Effects of Energy Commodity Price Risk on Firm Value A Case Study of Select Firms from Indian Power Sector

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Abstract

The energy commodity price volatility indicates a vital basis of risk to power sector business enterprises whose principal operations are subjected to direct exposure to thermal coal, crude oil and natural gas price fluctuations. Therefore, energy commodity price risk exploration has drawn considerable interest from academicians, investors, economist, financial analysts and risk management practitioners in recent years as it touches virtually every economic entity—from individuals, to organizations, to the economy. Hence, this paper empirically analyses the influence of energy commodity price risk on firm value of Indian power sector firms. The data has been sourced from PPAC of India, various AGM reports of sample firms, BSE database and analyzed using econometrics techniques with the help of EViews. GARCH analysis exhibits limited influence of energy commodity price risk on firm value of select sample firms. Effects of energy commodity price risk was not uniformly significant across the sample firm's firm value since their principal operations were directly or indirectly influenced by resource procurement practices, ownership pattern, operational diversification and other firm specific qualitative/quantitative factors. The observed outcome of this paper would be valuable to power sector stakeholders who needs to identify the effects of energy commodity price risk before strategizing their future course of activities to protect the top and bottom lines of their firms. Finally, the results are important to our country as power sector has been able to augment the growth of other allied sector dependent on energy.

Keywords: Commodity, power, energy, price-risk, thermal coal, stationary, regression,

Jel code classification: C22, C53, C58, G32

Introduction

During the past decade, energy commodity prices were highly instable exhibiting high volatility which is typically greater than the fluctuations observed in other financial risk factors such as exchange rate and interest rate volatility. According to corporate financial principles, price volatility indicates an important basis of risk to commodity intensive firms since commodity is a vital input or output factor of production process and thus it affects the firm value. The exposure and influence of price volatility has been highly significant to commodity intensive sectors like, oil-gas, power, transportation, metals, tyre, aviation etc. since commodity prices virtually affects their entire value chain.

Commodity price risk management strategies can vary significantly across the sectors based on the quantum of exposure and firm's competitiveness in the market. The strategy has been also greatly determined by the nature of the operations in the value chain. For instance, producers are not focused solely on the price risk of their raw material input price risk; they may also manage their output price risk through active revenue price risk management. Energy commodity consumers, on the other hand, are more likely to be focused on the purchase price variances created by market volatility.

Corporate entities that take a traditional approach to manage commodity price risk are able to address mild volatility but not large or sustained increases or decreases in prices. Traditional approaches in managing energy commodity price risk generally employ a series of risk management activities, including procurement contracts, financial hedging, passing on price increases to customers, and accepting cost increases in an uncoordinated fashion. These approaches result in risk management programs that are often reactive in nature and biased toward market opportunities and short-term tactics, which leads to excessive trading costs and the potential for trading losses.

In the present business environment power sector firms will continue to experience unprecedented price volatility and the business organizations are looking at energy commodity price risk management as an integral part of their strategy to manage costs, maintain competitive advantage and augment the enterprise value so that stakeholder's interest could be protected in the dynamic world. Firms need to manage price risk across the value chain, from trading and supply to distribution and marketing, and employ performance measures that are timely and relevant. To successfully manage the commodity price risk, firms must implement a structured approach that identifies, measures the exposure; quantifies the influence across the corporate value chain.

The existing research work in corporate risk management typically deals with the impact of foreign exchange and/or interest rate risk on firm value. In contrast, modest attention was given on commodity price risk and very few studies have been undertaken to analyze the influence of energy commodity price risk on enterprise value. Generally, commodity prices have been subjected to high fluctuations and therefore they exhibit a significant source of price risk to the power sector firms. On the basis of inadequate experiential research work in corporate risk management with special reference to energy commodity price risk, a broad analysis is needed in order to analyze the effects of commodity prices on individual firms belonging to resource intensive sectors or industries from the Indian context. This article analyzes the use of energy commodity as an essential input factor for corporate principal operation and thus tries to establish the relevance of energy commodities in Indian power sector. The Indian power sector provides a unique perspective from which we can empirically explore the influence of thermal coal, natural gas and crude oil price risk on enterprise value. This paper consists of following sections. Section I starts with introduction; section II & III specifies objectives & hypotheses of the paper respectively. Section IV provides a brief review of relevant literature. Section V discusses the overview of Indian power sector with select player's profile. Section VI represents the methodology and data description. Section VII contains the empirical hypothesis testing, VIII offer findings and section XI concludes the paper.

Objectives

1. To present an overview of Indian power sector
2. To determine the key factors affecting energy commodity price in India
3. To compute the level of energy commodity price exposure on Indian power sector firms
4. To measure the effects of energy commodity price risk on enterprise value of Indian Power sector firms

Hypotheses

$H1_0$: Select key determinants do not affect price volatility of energy commodity in India

$H1_a$: Select key determinants do affect price volatility of energy commodity in India

$H2_0$: Select firms of Indian Power sector do not exhibit significant level of energy commodity price exposure

$H2_a$: Select firms of Indian Power sector do exhibit significant level of energy commodity price exposure

$H3_0$: There is no influence of energy commodity price volatility on firm value of select firms of Indian Power sector

$H3_a$: There is an influence of energy commodity price volatility on firm value of select firms of Indian Power sector

Review of Literature

Eduardo Borensztein (1994), devised a new model for commodity price estimation using the macroeconomic determinants considering supply side effects.

Rene M. Stulz and Rohan Williamson (1996) tried to shed a light on past theories of exposure analysis and quantified the exposure using the regression and simulation methods.

