008 is due to a combination of the recession cutting demand for permits and the system being unable to respond to changes in economic circumstances (Koch, 2014). These factors have in turn undermined the price signal which the system is designed to generate.

As a result of the recession's decreased demand for permits and the system's incapacity to adapt to changes in the economic environment, observers of the EU emissions trading system believe that the fall and ongoing decline in carbon prices since 2008 are related. Review of literature on EU ETS Performance. In light of these outcomes, to lessen the overall regulatory load by spreading it out more equally across time, the paper supports the implementation of a responsive carbon pricing instrument. These instruments are referred to as indexed regulation or intensity targets. Alongside that Similarly, by restricting excessive changes in licencing costs, the hybrid tool seeks to combine the benefits of carbon taxes and emissions trading systems. A review of existing emissions trading systems. Their job is to persuade authorities to act when specific predefined criteria are satisfied. Lastly, some have demanded that carbon prices be controlled by an impartial organisation akin to a central bank. The agency's job is to evaluate whether carbon prices are appropriate in light of the larger policy goals related to climate change and, if required, to modify the degree of policy rigour. There is a vast literature on taxes and tradable permits aimed at correcting environmental externalities. This section does not attempt a comprehensive review of this literature, nor indeed of its subset concentrating on climate change. Such reviews are the focus of articles in this journal and elsewhere (Calel, 2013). Moreover, a basic understanding of carbon taxes and ETS is assumed throughout. A non-technical refresher can be found in Metcalf (2009) for the more technical reader. Weitzman (1974) provides an excellent treatment . Finally, this article does not review the emerging literature on the ex post evaluation of existing carbon pricing instruments where several studies find that carbon pricing has been effective, but that in some instances the effects have been small (Laing et al, 2014). In particular, they have been used to frame the recent discussion surrounding the reform of the EU ETS (Grosjean et al, 2014). Another key issue is whether market participants can manipulate the mechanism to their advantage at the expense of society at large, a possibility discussed by (Stocking, 2012). In practice, temporary business cycle deviations from permanent, structural deviations from the norm and to implement national policies consistent with the global target when free-riding incentives abound (Nordhaus, 2015). This stock is vast relative to business cycle variations in the flow of emissions, making marginal benefits approximately constant and creating a general preference for carbon taxes Hoel and Karp (2001).

2. Literature Review

Kydland and Prescott (1977) finds that discretion leads to dynamically inconsistent policies and suboptimal outcomes. The insights from this literature have been applied to climate change policy in general (Brunner et al, 2012).

In particular, they have been used to frame the recent discussion surrounding the reform of the EU ETS(Grosjean et al, 2014). The significance of the "dual-carbon" target has grown in the last several years, and it has been recognised as a crucial policy choice that might have a big effect on the China’s carbon emission trading market. These changes, potential yield changes, and potential market risks are all examined using the GARCH model. Through practical methods, "the purpose of dual carbon" aims to optimise and control the risks associated with China's carbon finance market.

Indeed, the World Bank (2014) identifies 35 nations (31 of which are regulated at the supranational level) and 13 subnational jurisdictions which are currently taking this approach, with 13 additional ETSs at various stages of development. This suggests that policymakers’ preferences include factors that are not explicit in the analysis of the economic efficiency of the instruments. For example, Stavins (2008) emphasises the current political unacceptability of carbon taxes in the USA and adds that it may be easier to construct a well-designed ETS than a well-designed carbon tax. Hepburn (2006) points out that if there are tipping points in the climate system, a quantity instrument might be preferred to preclude rapid climate change and associated damages. Pezzey and Jotzo (2012) highlight the political economy considerations of raising and recycling substantial revenues as factors that work against its wider adoption in practice.

Economic fluctuations can be analysed at various levels of aggregation and frequency, and using a number of indicators. The National Bureau of Economic Research provides a non-technical discussion of these choices in the US context(NBER, 2015). One way to study the interplay between carbon pricing instruments and economic fluctuations is to use annual real GDP data at the country level to identify recessions and booms, defined as years in which real GDP is respectively below or above what is considered normal for the country. Although determining the norm for a given year can be a technical and controversial question, it is innocuous for the question at hand.

