

How do macroeconomic determinants and weather conditions jointly influence the commodity derivative market?

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Abstract

The study aims to identify the long-run influence of macroeconomic determinants along with weather conditions on the commodity derivative market.

Keywords Commodity derivative market, Macroeconomic determinants, Weather conditions, Financial economic theory, environmental economic theory

Paper type Research article

1. Introduction

The financial market development helps in economic expansion and creates wealth and opportunities that motivate the enlargement and further development of the financial system. A sound financial market allocates risks appropriately, enhances market liquidity, reduces the cost of capital and makes economies more resilient to shocks (Bertocco, 2008; Chami *et al.*, 2010), especially in developing economies (Ullah *et al.*, 2024). Previous studies conducted by Ngong *et al.* (2022) and Zhang *et al.* (2024) revealed a bidirectional relationship between financial market development and economic growth, indicating that the financial market has an impact on economic growth, but at the same time, economic growth also has an impact on financial market development. Understanding the financial market seems to ride a bicycle with two wheels, i.e. risk and return; balancing between these two wheels is highly needed to ride efficiently. While the financial market is widely known for risk minimization, the derivative markets play a crucial role in managing this risk. Since the financial crisis, derivative markets have persistently been significant in reducing risk (Sakurai and Kurosaki, 2020).

Looking at the global scenario provides glimpses of various challenges, such as the COVID-19 pandemic, weather-related disruptions (Oskorouchi and Sousa-Poza, 2021), slow economic growth in China (Oxford Analytica, 2023) and geopolitical conflicts in Ukraine, Russia and the Middle East (Giovannetti *et al.*, 2023), all of which have significantly impacted the derivative market. All such events at the global level have also caused an increase in global inflation, food insecurity and economic vulnerability worldwide (World Bank, 2024), which affects the commodity's demand and supply in general and production level in particular. As a result, commodity derivative trading declined significantly in 2024, showing a 15.4% decrease compared to 2023.

JEL Classification — G13, E44, Q02

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Commodity derivatives are a chief segment of the financial market that attracts stakeholders due to their hedging capabilities and diverse attributes (Ordu *et al.*, 2018). A sound commodities market draws the attention of foreign as well as domestic investors and provides liquidity that may be utilized in many other sectors of the economy for growth and development (Vo *et al.*, 2019). Additionally, it provides tools for reducing hazards associated with global trade, such as fluctuations in commodity prices and currency values. Commodity derivative markets significantly contribute to economic development by minimizing these risks through hedging. The commodity markets significantly enlarged their importance as an indicator of economic activity (Li *et al.*, 2015; Enilov, 2024). Historical referencing to commodity derivatives shows that in the year 1990s, the prices of commodities and indices were relatively stable and flat (Matesanz *et al.*, 2014; Gomez *et al.*, 2011). At the beginning of the year 2002, a strong and upward trend was noticed. During the year 2008, prices recorded their maximum, and after the middle of the year, a significant drop in prices was measured (Mo *et al.*, 2018). Many researchers linked upward and downward trends of commodity prices with various economic determinants. Financial-economic theory proposed by Modigliani and Miller (1958), who measure the impact of macroeconomic determinants on the commodity derivative market in isolation without due consideration of weather conditions. Simultaneously, the literature warrants the pivot role played by weather conditions, especially temperature, on the production as well as productivity of the commodity. Hence, the present study attempts to examine how do macroeconomic determinants and weather conditions jointly influence the commodity derivative market?

The structure of this study is as follows: Section 2 reviews the previous research; Section 3 outlines the methodology; Section 4 presents the analysis of results; Section 5 discusses the findings; and Section 6 provides the study's conclusion and key implications.

2. Theoretical framework and review of literature

The relevant studies are categorized into three sections. The first section deals with the theoretical background related to the relationship between financial markets, financial instruments and macroeconomic determinants through financial economic theory. The second section explores the theoretical background related to the relationship between financial markets, financial instruments and macroeconomic determinants through environmental economic theory. The third section examines studies on the commodity derivative market and macroeconomic determinants.