G. David Haushalter, Randall A. Heron & Erik Lie (2002) examined the sensitivity of equity values of oil producers to changes in the uncertainty of future oil prices. They conclude that corporate risk management can increase shareholder value by reducing the expected costs of financial distress and under investment

Sohnke M. Bartram (2005), indicate that corporations exhibit net exposures with regard to several commodity prices. Even though commodity prices are highly volatile, commodity price risk is, however, not found to be of greater importance than other financial risks.

Yanbo Jin and Philippe Jorion (2007) showed that hedging activities are recognized by the market, as hedging variables do have an impact on stock price exposure to gold prices.

Narayan P. K. and Sharma S. S. (2011) oil price affects returns of firms differently depending on their sectoral location, lagged effect of oil price on firm returns and oil price affects firm returns differently based on firm size, implying strong evidence of size effects.

Ramos S. B. and Veiga H. (2011) found oil and gas sector in developed countries responds more strongly to oil price changes than in emerging markets.

Serkan Yilmaz Kandir et all (2014), investigated the exchange rate exposure to Turkish energy firms by adding Fama-French three factor model including oil price.

Indrani Hazarika (2015) in her paper analyzed the financial performance of top five oil and gas companies worldwide and revealed that fluctuating oil prices do not significantly impact the profitability, liquidity, efficiency and financial health of top oil and gas companies.

George Dionne and Martin Garand ( ) investigated North American gold mining firms and significant determinants that affect the hedging decision. The outcome of the study suggests that several factors significantly affect the firm value through hedging policy.

Sohnke M. Bartram ( ) says Firm value is influenced in many direct and indirect ways by financial risks, which consist of unexpected changes of foreign exchange rates, interest rates and commodity prices.

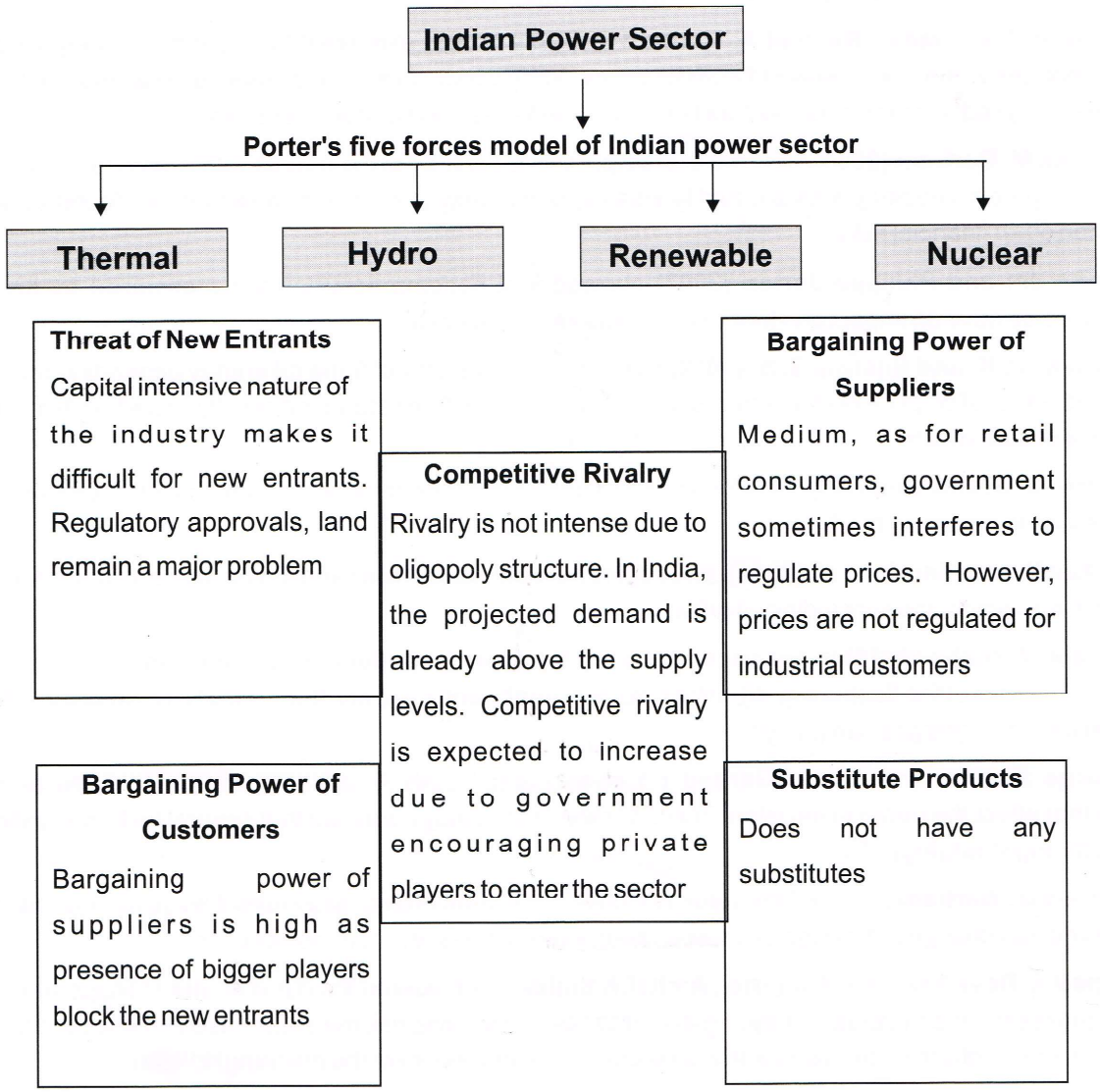
Sripad K. Devalkar, Ravi Anupindi, Amitabh Sinha ( ) considered the dynamic risk management problem for a commodity processor in a multi-period setting and proposes a dynamic risk measure based on the conditional value at risk (CVaR), to model the firm's risk aversion in a time-consistent manner over the planning horizon.