This paper focuses on three important characteristics for describing fluctuations in GDP and emissions. When a country enters a recession, its GDP declines relative to normal times and the opposite happens during a boom. The size of economic fluctuations measures how large these departures are from the norm. It can be summarised by the volatility of GDP growth rates, or one can use more complex times series filters to decompose an observed time series into growth and cyclical components, and focus on the volatility of the latter. Acemoglu and Zilibotti (1997) focusing on this question have produced robust findings to show that advanced countries experience smaller GDP fluctuations .

For example, decision makers in the idealised world are oblivious to the differences between a carbon tax and an ETS; they face no re-election constraint; and are insensitive to lobbying on how revenues are recycled, or on how many free permits are allocated to energy-intensive or trade-exposed sectors (Meckling, 2014). Kydland and Prescott (1977) finds that discretion leads to dynamically inconsistent policies and suboptimal outcomes.

How emissions change over the business cycle is captured by the correlation of emissions fluctuations with GDP fluctuations. One would expect emissions to be lower than normal in recessions and higher in expansions. Jotzo and Pezzey (2007) analyse historical data for advanced and developing countries. There is also evidence that the strength of the association is greater in advanced countries, so when the economy is in a boom, it is more likely that the emissions will be higher than normal compared with developing countries (Doda, 2014).

The final characteristic is the size of emissions fluctuations, especially relative to the size of GDP fluctuations. One can measure it by the volatility of emissions growth rates, or of cyclical components of the filtered emissions series. In a study of cross-country historical data on emissions fluctuations over business cycles, Doda (2014) shows that the size of emissions fluctuations is larger than the size of GDP fluctuations. The former study also shows that the size of emissions fluctuations declines as countries develop, both in absolute terms and relative to GDP. However, emissions always remain cyclically more volatile than GDP.

A common feature of the aforementioned studies is their focus on short-run GDP and emissions fluctuations. This is distinct from these variables' secular long-term trends. Indeed, both short– and long-run dynamics exhibit large uncertainties. These issues are illustrated elsewhere using the US as an example (Heutel, 2012). It is crucial to keep the distinction in mind. For example, Jakob, Haller, and Marschinski find that emissions and GDP growth are partially decoupled in that they are uncorrelated in advanced countries (Jakob et al., 2012). However, this finding is based on data averaged over five years and, therefore, is only informative about the long-term relationship. Put differently, it is possible that while emissions and GDP are positively correlated at business cycle frequencies, there may be no significant long-term relationship. Putting a price on carbon is generally considered an effective way to address the climate change externality (Financial Times, 2015).

There have been other DSGE models focusing on the cyclical behaviour of climate change policy. Fisher and Springborn (2011) use a DSGE model to evaluate the welfare implications of three fixed and comparable, as opposed to optimal, climate change policies: an ETS with a fixed cap, a fixed carbon tax and an ETS with a cap that is proportional to output. They find that the latter has desirable welfare properties.

The broad consensus is that the externalities of climate change may be effectively addressed by carbon pricing. However, it's unclear if adapting carbon pricing mechanisms to changes in the economy will make them more effective. For instance, the cost of emissions trading programme permits decreases with lower demand during a recession. while during a boom, the number of permits increases. The structure of carbon trading schemes affects how much these price swings vary. A well-thought-out system can keep prices from going too high during a boom, which would undermine incentives to cut emissions, and from going too low during a recession, which would keep incentives to do so intact. To investigate the first and second best emissions, Heutel (2012) recently adapted a conventional dynamic stochastic general equilibrium (DSGE) model. Heutel (2012) discovered that in the first ideal scheme, social planners lower emissions during a recession and raise emissions when the economy grows. Carbon pricing tools must be reactive, able to be modified at each period to take into consideration the impact of total factor productivity, in order to attain this optimal pace-cyclical emission. In the Heutel (2012) framework, the cap on carbon trading plans is specifically tightened during recessions and loosened during booms.