2.1 Relationship among financial markets, financial instruments and macroeconomic determinants: financial economic theory perspective

Previous literature has analyzed the relationship between financial markets, financial instruments and macroeconomic determinants through financial economic theory. This theory, first introduced by Modigliani and Miller (1958) and later expanded by Sharpe (1991), asserts the irrelevance of hedging under market efficiency. It focuses on how financial markets, institutions and instruments function and how they respond to various economic factors (Nittayakamolphon *et al.*, 2024). According to this theory, in an efficient financial market, policies, rules and guidelines for hedging are not much required. Further, through the risk-return trade-off, it underscores the existence of a positive relationship between risk-taking and the performance of the financial market. An efficient financial market with higher returns invites both domestic as well as non-domestic investors. Jin and Jorion (2006), with the application of financial economic theory, inspected the association among firm performance, stock prices and commodity prices. The findings of the study confirmed that though rising commodity prices in turn increase stock prices, yet it have a negative influence on the performance of the firm. It is observed that the consumer price index (CPI) exhibits non-linear influences, which provides though initially it stimulates the derivative market, yet later on continues to increase beyond the threshold and

increases uncertainty in the economy, other macroeconomic variables often display a monotonic relationship as confirmed by [Li et al. \(2015\)](#). Besides this, the CPI generally affects the nominal price of commodity in-turn hedging needs. Hence, drives the behavior of the derivative market more immediately and profoundly than variables, namely, exchange rate (ER), export (EXP), import (IMP), or Gross Domestic Product (GDP) ([Garg et al., 2025](#)). Additionally, the CPI carries a direct impact on investors' sentiments as well as participation rates. Therefore, CPI outlines the market expectation and risk-return trade-off in a non-linear manner than other macroeconomic variables, which lack comparable non-linear association ([Gourio and Ngo, 2020](#)).

2.2 Relationship among financial markets, financial instruments and macroeconomic determinants: environmental economic theory perspective

In order to determine the impact of weather conditions on the financial market in general and the commodity derivatives market in particular, the environmental economic theory has been widely recognized. This theory proclaims that the impact of weather conditions on economic activities plays a vital role in the production and trade of commodities ([Wyszomierski et al., 2024](#); [Ostic et al., 2022](#)). Further, [Musshoff et al. \(2011\)](#) examined the role of options in the mitigation of risk in the production of wheat and confirmed the existence of a strong relationship between yield and rainfall index. [Taşkin et al. \(2021\)](#) analyzed the impact of global warming on the futures prices of agricultural, energy, as well as industrial commodities and concluded that global temperature essentially affects the expectations in relation to agriculture and energy-related activities in the economy. [Makkonen et al. \(2021\)](#) acknowledged the adverse impact of temperature on the commodity derivative markets, alternatively, [Zhang et al. \(2023\)](#) linked high temperatures as well as global warming with adverse effects on financial market. However, [Luo and Zhang \(2024\)](#) validated the existence of a twofold effect, where a moderate increase in temperature had a positive impact. However, exceeding a certain threshold caused significant harm to the financial market.

2.3 Macroeconomic determinants and commodity derivative market

Existing studies underscored the impact assessment of macroeconomic determinants on price discovery and efficiency in commodity derivative markets. [Levin et al. \(2006\)](#) and [Cai et al. \(2001\)](#) studied the gold market; [Christian \(2008\)](#) examined the silver market; whereas [Hammoudeh and Yuan \(2008\)](#) analyzed the combined effect of oil and interest rate uncertainties on the copper, gold and silver as well. [He et al. \(2010\)](#) highlighted that crude oil prices were closely co-integrated with the Kilian economic index and US dollar index, signifying that prices of crude oil were considerably influenced by fluctuations in the economy. [Algieri \(2014\)](#) identified an inverse relationship between exchange rates and the performance of commodity derivative markets. [Zheng et al. \(2023\)](#) analyzed the two-fold impact of geopolitical risks on the price volatility of commodity. [Mahanama et al. \(2024\)](#) examined the role of financial markets in the construction of social well-being indices with reference to inflation and economic development. [Fernandes et al. \(2020\)](#) conducted an inclusive analysis of the commodity derivative market and confirmed the existence of extensive high fluctuations, though the causes were not explored. [Marashdeh et al. \(2020\)](#) concluded a unidirectional relationship between macroeconomic determinants and financial markets, confirmed that inflation adversely affects the functioning of the financial market.