Overview of Indian Power Sector

Power is one of the most critical components of infrastructure; crucial for the economic growth and welfare of nations. India's power sector is one of the most diversified in the world. Sources of power generation range from conventional sources such as coal, lignite, natural gas, oil, hydro and nuclear power to viable non-conventional sources such as wind, solar, and agricultural and domestic waste. Indian power sector is undergoing a significant change that has redefined the industry outlook. Sustained economic growth continues to drive electricity demand in India. The Government of India's focus on attaining 'Power for all' has accelerated capacity addition in the country. At the same time, the competitive intensity is increasing at both the market and supply sides (fuel, logistics, finances, and manpower). Figure 1 provides structure of Indian Power sector, Table 1 provides swot analysis of Indian power sector.

The Government of India has identified power sector as a key sector of focus so as to promote sustained industrial growth. Some initiatives by the Government of India to boost the Indian power sector. The Government of India plans to set up a US$ 400 million fund, sourced from The World Bank, which would be used to protect renewable energy producers from payment delays by power distribution firms, while at the same time protecting the distribution firms from the shrinking market for conventional grid-connected power, caused by wider adoption of roof-top solar power generation. Table 2 provides profile of sample firms in power sector.

Figure 1: Structure of Indian Power Sector



Source: TechSci Research & India Brand Equity Foundation

Table 1: SWOT Analysis of Indian Power Sector

STRENGTHS	WEAKNESSES
• Future growth potential • Huge resource based backup • Oligopoly market structure	• Financially unhealthy electricity board • Transmission and distribution challenges • Theft of power
OPPORTUNITIES	**THREATS**
• Technological upgradation • Automation and centralized grid system • Green energy imitative	• Energy commodity price risk • Liberal FDI policy • Dependence on traditional technology

Table 2: Profile of Sample Firms

Name of the firm	National Thermal Power Corporation	Tata Power	Adani Power
Year of Establishment	1975	1911	1996
Stock Market Listing	BSE and NSE	BSE and NSE	BSE and NSE
Enterprise Value [FY2015-16]	Rs. 188,177.92 crore	Rs. 27,960.36 crore	Rs. 35,235.36 crore
Annual Revenue [FY2015-16]	Rs. 71,770.50 crore	Rs. 8,993.37 crore	Rs. 12,685.59 crore
Net Profit [FY2015-16]	Rs. 10,242.91 crore	Rs. 771.62 crore	Rs. 5.62 crore
Total Assets [FY2015-16]	Rs. 214,619.26 crore	Rs.34,094.92 crore	Rs. 42,045.11 crore
EPS [FY2015-16]	Rs. 12.42	Rs. 2.36	Rs. 0.02
Total Workforce [FY2015-16]	21633	4126	2000
NPM [FY2015-16]	14.52%	9.14%	0.05%
ROA [FY2015-16]	4.77%	2.26%	0.01%
RONW [FY2015-16]	11.53 %	5.31%	0.06%
ROCE [FY2015-16]	5.66 %	2.76%	0.02%

Source: AGM reports 2015-16

Research Methodology

This research paper has used a mixed research design, consisting of exploratory and causal research design, research approach was deductive, research strategy was quantitative to analyze the effects of commodity price risk on enterprise value of select firms. The firms were selected referring to commodity exposure based on probability stratified & non-probability judgmental sampling technique. The following table provide brief summary of research methodology employed in this paper.

Table 3: Research Methodology

Type of Research	Applied; Exploratory and Causal	
Research Approach	Deductive and Inferential	
Research Strategy	Quantitative	
Research Method	Survey	
Time Horizon	Longitudinal, Time Series [2006 - 2016]	
Sampling Design	Sample Unit	Commodity intensive firm
	Sampling technique	Stratified and Judgmental
	Sample size	03 Commodity
		01 Sector
		03 Firms
Data Collection Method	Secondary Data	
Data Collection Sources	Multi Commodity Exchange, Bombay Stock Exchange, National Stock Exchange, Reserve Bank of India, CEA of India, website of firms, World Bank database, IMF commodity series, IEA commodity database, Indian petroleum & planning cell, UNCTAD database, OPEC commodity series	
Models and Tests for Data	Normality Test	Jarque-Bera Test
	Unit Root Test	ADF & PPP Tests

	Stationarity Test	KPSS Test
	Cointegration Test	Johansen Test
	Causality Test	Granger Test
	Exposure Test	Market model Test
	GARCH Test	Univariate Test

Data Analysis and Discussion

The data analysis was performed in three broad phases along with necessary sub-phases in order to have better interpretations and inference drawing on the observed results. In the first phage, authors have employed descriptive statistical analysis and time series econometrics analysis on the particular data variables related to energy commodity and firms selected for this study. Second phage deals with the unit root test on select data variables. Finally, third phage contains exposure and effects analysis related to energy commodity price risk and enterprise value of firms using market model regression and GARCH model respectively.

Effects of Key Determinants on Crude Oil Price Risk

According to Louis H. Ederington & et al, 2011 survey, energy information administration reports, OPEC white papers and referring to other several studies, crude oil price variations were not only affected by fundamental forces such as demand and supply but also by other exogenous factors like OPEC production, inventory level, exchange rate fluctuations, technological advancements, number of rigs in operation, growth in industrial production and wholesale price index.

Descriptive Statistical Analysis

The main component of the descriptive statistical analysis, summary statistics have been used to compute the measures of central tendency, measures of variability and dispersion of the given data set. Supplementary testing of data has been done in order to verify the normality assumption of time series data. Table 4 provides descriptive statistics of Crude oil price and its select determinants.