3. Observed fluctuations in economic activity and emissions

The overall level of economic activity usually rises over extended periods. This is mostly caused by population growth, capital accumulation, and technical advancement. For instance, between 1960 and the present, the real gross China’s product (GDP), a crucial indicator of economic activity, grew by about six times. When examining specific nations, the variations in GDP growth rate were even more pronounced.

Numerous indicators can be used to assess economic variations at different aggregation and frequency levels. A non-technical explanation of these decisions in the context of the US is given by the National Bureau of Economic Research. Using annual real GDP data at the national level to identify recessions and booms—described as years in which real GDP is, respectively, below or above what is considered average for the country—is one method of studying the interaction between carbon pricing tools and economic variations. Finding the norm for a particular year can be a complex and contentious subject, but for the purposes of

this discussion, it is unimportant.
Although economic swings impact all nations, the ways in which they manifest themselves vary. Considering that China and the UK have different economic structures, institutions, trading partners, and stages of growth, it would be remarkable if they went through identical oscillations. As a result, different countries may have different results from the same carbon pricing tool.
In order to explain variations in GDP and emissions, this article focuses on three key features. A nation's GDP decreases in comparison to normal times when it enters a recession, while the converse occurs during a boom. The degree to which these deviations from the norm occur is gauged by the size of economic swings. It can be summed up by looking at the volatility of GDP growth rates, or by breaking down an observed time series into its growth and cyclical components and concentrating on the volatility of the latter using more sophisticated time series filters. Whatever the methodology, a number of research addressing this issue have yielded solid results demonstrating that developed nations have less GDP volatility.
The relationship between fluctuations in emissions and changes in GDP captures how emissions change over the course of an economic cycle. In recessions, one would anticipate lower emissions than usual, and in expansions, more emissions. Numerous studies that examine historical data for developed and emerging nations validate this conclusion. Additionally, there is evidence that the link is stronger in developed nations than in developing nations, meaning that during economic booms, emissions are more likely to exceed average levels.
The extent of emissions fluctuations, particularly in relation to GDP fluctuations, is the final characteristic. It can be quantified by looking at the volatility of the filtered emissions series' cyclical components or growth rates of emissions. Doda demonstrates that the magnitude of emissions variations is greater than the magnitude of GDP changes through an analysis of cross-national historical data on emissions fluctuations throughout business cycles.
In summary, all nations are impacted by GDP changes, although the magnitude of these variations varies substantially throughout nations. Changes in emissions are usually more variable and procyclical than changes in GDP. Additionally, these characteristics of emissions differ throughout nations. These findings imply that by explicitly accounting for economic cycle changes, carbon pricing regimes may be better designed.

4. Case analysis: selection and description of data

4.1 Selection and description of the sample data

The research object in this work is the daily closing prices of six carbon emission rights exchanges located in Beijing, Shanghai, Tianjin, Hubei, Guangdong, and Shenzhen. However, because of their low trading volume and comparatively flat price movements, the markets in Chongqing and Fujian were excluded. We gathered data on "double carbon" from many exchanges through the study on September 22, 2022, and we used R to create a thorough evaluation of the changes in the price of carbon emission rights. Furthermore, we employ a range of scientific techniques and a thorough analysis of the risk features of carbon financing. By thoroughly examining the risk features of the carbon emission rights of various exchanges through the first stage analysis,

We are able to construct a sample time range for carbon trading markets in seven major Chinese cities. Refer to sampling time range of each exchange as shown in Table 1.