From the above, it is evident that over the past 3 decades, extensive research has been conducted on commodity derivative markets. The existing literature has examined the financial markets in relation to macroeconomic determinants, the commodity derivative market remains relatively underexplored in this context. The majority of studies have concentrated on price discovery, market efficiency and macroeconomic factors in isolation. Yet the integration of macroeconomic determinants with weather conditions remains largely unaddressed. Most of the previous studies consider the linear role of inflation but ignore the non-linear role of inflation within the commodity derivative market. Further, no studies on the

commodity derivative market and macroeconomic determinants utilize strong panel data estimation, such as Driscoll-Kraay Standard Errors (DKSE) and Panel-Corrected Standard Errors (PCSE), to account for cross-sectional dependencies, autocorrelation and heteroscedasticity while testing the non-linear relationship between inflation and the commodity derivative market. In addition, for measuring the U-shaped relationship, the U test is rarely observed. Hence, the present study aims to fill the gap with the examination of the joint influence of economic indicators and weather conditions on the commodity derivative market. The study integrates both financial and environmental economic theories to examine the joint influence of macroeconomic determinants and weather conditions on the performance of the commodity derivative market. In accomplishing, it seeks to provide deep, fruitful insights into the wider implications for food for all, stability of inflation and resilience in the overall financial market in general and the derivative market in particular.

3. Methodology

3.1 Data collection and sample selection

The present study attempts to analyze the joint influence of diverse macroeconomic determinants and weather conditions on the commodity derivative market across selected countries under consideration. For this, quarterly data are used, which is majorly collected from the websites of the International Monetary Fund (IMF), World Federation of Exchange (WFE) and Organization for Economic Co-operation and Development (OECD) for the 10 years tenure ranging from 2014 to 2023. The base for the present study is taken as 2014, as this year was carried significant regulatory reforms in the derivative market ([Bank for International Settlement, 2014](#); [Financial Stability Board, 2014](#)). These reforms, developed by the Financial Stability Board (FSB) and G20, focused on central clearing, trade reporting and margin requirements to standardize and secure the market ([Ghamami and Glasserman, 2017](#)). The process of the sample stock exchanges dealing in commodity derivatives is given in [Figure 1](#) and the list of these selected commodity derivative exchanges is given in [Table 1](#).