Table 4: Descriptive Statistics of Crude Oil Price and its Select Determinants

Particulars	Co-Price	Cons	IIP	Forex	OPEC-Prod	OPEC-Int	WPI	Rigs
Mean	1.898	4.086	2.112	1.705	4.468	3.431	2.315	3.188
Median	1.916	4.082	2.104	1.687	4.472	3.429	2.293	3.244
Max	2.122	4.242	2.240	1.834	4.511	3.484	2.569	3.304
Min	1.448	3.961	2.000	1.595	4.421	3.407	2.008	2.678
Std. Dev.	0.147	0.057	0.047	0.068	0.023	0.015	0.162	0.133
Skewness	-0.767	0.162	0.368	0.267	-0.317	1.387	0.057	-1.753
Kurtosis	2.946	2.618	2.478	1.822	2.183	5.283	1.644	5.369
J-BTest	11.80	1.253	4.079	8.355	5.352	64.544	9.257	89.602
Prob.	0.000	0.534	0.130	0.015	0.068	0.000	0.009	0.000
Obs.	120	120	120	120	120	120	120	120

Source: data compilation and computation by authors using EViews 7

All the data series have shown a positive mean value justifying the upward trend of time series in which OPEC crude oil production has recorded highest mean value and foreign currency has observed the lowest mean value among

the select variables. Standard deviation being less than one for all select variables which indicate limited variability during the reference period of the study. The measures of dispersion have indicated non-normality of data series that has been confirmed by the Jarque-Bera test.

Unit Root Test

Theory of price behavior in commodity markets indicates that commodity prices are autocorrelated, convergent and stationary series (Dabin Wang and William Tomek, 2007). Hence, to assess the unit root of all series, test was performed at levels and first difference with the insertion of intercept in the test equation. Table 5 provides unit root test of crude oil and its select determinants.

Table 5: Unit root test of crude oil and its select determinants

Variable	ADF Test Statistics	5% Level CV	p-value	H_0	Unit Root
Co-Price	-2.1734		0.2171	Accept	Yes
Consumption	1.5389		0.9993	Accept	Yes
IIP	0.6216		0.9898	Accept	Yes
Forex	-0.3938		0.9055	Accept	Yes
OPEC-Prod	-1.2691		0.6420	Accept	Yes
OPEC-Int	-0.2387		0.9291	Accept	Yes
WPI	-1.4172		0.5717	Accept	Yes
Rigs	-0.5869		0.8682	Accept	Yes
D(Co-Price)	-6.6490	-2.886	0.000	Reject	No
D(Consump.)	-3.1897		0.0237	Reject	No
D(IIP)	-4.2568		0.0009	Reject	No
D(Forex)	-7.861		0.000	Reject	No
D(OPEC-Prod)	-6.3750		0.000	Reject	No
D(OPEC-Int)	-13.8083		0.000	Reject	No
D(WPI)	-10.4784		0.000	Reject	No
DD(Rigs)	-3.8745		0.003	Reject	No

Source: data compilation and computation by authors using EViews 7

Since this study has used ten-year data and during that period data series might have witnessed structural breaks/changes, long memory, effects of exogenous factors so it is necessary to employ ADF unit root test. During the reference period of the study, crude oil prices were subjected to 2008 Global economic crisis, commodity super cycle bust in 2012 and unrest in MENA region etc. It is inferred that data series have recorded low variability patters followed by small variations over an extended time horizon and large fluctuations followed by high variability for a prolonged period. The first difference form of data series justifies absence of unit root and facilitate rejection of null hypothesis as p-value is significant as per test result for all select variables.

Granger Causality Test

Crude oil price risk was kept as dependent variable and other select variables were used as the causal factor to ascertain the significant effects. Table 6 provides Granger causality test for Null Hypothesis

Table 6: Granger Causality Test

Null Hypothesis	F-Stat	Prob.
CONS does not Granger Cause CODOL	1.45632	0.1762
FX does not Granger Cause CODOL	1.20046	0.3044
IIP does not Granger Cause CODOL	0.90088	0.5280
OPECINVENT does not Granger Cause CODOL	1.64394	0.1144
OPECPROD does not Granger Cause CODOL	1.93067	0.0570
RIGS does not Granger Cause CODOL	0.89355	0.5343
WPI does not Granger Cause CODOL	0.62496	0.7730

Source: data compilation and computation by authors using EViews 7

Rising consumption of crude oil is the fundamental factor that demonstrates the growth and expansion of economic activities of a country and India being the second fastest growing economy in the world in terms of GDP it supports the demand side effects on crude oil prices. In the past decade India have recorded a CAGR of 9% in crude oil consumption and was ranked the third highest consumer worldwide.
India's balance of trade statistics indicates that crude oil products alone accounted for around 80% of import bill and therefore the Dollar rate has a direct impact on crude oil prices.

Crude oil is a major energy source for manufacturing industries in India and to maintain steady industrial production cycle running energy plays vital role. Referring to the IIP statistics, it is evidenced that our country has been demonstrating healthy growth rate and this corroborates demand side pressure on crude oil prices.

OPEC controls majority of crude oil reserves and production activities so any decision by OPEC member would affect the crude oil prices directly.

The number of rigs in operation for crude oil exploration indicates the supply side adjustments made by the oil producing members and will have a corrective effect on price. If more rigs are in operation, more supply and oil prices may cool off in short-run.

Wholesale Price Index shows the overall status of economy and level of price changes in goods. Crude oil goes in to almost all aspects of economic activities and hence influences growth momentum both in short and long terms.

GARCH TEST

General Autoregressive Conditional Heteroscedasticity test procedure evaluates the variance of a data series which is sum total of three components. Long-term average variance, variance in the immediate past and returns in the immediate past. Table 7 provides Grach Test for various determinants.