Table 1: Sampling time range of each exchange

Exchange	Stage 1	Stage 2
Beijing	2015.11.28—2022.09.22	2022.09.23—2023.12.31
Shanghai	2015.12.19—2022.09.22	2022.09.23—2023.12.31
Tianjin	2015.12.26—2022.09.22	2022.09.23—2023.12.31
Hubei	2015.04.02—2022.09.22	2022.09.23—2023.12.31
Guangdong	2015.12.19—2022.09.22	2022.09.23—2023.12.31
Shenzhen	2015.06.19—2022.09.22	2022.09.23—2023.12.31

4.2 Empirical analysis of China's carbon market volatility based on the GARCH model Model parameter estimation

Following AIC and SIC examination, the GARCH (1,1) model showed good performance. We utilise it as a normally distributed approach to assess the exchange's yield and determine the P-value for each parameter based on this conclusion. The parameter assessment of the yield sequence of the six exchanges under the "double carbon" direction demonstrated good consistency, indicating that we can clearly notice a specific fluctuation tendency in the return rate of the national carbon finance market. To further support this claim, we also evaluated the yield rate of the six exchanges collectively using the average approach. Refer to parameter estimation of the GARCH (1,1) model under each normal distribution in the first stage as shown in Table 2.

4.3 Analysis of price volatility of carbon emission rights of each exchange

Following a thorough investigation, we discovered that each exchange's GARCH and ARCH term parameters were greater than or equal to 0, suggesting that outside influences would have a bigger influence on the exchange's prices. Furthermore, these factors likewise fall between 0 and 1, indicating that they fluctuate in price continuously and that the subsequent market would be impacted by their yields. For the analysis of volatility characteristics, three cities are chosen. Although there is not much of a shift in α_1 at Beijing Exchange, there is a clear increase trend in β_1. Before and after the "double-carbon" aim was put forth, the total of $\alpha_1 + \beta_1$ saw significant changes, with the second stage approaching 1. This could be because Beijing's businesses are becoming more efficient in their production, which lowers the demand for carbon emissions, and because the "dual carbon" aim has been put into place. The price of carbon emission trading also experiences short-term volatility due to the growth of the new energy index, but eventually, the price will stabilise. The significant increase in α 1 suggests that modifications to external environmental factors will intensify fluctuations in prices. The GARCH term weakening in stage 2 and the drop in β_1 suggest that the current variable has little influence on changes in the variable at later stages. This is mainly because of the stringent regulations that the first Shanghai Exchange implemented, the environmental rules that were subsequently put into place, and the strong partnership with the carbon emission trading market, which increased the activity of the exchange as a whole. Since "dual carbon" was implemented, Shenzhen Exchange's α_1 performance has significantly increased while β_1 performance has significantly deteriorated. This demonstrates how the introduction of "dual carbon" has significantly reduced the memory of the fluctuation impact of the Shenzhen Exchange's market volatility and increased the likelihood that it would be influenced by outside influences. The Shenzhen Stock Exchange's role as a major financial hub in the Guangdong-Hong Kong-Macao Greater Bay Area, its aggressive adoption of green finance, and its quick response to market fluctuations are mostly to blame for this predicament.

Table 2: Parameter estimation of the GARCH (1,1) model under each normal distribution in the first stage

	Beijing	Shanghai	Tianjin	Hubei	Guangdong	Shenzhen	Nationwide
α0	0.0049	0.0010	0.0001	0.0003	0.0001	0.0002	0.2361
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	
α1	0.2120	0.1519	0.1035	0.3035	0.2865	0.3590	0.5191
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	
β1	0.0323	0.5152	0.8515	0.3608	0.7135	0.6410	0.7551
	(0.7708)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	

4.4 Risk measure of volatility in the China's carbon market

Results of the GARCH (1,1) -VaR model calculation We can characterise the risk variations in the carbon finance market more precisely by using the GARCH (1,1) model's parameter estimate. To find the relevant VaR value, we will start with a 1000 yuan investment and use 99% and 95% confidence intervals to assess each exchange's projected price change. Refer to calculation of VaR values for the GARCH (1,1) model as shown in Table 3.