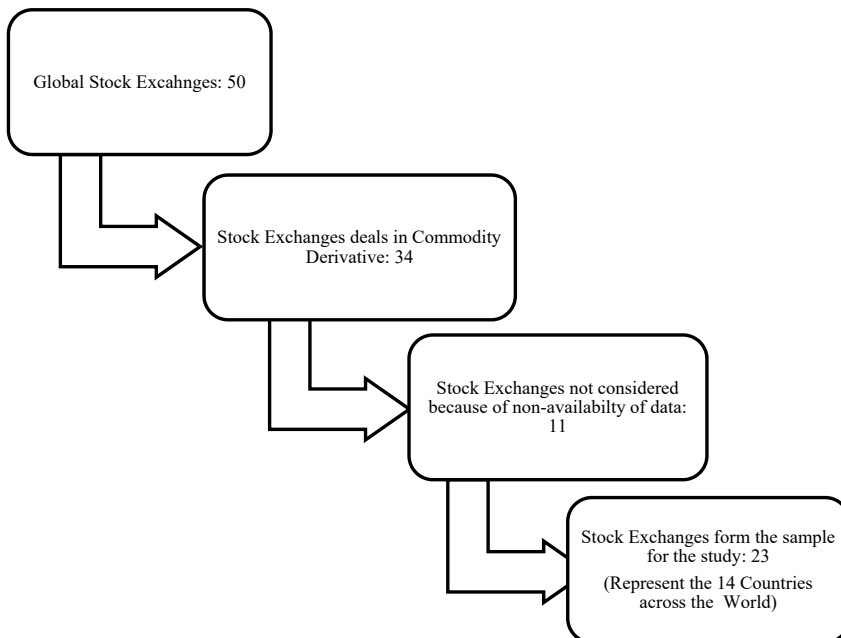


Figure 1. Sample derivation for the study. Source: Authors' own compilation

Table 1. List of selected commodity derivative exchanges

S.No	Exchanges	Country
1	ASX Australian Securities Exchange	Australia
2	ASX Sydney Futures Exchange Derivatives Trading	
3	B3 - Brasil Bolsa Balcão	Brazil
4	Dalian Commodity Exchange	China
5	Shanghai Futures Exchange	
6	Zhengzhou Commodity Exchange	
7	Bolsa de Valores de Colombia	Colombia
8	Deutsche Boerse Aktiengesellschaft	Germany
9	Hong Kong Exchanges and Clearing	Hong-Kong
10	Budapest Stock Exchange	Hungary
11	India International Exchange	India
12	Indian Commodity Exchange	
13	Multi Commodity Exchange of India	
14	National Stock Exchange	
15	Indonesia Commodity and Derivative Exchange	Indonesia
16	Moscow Exchange	Russia
17	The Saint Petersburg International Mercantile Exchange	
18	Johannesburg Stock Exchange	South Africa
19	Borsa Istanbul	Turkey
20	Intercontinental Exchange Futures Europe	UK
21	London Metal Exchange	
22	Chicago Mercantile Exchange Group	USA
23	Intercontinental Exchange Future Futures US	

Source(s): World Federation of Exchange (WFE)

3.2 Variable selection and measurement

The notional value (NV) of the commodity derivative contract entered is used to quantify the development of the commodity derivative market. In order to measure the weather conditions, average temperature (AT) is used as a proxy, whereas for the economic development, GDP is used as proxy. In the present study, EXP, IMP, gross fixed capital formation (GFCF), CPI and ER are used as control variables (Vo *et al.*, 2021; Adams *et al.*, 1979; Rauf *et al.*, 2018; Uddin, 2024). The natural logarithms of the variables GDP, EXP, IMP and GFCF are considered. The list of variables along with the data source is given in Table 2.

Table 2. Variable descriptions, measurements and data sources

Variable	Description	Source
Dependent Variable		
LN _{NV}	log of Notional Value of Commodity Derivative Contract	WFE
Independent Variable		
AT	Average surface temperature	Our World in Data
LGDP	log of real GDP	IMF
CPI	Consumer Price Index of all items	IMF
ER	Exchange Rate, Domestic currency per USD	IMF
LEXP	log of Export of goods and services	IMF
LIMP	log of Import goods and services	IMF
LGFCF	log of Gross Fixed Capital Formation	IMF

Source(s): Authors' own compilation

3.3 Econometric models

The study employs two models to examine the joint influence of the macroeconomic determinants and weather conditions on the commodity derivative market.

Model-1

$$LNV = \alpha_0 + \alpha_1 AT_{it} + \alpha_2 LGDP_{it} + \alpha_3 CPI_{it} + \alpha_4 ER_{it} + \alpha_5 LEXP_{it} + \alpha_6 LIMP_{it} + \alpha_7 LGFCF_{it} + \varepsilon_{it}$$

Model-2 [A squared term of $(CPI)^2$ is added with the addition of the variable $CPI2$ to capture possible non-linear effects]

$$LNV = \alpha_0 + \alpha_1 AT_{it} + \alpha_2 LGDP_{it} + \alpha_3 CPI_{it} + \alpha_4 CPI2_{it} + \alpha_5 ER_{it} + \alpha_6 LEXP_{it} + \alpha_7 LIMP_{it} + \alpha_8 LGFCF_{it} + \varepsilon_{it}$$