Table 7: GARCH Test

Determinants	z-Stat	Prob.	R^2	ARCH-LM	Q-Stat	Normality
Consumption	12.08	0.000	-0.52	0.3122	Insignificant	Yes
Forex	30.02	0.000	-0.47	0.0557	Insignificant	Yes
IP	10.14	0.000	-0.44	0.5228	Insignificant	Yes
OPEC Invent.	-10.50	0.000	0.36	0.5374	Insignificant	Yes
OPEC Prod.	10.75	0.000	-0.61	0.0087	Significant	No
Rigs in use	29.62	0.000	0.32	0.0068	Significant	No
WPI	41.38	0.000	0.48	0.1532	Insignificant	Yes

Source: data compilation and computation by authors using EViews 7

The test statistics revealed a highly significant result and thus supports the rejection of null hypothesis, "Select key determinants do not affect price volatility of energy commodity in India" and non-rejection of alternative hypothesis, "Select key determinants do affect price volatility of energy commodity in India".

The diagnostic tests were conducted in order to justify the model correctness for the variables under study and it was found that both ARCH-LM and Q-Stat were highly insignificant. J-B test disclosed residual normality for majority of the key determinants with the exception of OPEC production and rigs in operations. This insignificant result supports the classic econometric model building principles and hence the test was correct to explain the influence of select determinants on crude oil price risk. Table 8 provides descriptive statistical analysis of natural gas determinants.

Table 8: Descriptive Statistical Analysis of Natural Gas determinants

Particulars	NGPRICE	COPRICE	FOREX	IIP	US CONSMP	WPI	OPECINVT
Mean	2.3388	1.8989	1.7055	2.1122	3.3044	2.3252	3.4317
Median	2.3339	1.9168	1.6870	2.1043	3.2792	2.2939	3.4291
Maximum	2.7347	2.1221	1.8340	2.2407	3.5057	2.5698	3.4841
Minimum	2.0047	1.4483	1.5952	2.0000	3.1643	2.0081	3.4072
Std. Dev.	0.1397	0.1476	0.0685	0.0470	0.0861	0.1620	0.0154
Skewness	0.2404	-0.7677	0.2671	0.3689	0.4970	0.0575	1.3870
Kurtosis	2.8893	2.9465	1.8228	2.4789	2.1646	1.6442	5.2832
Jarque-Bera	1.21751	1.8040	8.3554	4.0798	8.4311	9.25716	4.5449
Probability	0.5440	0.0000	0.0153	0.1300	0.0147	0.0097	0.0000
Observations	120	120	120	120	120	120	120

Source: data compilation and computation by research scholar using EViews 7

Standard deviation being less than one for all select variables which indicate limited variability during the reference period of the study. OPEC crude oil inventory has expressed kurtosis value greater than 3 indicating leptokurtic nature with heavy peak tails. The measures of dispersion have indicated non-normality of data series that has been confirmed by the Jarque-Bera test. Table 9 provides unit root test - ADF test for natural gas determinants.

Table 9: Unit Root Test - ADF test for natural gas determinants

Variable	ADF Test Statistics	5% Level CV	p-value	H0	Unit Root
NGas-Price	-1.782	-2.886	0.387	Accept	Yes
Co-Price	-1.506		0.526		
Forex	0.137		0.967		
OPEC-Int	-0.2387		0.9291		
IIP	0.621		0.989		
US Cons.	-0.548		0.876		
WPI	-1.417		0.571		
D(NGas-Price)	-10.109		0.000	Reject	No
D(Co-Price)	-6.6490		0.000		
D(Forex)	-7.832		0.000		
D(OPEC-Int)	-13.808		0.000		
D(IIP)	-4.256		0.000		
D(US Cons.)	-5.898		0.000		
D(WPI)	-10.478		0.000		

Source: data compilation and computation by research scholar using EViews 7

It is inferred that data series have recorded low variability patters followed by small variations over an extended time horizon and large fluctuations followed by high variability for a prolonged period. The first difference form of data series justifies absence of unit root and facilitate rejection of null hypothesis as p-value is significant in both the tests for all select variables. Table 10 provides Granger test for Natural gas determinants.

Table 10: Granger test for Natural Gas Determinants

Particular	F-Stat	Prob.
CODOL does not Granger Cause NGPRICE	2.32244	0.0613
FX does not Granger Cause NGPRICE	1.23271	0.3014
IIP does not Granger Cause NGPRICE	0.51498	0.7249
OPECINVENT does not Granger Cause NGPRICE	1.86423	0.1220
USCONS does not Granger Cause NGPRICE	0.75284	0.5583
WPI does not Granger Cause NGPRICE	0.41550	0.7971

Source: data compilation and computation by research scholar using EViews 7

Crude oil and natural gas are substitute to each other and both the commodities are major input of energy generation. Therefore, crude oil and natural gas prices have shown bi-directional influence on each other.

Natural gas is a major source for power generation and manufacturing of fertilizers in India. The growth in the power generation and fertilizer production has illustrated upward trend over the past decade and thus justified the effects of industrial production of natural gas price volatility.OPEC is the main energy cartel in the world and any action taken by it on production front would have direct effect on the energy commodity prices both in short run and long run worldwide. Table 11 provides Garch test for Natural Gas determinants.

Table 11: GARCH test for Natural Gas Determinants

Determinants	z-Stat	Prob.	R2	ARCH-LM	Q-Stat	Normality
CO-PRICE	1.370	0.170	-0.17	0.373	Insignificant	No
FOREX	-7.35	0.000	0.15	0.177	Insignificant	No
IIP	-5.432	0.000	0.10	0.298	Insignificant	No
OPECINVT	-17.19	0.000	0.29	0.531	Insignificant	Yes
US-CONS	-1.041	0.297	-0.14	0.366	Insignificant	No
WPI	-11.54	0.000	0.05	0.126	Insignificant	No

Source: data compilation and computation by research scholar using EViews 7

The test statistics revealed a highly significant result except for crude oil & US gas consumption and hence supports the rejection of null hypothesis, "Select key determinants do not affect price volatility of energy commodity in India" and non-rejection of alternative hypothesis, "Select key determinants do affect price volatility of energy commodity in India". The diagnostic tests were accompanied in order to validate the model correctness for the variables under study and it was found that both ARCH-LM and Q-Stat were highly insignificant. Table 12 provides descriptive statistical for Thermal Coal determinants.