Table 3: Calculation of VaR values for the GARCH (1,1) model

Exchange	Stage 1		Stage 2	
	99%	93%	99%	93%
Beijing	16.1714	11.4368	11.4171	8.0745
Shanghai	1.0331	0.7306	0.7294	0.5158
Tianjin	3.6047	2.5494	2.5450	1.7999
Hubei	0.8452	0.5977	0.5967	0.4220
Shenzhen	3.0463	2.1544	2.1507	1.5210
Guangdong	5.0750	3.5891	3.5830	2.5340

We discovered that the VaR value of the GARCH (1,1) model has good dependability by using the Kupiec test. The 99% confidence level suggests that the total number of exchanges in the "double carbon" will not surpass 5%. This suggests that the risk characteristics of the trade can be precisely represented by the GARCH (1,1) model, as illustrated in Table 3. Shenzhen Stock Exchange has a strong financial vitality due to its large trading volume and location in the Guangdong-Hong Kong-Macao Greater Bay Area, which makes investors prone to deviation in the analysis and understanding of relevant policies, thus leading to drastic changes in their expected returns. Refer to Back test results of VaR values as shown in Table 4.

Table 4: Back test results of VaR values

	Stage	Test days	Failed days	Failure rate(%)
Beijing	1	425	9	2.12
	2	100	0	0.00
Shanghai	1	730	24	3.29
	2	94	4	4.26
Tianjin	1	724	6	0.83
	2	70	3	4.29
Hubei	1	694	7	1.01
	2	115	3	2.61
Shenzhen	1	810	15	1.85
	2	66	15	22.73
Guangdong	1	744	7	0.94
	2	124	3	2.42

Seven cities—Beijing, Tianjin, Shanghai, Chongqing, Hubei, Guangdong, and Shenzhen—introduced voluntary programmes to cut greenhouse gas emissions between June 2022 and June 2023. More than 2,000 businesses have been able to cut greenhouse gas emissions by more than 1.2 billion tonnes as a result of the implementation of these rules. Refer to Variables definitions as shown in Table 5.

Table 5: Variables definitions

Type	Symbol	Name	Definitions
Dependent variables	rCoal	rCoal	The specific meaning of rCoal refers to the carbon dioxide emissions produced during the combustion of coal. Coal is a fossil fuel that produces large amounts of carbon dioxide when burned, which is one of the main causes of greenhouse effect and global climate change.
Dependent variables	rOil	rOil	rOil refers to the carbon dioxide emissions produced during the combustion of petroleum and its related products. Petroleum is a fossil fuel primarily composed of hydrocarbons, which release large amounts of carbon dioxide when burned, one of the main causes of the greenhouse effect and global climate change.
Core variable	LNG	Liquefied Natural Gas	The specific meaning of LNG is mainly reflected in its low carbon emission as a clean energy, which is one of the important energy sources to help achieve the carbon reduction target.
Core variable	TEMDIF	Time Difference	The specific meaning of TEMDIF refers to Time Difference. In the field of carbon emissions, time differences mainly refer to changes and comparisons in carbon emissions over different periods. For example, differences in annual carbon emissions, variations in seasonal carbon emissions, etc. Such time differences are significant for assessing carbon emission trends, formulating reduction strategies, and optimizing carbon emission management.
Mediator variables	Cooling	Cooling	The specific meaning of Cooling mainly involves the greenhouse gas emissions produced by refrigeration equipment during operation. Specifically, when refrigeration equipment is in operation, it consumes electricity, and the process of electricity production may generate greenhouse gases such as carbon dioxide (CO2), thus affecting carbon emissions.
Mediator variables	Heating	Heating	The specific meaning of Heating refers to greenhouse gas emissions produced during the heating process. Heating is an important source of carbon emissions, especially in the United States, where nearly half of all carbon emissions come from heating, cooling, and powering homes, offices, and other buildings.
Moderator variables	Industry	Industry	Industry refers to greenhouse gas emissions associated with industrial production activities. In the process of industrial production, due to energy consumption, chemical reactions, and material processing, a large amount of greenhouse gas emissions is generated, especially carbon dioxide. These emissions mainly come from the combustion of fossil fuels, chemical reactions in industrial production processes, and the operation of industrial equipment.
Moderator variables	Stock	Carbon Stock	In carbon emissions, Stock typically refers to carbon stocks. Carbon stocks refer to the amount of carbon in a reservoir, measured in tons of carbon. Changes in carbon stocks reflect the differences between increases and losses of carbon within these systems, serving as one of the key indicators for assessing the impacts of the carbon cycle and climate change.
Control variables	Policy	Policy	Policy refers to a series of rules, measures, and guidelines established by governments, international organizations, or institutions to control and reduce greenhouse gas emissions. These policies aim to promote carbon reduction across society through means such as setting emission limits, providing economic incentives, promoting clean energy, and technological innovation, thereby addressing global climate change.
Control variables	RE	Renewable Energy	The specific meaning of RE is Renewable Energy. It holds a significant position in discussions about energy transition, sustainable development, and corporate carbon neutrality. The renewable energy represented by RE includes various forms such as wind power and bioenergy. The use of these energy sources aims to reduce dependence on fossil fuels, lower carbon emissions, and thus address global climate change.