Where,

LNV: Log of Notional Value of Commodity Derivative Contract

AT: Average Temperature

LGDP: Log of Gross Domestic Product

CPI: Consumer Price Index

CPI2: Squared term of Consumer Price Index

ER: Exchange Rate

LEXP: Log of Export

LIMP: Log of Import

LGFCF: Log of Gross Fixed Capital Formation

α_0 and ε_t show the constant term and error term, respectively

3.4 Methods

Cross-sectional dependence (CD) arises in panel data analysis when different cross-sections depict correlated error terms as well as observable characteristics because of common uncertainties and spillover effects. Accordingly, in the present study, the CD test and Breusch-Pagan Lagrange Multiplier (LM) test are used to test the null hypothesis, which assumes strict cross-sectional independence or weak CD (Pesaran, 2015). Hence, to accommodate CD, the second-generation Cross-Sectionally Augmented Im-Pesaran-Shin (CIPS) unit root test is applied to examine stationarity in panel data (Pesaran, 2015). Further, in order to estimate the long-run relationships among the variables under consideration, both first-generation panel co-integration tests (Pedroni and Kao assuming cross-sectional independence) and second-generation tests (Westerlund co-integration assuming CD) are employed.

For the long-run estimation, the Driscoll-Kraay Standard Error Method (DKSE), which deals with both heteroskedasticity and CD, is used (Driscoll and Kraay, 1998; Baloch *et al.*, 2019). Besides this, the PCSE method is applied to address the CD as well as first-difference stationary variables, to produce robust standard errors and precision in the relationship (Reed and Webb, 2010; Mamba *et al.*, 2020). Finally, feasible generalized least squares (FGLS) and generalized method of moments (GMM) have been used for robustness and to address the endogeneity problem (Shinwari *et al.*, 2024).

4. Analysis and interpretation

This section is consistent with the various econometric tests used to measure the joint influence of macroeconomic determinants and weather conditions on the commodity derivative market. The CD, Unit root and cointegration test are elaborated along with the regression result. The results of the CD and unit root tests are presented in Table 3.

Table 3 shows the results of the CD test, which exhibit the rejection of the null hypothesis of cross-sectional independence and require the use of second-generation panel data methods to account for cross-sectional dependencies among the variables under consideration. Hence, the study applies CIPS test to determine the stationarity. The results reveal that some variables are stationary at level, while others become stationary after first differencing and none requires further differencing. The existence of mixed integration orders entails that the traditional estimation methods that assume uniform stationarity are not suitable, supporting the application of advanced econometric techniques.

Table 4 shows the results of long-run relationships among macroeconomic determinants, weather conditions and the development of the commodity derivative market, which is shown with the help of a co-integration test. The study employs both first-generation tests like Pedroni and Kao and second-generation tests like the Westerlund test. The second-generation test accounts for cross-sectional dependencies and the Westerlund test results provide for the rejection of the null hypothesis of no co-integration exist (at the 1% level of significance).

Table 3. Results of cross-section dependency and unit root test

Variables	CD-test	p-value	I(0)	I(1)
LNV	13.618***	0.000	-2.068	-5.929***
AT	7.181***	0.000	-5.110***	-
LGDP	47.352***	0.000	-3.951***	-
CPI	57.075***	0.000	-0.59	-4.584***
ER	36.417***	0.000	-1.091	-3.879***
LEXP	35.773***	0.000	-2.550***	-
LIMP	34.716***	0.000	-2.793***	-
LGFCF	22.857***	0.000	-2.951***	-

Note(s): *** Significant at level of 1%

Source(s): Authors' own compilation

Table 4. Results of co-integration test

	Statistics	p-value
<i>Westerlund test for cointegration</i>		
Variance Ratio	4.474***	0.000
<i>Pedroni test for cointegration</i>		
Modified variance ratio	-4.734***	0.000
Modified Phillips-Perron	3.939***	0.000
Phillips-Perron	-0.349	0.363
Augmented Dickey-Fuller	-1.541*	0.061
<i>Kao test for Cointegration</i>		
Modified Dickey-Fuller	-2.837***	0.002
Dickey-Fuller	-2.610***	0.004
Augmented Dickey-Fuller	-1.382*	0.083
Unadjusted Modified Dickey-Fuller	-5.531***	0.000
Unadjusted Dickey-Fuller	-3.688***	0.000

Note(s): * and *** Significant at level of 10% and 1% respectively

Source(s): Authors' own compilation

Hence, confirm that the long-run relationship exists among the variables under consideration. In other words, the findings confirm that the macroeconomic determinants and weather conditions jointly influence the development of the commodity derivative market over a period. Therefore, it highlights the need for a model that captures these persistent interdependencies in policy analysis for further financial decision-making.