Table 12: Descriptive Statistical for Thermal Coal Determinants

Particulars	COALPRICE	OILPRICE	NGPRICE	WPICOAL	IIPELE	FX
Mean	3.639	1.89	4.119	2.218	2.158	1.705
Std. Dev.	0.128	0.147	0.141	0.082	0.073	0.068
Maximum	3.917	2.122	4.378	2.322	2.304	1.834
Minimum	3.331	1.448	3.807	2.070	2.025	1.595
Skewness	-0.545	-0.767	-0.070	-0.656	0.139	0.267
Kurtosis	2.702	2.94	1.930	2.168	1.861	1.822
Jarque-Bera	6.386	11.80	5.819	12.069	6.871	8.355
Probability	0.041	0.002	0.054	0.002	0.032	0.015
No. of Obs.	120	120	120	120	120	120

Source: data compilation and computation by research scholar using EViews 7

All the data series have shown a positive mean value vindicating the upward trend of time series in which natural gas has observed the highest mean value and foreign currency has observed the lowest mean value among the select variables. All of the select data series have observed the skewness values less than one and indicate the overall absence of symmetric distribution. The measures of dispersion have indicated non-normality of data series that has been confirmed by the Jarque-Bera test. Table 13 provides unit root test ADF test for thermal coal determinants.

Table 13: Unit Root test - ADF test for Thermal Coal Determinants

Variable	ADF Test Statistics	5% Level CV	p-value	H0	Unit Root
COALPRICE	-2.903		0.048	Reject	No
OILPRICE	-2.173		0.217	Accept	Yes
NGPRICE	-1.739		0.408	Accept	Yes
WPICOAL	-1.696		0.430	Accept	Yes
IIPELE	0.947		0.995	Accept	Yes
FX	-0.393	-2.886	0.905	Accept	Yes
D(OILPRICE)	-6.649		0.000	Reject	No
D(NGPRICE)	-8.157		0.000	Reject	No
D(WPICOAL)	-8.736		0.000	Reject	No
D(IIPELE)	-9.827		0.000	Reject	No
D(FX)	-7.861		0.000	Reject	No

Source: data compilation and computation by research scholar using EViews 7

It is inferred that data series have recorded low variability patters followed by small variations over an extended time horizon and large fluctuations followed by high variability for a prolonged period. The first difference form of data series justifies absence of unit root and facilitate rejection of null hypothesis as p-value is significant in both the tests for all select variables. Table 14 provides granger test for thermal cost determinants.

Table 14: Granger test for Thermal Coal Determinants

Particular	F-Stat	Prob.
OILPRICE does not Granger Cause COALPRICE	5.291	0.006
NGPRICE does not Granger Cause COALPRICE	3.452	0.035
IIPELE does not Granger Cause COALPRICE	0.445	0.641
WPICOAL does not Granger Cause COALPRICE	0.851	0.429
FX does not Granger Cause COALPRICE	3.109	0.048

Source: data compilation and computation by research scholar using EViews 7

Thermal coal, Crude oil and natural gas are substitute energy commodities and are used extensively by power generation, steel, metal and heavy manufacturing sectors in India. The consumption decisions are done by these sectors in terms of price level and supply of commodity. Thus thermal coal, crude oil and natural gas prices have shown influence on each other both in the long-run as well as in the short run.

Thermal coal is the main input for electricity generation in India and it accounts for 55% of power generation which is nearly twice as compared with world standard for power generation. Electricity is a main source for manufacturing industries in India and to maintain their production cycle running smoothly, demand for electricity is growing drastically over the past five years. The policy maker's action plan for major electrification of our country puts demand side effects on thermal coal and augments the price volatility.

India have sufficient coal reserves but not able to extract sufficient quantity of coal to fulfill the demand on policy grounds and technological obsoleteness. Therefore, to maintain the steady economic growth, the need to import the coal from other countries is necessary and thus it augments the import bill of our country. To obligate the import bill, foreign currency (Dollar) adds influence on thermal coal prices. Table 15 provides GARCH stat for thermal coal determinants.

Table 15: GARCH stat for Thermal Coal Determinants

Determinants	z-Stat	Prob.	R2	ARCH-LM	Q-Stat	Normality
OILPRICE	28.411	0.000	0.29	0.120	Insignificant	Yes
NGPRICE	24.266	0.000	0.55	0.500	Insignificant	Yes
IIPELE	3.611	0.000	-0.04	0.166	Insignificant	No
FX	4.273	0.000	-0.15	0.004	Insignificant	No
WPICOAL	28.845	0.000	0.35	0.976	Insignificant	Yes

Source: data compilation and computation by research scholar using EViews 7

The test statistics revealed a highly significant result and hence supports the rejection of null hypothesis, "Select key determinants do not affect price volatility of energy commodity in India" and non-rejection of alternative hypothesis, "Select key determinants do affect price volatility of energy commodity in India".

The diagnostic tests were executed to confirm the model correctness for the variables under study and it was found that both ARCH-LM and Q-Stat were highly insignificant. This insignificant result supports the classic econometric model building theory and hence the test was correct to explain the influence of select determinants on thermal coal price volatility.

Exposure Analysis

The analysis of commodity price exposure on firm's market value was carried out using the market model regression in which continuous stock return of a firm is considered as dependent variable, percentage change in

commodity price as independent variable and market index (BSE) continuous returns as a control variable. The main goal of this market model is to analyze the commodity price exposure and not the pricing of commodity price risk on firm's market value. Table 16 provides analysis of power sector firms.