4.5 Correlation test

This article will test the correlation between variables to prevent multicollinearity. With the exception of LNG price and switching price, all of the variables' VIF values are significantly less than 10. Therefore, the eleven explanatory variables selected for the model exhibit multicollinearity. As a result, we lower switching cost. We also look for any correlation between the variables. Only the weather condition variables in the model have weak correlations, as shown by the correlation coefficients in Table 6 below (correlated coefficient is larger than 0.3 but less than 0.7).

Table 6: Pearson correlation matrix

	rCoal	rOil	LNG	TEMDIF	Cooling	Heating	Industry	Stock	Policy	RE
rCoal	1.00									
rOil	0.06	1.00								
LNG	-0.14	-0.07	1.00							
TEMDIF	-0.03	-0.06	-0.33	1.00						
Cooling	0.06	0.03	-0.24	-0.56	1.00					
Heating	-0.09	-0.22	0.30	0.53	-0.36	1.00				
Industry	0.03	0.04	-0.13	-0.07	0.11	0.02	1.00			
Stock	0.02	0.06	-0.06	0.02	0.00	-0.02	-0.18	1.00		
Policy	-0.08	0.03	0.00	-0.01	0.16	0.00	0.08	-0.04	1.00	
RE	-0,05	0.01	0.04	0.04	0.20	-0.19	0.17	0.10	0.21	1.00

4.6 Empirical study on the price fluctuation of carbon emission right trading

The carbon trading policies in China's seven largest cities differ. Our reference for carbon trading in China is the pilot carbon emission trading in Shenzhen, Beijing, Shanghai, and Hubei since the trading in these cities is continuous, active, and of typical representative significance.4,324 cities' worth of carbon trade data were gathered between June 16, 2019, and May 15, 2024. Refer to Descriptive statistics of returns as shown in Table 7.

Table 7: Descriptive statistics of returns

Carbon trading pilot city	Mean	Standard deviation	Skewness	Kurtosis	The P-value of the J-B quantities
Shenzhen	-0.000993	0.045518	0.174388	4.838499	0
Beijing	0.000226	0.080083	-0.535346	6.249640	0
Shanghai	-0.000119	1.668227	1.668227	33.80777	0
Hubei	0.000339	0.030861	-0.109764	6.963778	0

Table 7's descriptive statistics of yields demonstrate that while the earlier levels have stabilised, they have grown increasingly striking in tandem with the growth of the carbon trading market. To better understand the shifting tendency, we therefore compared the yield for each day. The Eview8.0 data analysis indicates that the yields in Shenzhen and Shanghai are negative, indicating a highly volatile market in Shanghai. The yield also shows a clear peak trend, with the Jarque-Bera P value being lower than 0, and the four region peaks being higher than the normal distribution peak 3.