Table 5 exhibit the results of the panel fixed and random effect models. The results of the Wooldridge and Modified Wald tests exhibit that these methods do not sufficiently address matters of autocorrelation as well as heteroscedasticity. Hence, to mitigate these issues, the study uses fixed as well as random effect models with robust standard errors. The Breusch-Pagan LM test results suggest that using robust standard errors alone is insufficient to account for cross-sectional dependency in the model. Consequently, the study adopts DKSE and PCSE methods to effectively address autocorrelation, heteroscedasticity and cross-sectional dependency concerns.

Table 6 shows the results of DKSE and PCSE methods, which address issues such as autocorrelation, heteroscedasticity, as well as cross-sectional dependency. The findings

Table 5. Results of random and fixed effect model with robust standard errors

Dep. Var.:	Random effect		Fixed effect		Random effect with robust standard error		Fixed effect with robust standard error	
LNV	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
AT	-0.008	0.623	-0.008	0.623	-0.008*	0.052	-0.008*	0.083
LGDP	4.699***	0.000	4.672***	0.000	4.699*	0.051	4.672	0.185
CPI	0.007***	0.000	0.006***	0.000	0.007***	0.000	0.006***	0.004
ER	-0.001***	0.000	-0.001***	0.000	-0.001	0.131	-0.001	0.348
LEXP	-3.385***	0.005	-2.596***	0.005	-3.385*	0.085	-2.596	0.276
LIMP	3.846***	0.002	5.025***	0.002	3.846*	0.097	5.025*	0.090
LGFCF	-4.293***	0.000	-5.073***	0.000	-4.293*	0.089	-5.073	0.121
Constant	-8.478	0.264	-23.723	0.264	-8.478	0.421	-23.723	0.229
Wooldridge test							6.141**	
Breusch-Pagan LM test							557.268***	
Modified Wald test							2.5e+05***	

Note(s): *, ** and *** Significant at level of 10%, 5% and 1%, respectively
Source(s): Authors' own compilation

Table 6. Results of the Driscoll-Kraay standard errors (DKSE) and Panel Corrected Standard Error (PCSE) methods

Variables	DKSE (Model-1)	p-value	DKSE (Model-2)	p-value	PCSE (Model-1)	p-value	PCSE (Model-2)	p-value
AT	-0.059***	0.000	-0.063***	0.000	-0.053***	0.000	-0.048***	0.000
LGDP	2.484***	0.000	2.534***	0.000	3.258***	0.000	2.898***	0.000
CPI	0.003*	0.098	0.021***	0.001	0.004*	0.074	0.159***	0.000
CPI2	-		-0.000***	0.001	-		-0.000***	0.000
ER	-0.000***	0.000	-0.000***	0.000	-0.000***	0.000	-0.000***	0.000
LEXP	-1.607***	0.009	-2.135***	0.001	-1.294***	0.000	-1.182***	0.000
LIMP	-0.804	0.161	-0.169	0.748	-1.251	0.108	-1.382	0.762
LGFCF	0.162	0.746	-0.043	0.931	-0.459	0.611	-0.144	0.894
CONSTANT	5.411***	0.001	3.872**	0.036	3.821***	0.000	3.967***	0.000