Table 16: Exposure analysis of Power Sector Firms

Firm	Crude oil				Natural Gas				Thermal Coal			
	R2	Coeff.	Sig.	F-Sig	R2	Coeff.	Sig.	F-Sig	R2	Coeff.	Sig.	F-Sig
NTPC	0.27	0.001	0.61	0.000	0.29	-0.001	1.55	0.000	0.28	0.002	0.318	0.000
AP	0.40	-0.001	0.134	0.000	0.38	0.008	0.809	0.000	0.40	-0.001	0.101	0.000
TP	0.11	0.001	0.529	0.001	0.11	0.001	0.628	0.000	0.10	0.001	0.895	0.000

Source: data compilation and computation by authors using EViews 7

Based on the market model exposure analysis, it was realized that sample firms from Indian Power sector did not reveal considerable level of energy commodity price exposure on market return variable. Therefore; the null hypothesis, "Select firms of Indian Power sector do not exhibit significant level of energy commodity price exposure" was not rejected. The select firms have exhibited small exposure to energy commodity price variations. The observed outcomes of this study are comparable to the documented results of past studies conducted on commodity price exposure by Tufano (1996), Peterson and Thiagarajan (2000), Haushalter (2001), Chidambaran, fernado and Spindt (2001), Sohnke Bartram (2005). There could be many potential validations for the obtained results. Energy commodity prices indicate high level of volatility which might only affect few small cash flows, specifying the trivial influence in contrast to other risk factors that are more imperative, less volatile but influences larger cash flows of firms. Power sector firms are commodity intensive; commodity is an important input factor of principal business operation and commodity prices affects the cost-revenue equation, hence firms routinely control their exposure to protect the downside effects.

Influence of energy commodity price risk on Firm value

This section provides a quantitative overview of energy commodity price risk and its influence on enterprise value of select firms. The following univariate GARCH model was used to assess the influence of crude oil price risk on enterprise value. Table 17 provides GARCH TC-EV of power sector firms.

$$EV_{Firm} = C + Cd$$

Where, EV_{Firm} *is dependent variable (Enterprise Value)*

Cd is independent variable (crude oil, thermal coal and natural gas price risk)

C expresses constant of the model

Table 17: GARCH TC-EV of Power Sector Firms

Test	Particular	NTPC	ADANI	TATAP
GARCH Test	R2	-0.038	0.129	0.103
	z-Stat	0.2510	0.279	3.113
	Prob.	0.801	0.780	0.001
Correlogram Q-Stat	Prob.	Insignificant	Insignificant	Insignificant
Correlogram Squared Residuals Test	Q-Stat Prob.	Insignificant	Insignificant	Insignificant
ARCH L-M Test	Test statistics	0.049	1.173	0.041
	Prob. Chi-Sq.	0.824	0.278	0.839
Residuals Normality Test	Jarque-Bera	0.998	0.045	0.963
	Prob.	0.607	0.977	0.617

Source: data compilation and computation by research scholar using EViews 7

The table 17 illustrates the influence of thermal coal price fluctuations on enterprise value in which TATA Power have revealed a partial significant result. The non-significant outcome of thermal coal price on firm value might be attributed to the fact that, all firms have captive coal mine license and price variability may not be directly affect them unless otherwise regulatory body make changes in royalty payment proportion or in other scenario firms need to import the thermal coal to fulfill the additional demand of power generation. Also firms employ substitutability strategy for generation of power using different mixture of energy input commodities. Table 18 provides GRAPH CO-EV of power sector firms.

Table 18: GARCH CO-EV of Power Sector Firms

Test	Particular	NTPC	ADANI	TATAP
GARCH Test	R^2	-0.128	0.028	0.070
	z-Stat	-9.822	-2.799	52.496
	Prob.	0.000	0.005	0.000
Correlogram Q-Stat	Prob.	Insignificant	Insignificant	Insignificant
Correlogram Squared Residuals Test	Q-Stat Prob.	Insignificant	Insignificant	Insignificant
ARCH L-M Test	Test statistics	0.252	0.373	0.864
	Prob. Chi-Sq.	0.615	0.540	0.352
Residuals Normality Test	Jarque-Bera	0.774	0.719	0.559
	Prob.	0.678	0.697	0.755

Source: data compilation and computation by research scholar using EViews 7

The above table illustrates the influence of crude oil price volatility on enterprise value of select firms. NTPC, ADANI and TATA power have revealed partial significant results. The test statistic revealed small effects of crude oil price volatility on the sample firm's operational/strategic activities and affected the enterprise value during the past decade. In the Indian Power sector, crude oil is not commonly used energy commodity since majority of power plants are fired using thermal coal or natural gas as an input. The major reason for limited usage of crude oil is credited to timely supply, storage issues, price fluctuations, technological obsoleteness, and overall margin gain. Table 19 provides GARCH NG-EV of power sector firms.

Table 19: GARCH NG-EV of Power Sector Firms

Test	Particular	NTPC	ADANI	TATAP
GARCH Test	R^2	0.126	-0.110	0.273
	z-Stat	-12.619	0.104	-2.091
	Prob.	0.000	0.916	0.030
Correlogram Q-Stat	Prob.	Insignificant	Insignificant	Insignificant
Correlogram Squared Residuals Test	Q-Stat Prob.	Insignificant	Insignificant	Insignificant
ARCH L-M Test	Test statistics	0.244	1.548	0.888
	Prob. Chi-Sq.	0.620	0.213	0.345
Residuals Normality Test	Jarque-Bera	1.420	0.747	0.427
	Prob.	0.491	0.688	0.807

Source: data compilation and computation by research scholar using EViews 7

The test statistic revealed direct exposure of natural gas price volatility on the sample firm's operational/strategic activities and affected the enterprise value during the past decade. The insignificant influence of natural gas price on firm value might be attributed to the fact that, all firms have contractual supply deal on fixed price basis and price variability may not be directly affect them unless otherwise new contractual terms are enforced when the

regulatory body brings in new norm for natural gas price or firms need to procure additional gas at market price to fulfill the supplementary demand of power generation. Firms may employ substitutability strategy for generation of power using different mixture of energy input commodities when the prices are highly volatile.