We must move swiftly to support the establishment of a carbon emission trading market and put in place efficient financial controls to effectively restrict changes in the price of carbon in order to prevent the associated market risks and manage and promote sustainable development. To encourage more people to join, it is also essential to create more sustainable carbon trading products, greatly decrease the entry threshold for investors, greatly increase transaction liquidity, and pique everyone's interest. Enhancing the transparent and open information process will enable us to give investors up-to-date, accurate, and complete value measurements, enabling them to make well-informed judgements.

5. Conclusion

This study combines the empirical data and theoretical findings from pertinent literature to examine if and how policy instruments for carbon pricing are intended to address the issue. An examination of the industry cycle fluctuations and the appropriate price decrease for carbon emissions. The main finding is that responsive policies should, in theory, increase wellbeing. In order to implement such policies and maintain the long-term objectives of climate policy, the ceiling on carbon emissions trading programmer can be raised during economic expansion and lowered during recession. Optimal response rules in practice involve very strict information and system constraints.

The article outlines several categories of mechanisms, including indexed regulation, hybrid tools, and an independent agency tasked with ensuring that carbon prices are in line with wider climate change policy objectives, that can make real-world carbon pricing policy tools more responsive in light of these and other constraints. The best way to realize the welfare gains from a flexible carbon price mechanism is not to rely solely on one method. This is not surprising given that a key result of this analysis is that national characteristics are important in designing mechanisms that work, particularly when it comes to the business cycle fluctuations of GDP and emissions. We employed the GARCH model to analyze the carbon market performance of six carbon emission rights exchanges in Beijing, Shanghai, Tianjin, Hubei, Shenzhen, and Guangdong, and we also examined the revenue and expenses of these exchanges under the "two-carbon" framework. We discovered that these six exchanges' revenue and cost had notable high and low points, which the GARCH (1,1) model does a great job of capturing. Due to a variety of factors, including the market structure and the execution of local policies, "the implementation of dual carbon" has resulted in a shift in the cost of "dual carbon." Nonetheless, as China's carbon emission trading market continues to develop, the overall market's operation is becoming more compliant, and cost adjustments are often occurring gradually. We are better able to comprehend the advantages and disadvantages of the various carbon emission rights trading platforms based on the findings of the GARCH (1,1) model. But because of these platforms, our VaR values might not be ideal given the categories and requirements. We recommend encouraging the creation of China's carbon emission trading platform as soon as possible in order to address this issue. To ensure the healthy development of the carbon sink, building a comprehensive carbon emissions trading system requires not only methodical work but also full utilization of current practices and the province's pilot results into a more comprehensive national system. Additionally, a unified trading, pricing, and quota mechanism must be established.

To guarantee the stability of the carbon market, it is imperative to establish a robust system for predicting and managing carbon financial risks. Additionally, relevant departments or institutions should develop early warning indicators and risk measurement models to precisely identify and regulate potential risks associated with carbon market trading across various regions. Furthermore, we ought to broaden the range of China’s carbon financial products and fully leverage their risk-hedging and market-stabilizing capabilities. We should actively engage in international cooperation and exchanges, learn from the global carbon financial market, and encourage coordinated development in order to accomplish the "double carbon" goal. This will help to better promote the internationalization of China's carbon emission trading market. According to economic theory, the size of welfare benefits and the manner in which they are realized are determined by the relative volatility and correlation of these factors.

Background in institutions is also very important. It might be ineffective to introduce carbon central banks, the ostensibly independent regulators of political involvement, in a nation where they already exist. In a broader sense, consideration must be given to political and economic factors. Within a government It seems unclear that promoting hybrid tools will have an impact in a setting where price-aversion tools are prevalent. Future studies will therefore be crucial in helping to better understand the relationships between these national traits and response mechanisms, especially in the context of explicit information, institutional limits, political, and economic constraints.

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