Note(s): *, ** and *** Significant at level of 10%, 5% and 1%, respectively
Source(s): Authors' own compilation

exhibit that AT, ER and LEXP have negative and significant impacts on LNV. On the other hand, LGDP and CPI exert significant positive influence on LNV. Additionally, other macroeconomic variables exhibit diverse relationships as confirmed by [Li et al. \(2015\)](#). Besides this, the results include the squared of CPI as a variable to examine its possible non-linear effect on LNV. The results depict that CPI has a non-linear effect on LNV, as initially it stimulates participation in the market with moderate inflation. However, once the inflation surpasses a critical threshold, it magnifies uncertainties and unfavorably affects the dynamics of the market. The CPI serves as the target of monetary policy and predominantly influences price stability. Hence, an inclusive understanding of its impact on financial markets in general and the derivative market in particular is imperative. It requires non-linear testing to capture threshold effects to guide evidence-based policy interventions ([Basu and Gavin, 2011](#)). The results demonstrate the existence of an “inverted U-shaped” relationship and indicate that CPI initially endorses LNV but, beyond the limit exerts a diminishing effect.

[Table 7](#) exhibits results of the *U* test and rejects the null hypothesis, which assumes a monotonic or U-shaped relationship between LNV and CPI. Therefore, it confirms the presence of an “inverted U-shaped” relationship between LNV and CPI at 1% significance level. The estimated turning point is 0.441. It indicates that an initial increase in CPI positively influences LNV up to this point and beyond this, CPI exerts a negative impact on LNV.

[Table 8](#) shows the results of IV GMM and FGLS tests for endogeneity and robustness. The application of IV-GMM mitigates the endogeneity bias, and the results remain consistent across both IV-GMM and FGLS techniques. The coefficients are stable, with the signs (positive or negative) of the variables are preserved, hence strengthening the credibility of the findings. The analysis shows that economic growth, inflation, as well as trade dynamics are central in influencing the development of commodity derivative markets. The growth of GDP

Table 7. Results of *U*-test

	Lower bound	Upper bound
Interval	1.072	1011.769
Slop	0.015	−0.017
t-value	8.207	−2.678
$P> t $	7.78e−16	0.003
Test for U-shape	2.681 (<i>t</i> -value)	0.003 ($P> t $)

Note(s): *, ** and *** Significant at level of 10%, 5% and 1%, respectively
Source(s): Authors’ own compilation

Table 8. Results of IV GMM and FGLS test for endogeneity and robustness

Variables	IV-GMM				FGLS			
	Model −1	<i>p</i> -value	Model-2	<i>p</i> -value	Model −1	<i>p</i> -value	Model-2	<i>p</i> -value
AT	−0.008	0.557	−0.007	0.560	−0.002	0.247	−0.002	0.286
LGDP	4.672**	0.006	1.687	0.311	2.008**	0.000	2.079**	0.000
CPI	0.006**	0.000	0.036**	0.000	0.000*	0.553	0.001	0.776
CPI2	−	−	−0.000**	0.000	−	−	−2.40e−07	0.944
ER	−0.001**	0.000	−0.001**	0.000	−0.000**	0.000	−0.000**	0.000
LEXP	−2.596**	0.031	−3.621**	0.004	−1.075**	0.001	−1.220**	0.000
LIMP	5.025**	0.000	5.718**	0.000	0.707*	0.060	0.760*	0.051
LGFCF	−5.073**	0.000	−4.304**	0.000	−0.324*	0.082	−0.326*	0.086

Note(s): *, ** and *** Significant at level of 10%, 5% and 1%, respectively
Source(s): Authors’ own compilation

positively influences the market participation rate, whereas inflation exhibits a non-linear effect. Besides this, imports enhance derivative usage, whereas exports display a negative association with derivative usage. Further, GFCF exerts a negative effect on the development of the commodity derivatives market, indicating the presence of structural inefficiencies or delayed impacts of investment. Lastly, the robustness analysis confirms the reliability of results, which indicate that the commodity derivative markets can play a significant role in supporting economic growth.