Based on the analytically obtained results, the hypothesis testing was performed to investigate the validation of proposed postulation with respect to commodity price volatility and firm value. The empirical result suggests that two out of three firms of Indian Power sector have witnessed limited influence and rejection of null hypothesis was not done. Thus, the null hypothesis, "There is no influence of energy commodity price volatility on firm value of select firms of Indian Power sector" was not rejected and the alternative hypothesis, "There is an influence of energy commodity price volatility on firm value of select firms of Indian Power sector" was rejected based on the test statistics.

The diagnostic tests were employed to validate the right model specification. The ARCH-LM test was executed to check for remaining ARCH effect if any and it was found that the test statistic was insignificant at all standard levels of significance. The *p-value*> 0.05 and supports the acceptance of null hypothesis, i.e. 'there is no ARCH effect'. The correlogram squared residuals test was performed & observed that test output has been insignificant at all standard levels and it suggests to acceptance of null hypothesis, i.e. 'there is no serial correlation in the residual' and justifies correct specification of variance equation. Correlogram Q-statistic has been insignificant for mean equation and validating optimal arrangement of mean equation. The residual normality test was conducted using the Jarque-Bera test, the results were non-significant specifying fulfillment of normality assumption. Therefore, it is concluded that model specification was appropriate on the basis of insignificant diagnostic tests results.

Findings

- Energy commodity prices are more volatile than financial assets like foreign exchange rate and interest rate but the quantum and level of risk was relatively very small.
- Energy commodity prices were subjected to major structural breaks/changes during the past decade like global financial crisis, credit challenges in Euro zone, slowdown of Chinese GDP, bust of commodity super cycle etc.
- Rise of commodity exchanges in the developing countries have led to excessive derivative contract trading and this affected the spot prices of commodity referring to the future/forward settlement prices.
- Crude oil price has disclosed partial long term association but strong short term causal relationship with select determinants and GARCH test found to be highly significant.
- OPEC action or behavior with respect to crude oil had drastically affect the prices as it enjoys the cartel power in the world.
- Thermal coal and natural gas prices did record limited short run association but a very strong long run relationship with select determinants indicating substantial effects on price volatility.
- Crude oil, natural gas, thermal coal & natural rubber prices along with key determinants indicated stationarity at first difference thus representing mean reverting feature and also limited exposure to seasonality trend
- Thermal coal is the main input for electricity generation in India and it accounts for 55% of power generation which is nearly twice as compared with world standard for power generation.
- India have sufficient coal reserves but not able to extract sufficient quantity of coal to fulfill the demand on policy grounds and technological obsoleteness.
- To maintain the steady economic growth, the need to import the coal from other countries is necessary and thus it augments the import bill of our country, also affecting exchange rate.
- The overall commodity price exposure effects were not significant to Power sector firms as select firms were able to mitigate the price risk with operational expertise, economies of scale, focus on institutional market, regulatory support, and persistent increasing demand for power by the Indian economy to maintain growth momentum.
- Power sector firms have not revealed significant influence of commodity price volatility and all firms were able to safeguard themselves from price risk based on backward integration.

- In the Indian Power sector, crude oil is not commonly used energy commodity since majority of power plants are fired using thermal coal or natural gas as an input.
- Competition is not intense due to oligopoly structure of Indian power sector
- Launch of the UMPP scheme through tariff-based competitive bidding Ease of land possession, provision of fuel, water and necessary clearances for enhancing investor confidence in Indian power sector
- Elimination of licensing policy for electricity generation in Indian power sector
- 100 per cent FDI is allowed under automatic route for power sector except atomic energy.
- Crude oil accounts for 33% of the world's primary energy consumption.
- Natural gas is a vital component of the world's energy supply.
- Natural gas is one of the cleanest, safest, and the most useful of all energy sources
- The largest coal reserves are found in the United States, Russia, China, Australia and India
- Coal is the largest source of energy for the generation of electricity worldwide, as well as one of the largest worldwide anthropogenic sources of carbon dioxide releases
- The largest exporters of coal are Australia and Indonesia while the largest importers are Japan China South Korea.

Conclusion

The paper empirically analyzes the influence of energy commodity price risk on firm value of Indian power sector. Determinants of energy commodity price risk have indicated strong association and they affect the price variability in short as well as in the long run. Commodity exposure was not significant across the firms. Effect of commodity price risk was not uniformly significant across the sample firms since their principal operations were directly or indirectly influenced by ownership pattern, operational diversification, economies of scale/scope, exposure to international trade, backward/forward integration, pass-thorough mechanism, involvement in derivative contracts and other firm specific qualitative/quantitative factors. The empirical outcome of this study would be valuable to energy commodity intensive sector stakeholders who needs to identify the influence of commodity price risk before strategizing their future course of activities to protect the top and bottom lines of their enterprises. Finally, the results are important to our country since the commodity intensive sector like power going to play a vital role in days to come as our regulatory body have taken forward looking progressive initiatives like deregulation of commodity pricing policy, implementation of progressive FDI norms, new energy policy, national electrification mission, global investors meet etc. to fillip the untapped commodity intensive sectors in India. Future studies may use multivariate models to identify the influence of other quantitative factors of price risk on enterprise value in a more sophisticated manner and other outstanding aspects of corporate firm value are left for future empirical exploration.

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