5. Findings and discussion

The study attempts to examine the combined impact of macroeconomic determinants and weather conditions on the development of the commodity derivative market. The second-generation co-integration test endorses the presence of long-run relationships among the variables under consideration. These findings align with previous studies by [Stevens and Vermeulen \(2024\)](#), [Vo et al. \(2019\)](#), [Shakil et al. \(2018\)](#) and [Pradhan et al. \(2020\)](#). The results indicate that AT has a significant negative impact on the commodity derivative market. Rising temperatures disrupt production and trade flows, leading to a decrease in commodity derivative contracts. It supports the environmental economic theory and is consistent with studies by [Donadelli et al. \(2017\)](#), [Makkonen et al. \(2021\)](#) and [Zhang et al. \(2023\)](#). The adverse impact of temperature on financial markets highlights the need for strict environmental policies to mitigate climate-related risks, as suggested by [Stern \(2019\)](#) and [Ashour and Sayed \(2024\)](#). Extreme weather condition introduces a level of uncertainty that increases market risk, thereby having a negative impact on commodity futures returns. Eventually, this heightened risk environment has a negative impact on the commodity derivative market ([Jia et al., 2023](#)). This result supports the environmental economic theory and is consistent with the previous study conducted by [Donadelli et al. \(2017\)](#) and [Makkonen et al. \(2021\)](#).

The results provide that GDP positively influences the development of the commodity derivative market. In other words, the higher the growth of GDP, the more efficient the financial environment and market will be, as it may attract both domestic and international investors. These findings are in consonance and supported by existing research by [Hu et al. \(2020\)](#) and [Sreenu et al. \(2021\)](#). Likewise, CPI has a positive influence on the derivative market, as moderate inflation encourages both producers and consumers to hedge against price uncertainties. Additionally, the results also exhibit a nonlinear “inverted U-shape” relationship between CPI and the development of commodity derivative market. At the same time, ER exerts a significant negative effect, as ER fluctuations reduce the returns, discouraging investors’ participation. In addition, exports have a negative influence on the commodity derivative market. Increased exports reduce the domestic availability of commodities for derivative contracts, thereby limiting market activity. These results are in consonance with the findings of the authors [Jumah and Kunst \(2001\)](#), [Algieri \(2014\)](#), [Arfaoui and Ben Rejeb \(2017\)](#), [Nugroho et al. \(2021\)](#) and [Makkonen et al. \(2021\)](#).

6. Conclusion and key implications

The present study uses financial economic theory with the incorporation of environmental economic perspectives. Hence, offering a comprehensive view of the commodity derivative market, which accounts for both macroeconomic determinants as well as weather conditions. From a practical point of view, the findings indicate that macroeconomic stability, indicated by GDP growth as well as controlled inflation play profound role in fostering the development of commodity derivative market. Hence, strong economic fundamentals stimulate market participation, attract new investors, traders, suppliers and producers to hedge against uncertainties. However, avoidance of excessive inflation is a mandate, as it increases risk as well as market volatility; a balanced inflation level supports sustainable investors’

participation. The study also highlights the potential for food-based or commodity derivatives to mitigate risks associated with CPI. Besides this, rising average temperatures negatively impact commodity derivative market development, exhibiting disruptions in commodity production.

Further, these findings hold significant implications for the various stakeholders. Investors should diversify portfolios and include climate-resilient instruments for long-term stability. It's imperative for traders to closely monitor weather risks before executing any trade. Producers should also invest in climate-resilient instruments as well as technologies, and governments must facilitate such efforts through policy initiatives in the area of crop insurance and renewable energy initiatives. Additionally, stakeholders may consider countries having strong currency values in relation to the USD to mitigate risks related to price and currency fluctuations.

Overall, this study provides empirical evidence that adverse macroeconomic conditions and environmental uncertainties adversely affect commodity consumption as well as production. Therefore, it endorses challenges not only to food security but also to long-term economic development. In order to mitigate these risks, policymakers must prioritize inflation control and initiate investment in climate-resilient instrument and infrastructure. Stable exchange rates and balanced trade flows are essential for reducing trade uncertainties to foster market development. However, the present study is limited in scope, as it focuses on only 23 commodity derivative markets of 14 countries and considered AT as a weather variable only. Therefore, future research may expand the sample size as well as include additional environmental indicators, such as rainfall and precipitation indices, to provide deeper insights into the financial market in general and derivative market in particular.

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