Commodity and Equity Linkage
- A Study of Base Metal Futures in India

Ipsita Saishree
Indian Institute of Technology Bombay

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Outline

- Context of commodity-equity linkage
- Literature in brief
- Objective
- Data
- Methodology
- Result analysis
- Overall implications

CONTEXT OF COMMODITY-EQUITY LINKAGE

COMMODITY PRICE RISK		INPUT PRICES: Fixed	INPUT PRICES: Floating
OUTPUT PRICES	Fixed	No Risk	Risk of input prices going higher
OUTPUT PRICES	Floating	Risk of output prices going lower	Risk on inventory

Primary participant- producers, purchasers (manufacturing firms)

-Volatility

-Price vs cost based hedging

Context

Channels of Linkage

(i) Primary Commodities **as inputs** for industrial production/manufacturing (Industry specific demand – commodity specific supply)

(ii) **Cross Market** hedging

Present scenario

- Increasing **financialization** of commodity markets
- **Portfolio diversification** avenue
- **Same set** of financial investors across both markets

Issues

- ✓ **Different strategies**, no more commodity specific
- ✓ Entry exit based on overall **market/macroeconomic perception**
- ✓ **Disruption** in the volatility transmission channel

Literature

- Seminal work by Hamilton (1983) - ***Increase in oil prices*** are responsible ***for declines in real GNP.***

{Gilbert and Mork (1984), Mork *et al.,*(1994) - ***Negative correlation*** between oil prices and real outputs}

- Stock prices are nothing but ***discounted values*** of expected future cash flows.

{Huang *et al.,* (1996) Jones and Kaul (1996)}

- Real resources , essential input for production

- ***Diverse pattern of response*** to price shocks.

Literature

- **Existence** of volatility transmission from **oil prices to stock markets** returns.

{Arouri *et al.,*(2011), Thuraisamy *et al.,*(2012) Mensi *et al*.,(2013), Sadorsky (2014), Gokmenoglu and Fazlollahi (2015), Basher and Sadorsky (2016), Zhang *et al.,*(2017)}

- Commodities contribute to the overall costs of **specific sectors** like manufacturing and transport, **not** reflected at the **aggregate level.**

{Singhal and Ghosh (2016), Kumar (2014), Roy and Roy (2017) Kumar *et al.,* (2019)}

Objective

To empirically examine whether volatility transmission exists between the returns of base metal futures and the returns of equity indices of industries that primarily use base metals as primary inputs.

Why not base metals ?

- Numerous studies on the linkages between crude oil, gold and stock markets but very few studies on base metals.
- Critical inputs for industries - non ferrous base metals (Todorova *et al.*, 2014)
- Imbalance in global production and consumption (Gil-alana and Tripathy, 2014,Wu and Hu, 2016)

Implications

- Confirmation of nature of linkage
- Persistence of volatility transmission
- Direction of volatility transmission
- Transmission pattern across sectors

Choice of indices based on usage statistics

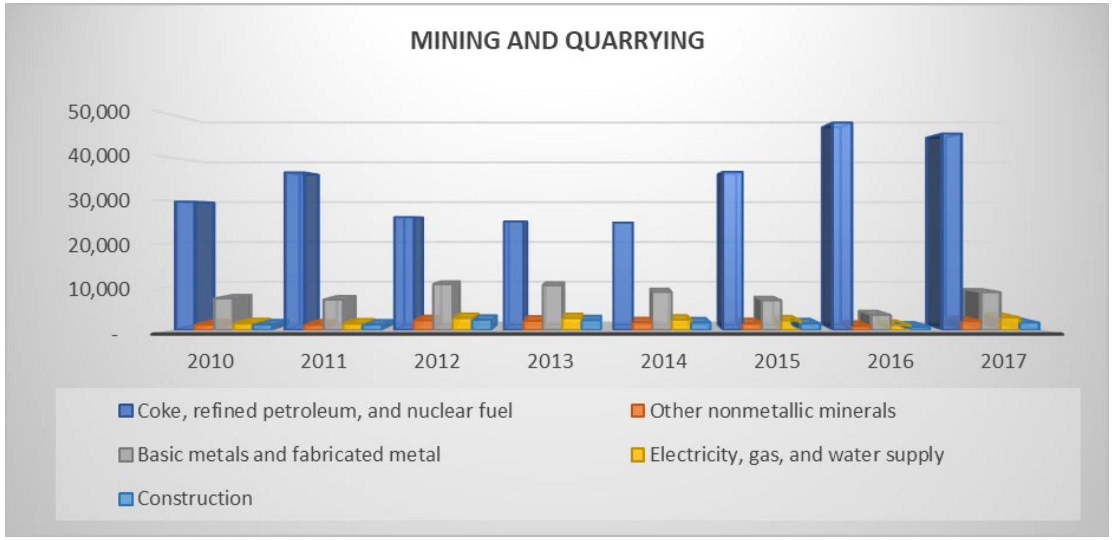


Fig.1(a) Top five users of the output of NIC Division 07 - Mining of metal ores - Group 072 - Mining of non-ferrous metal ores (in current prices, $ million) Source:

Source: India input-output table (2010-17), Asian Development bank database

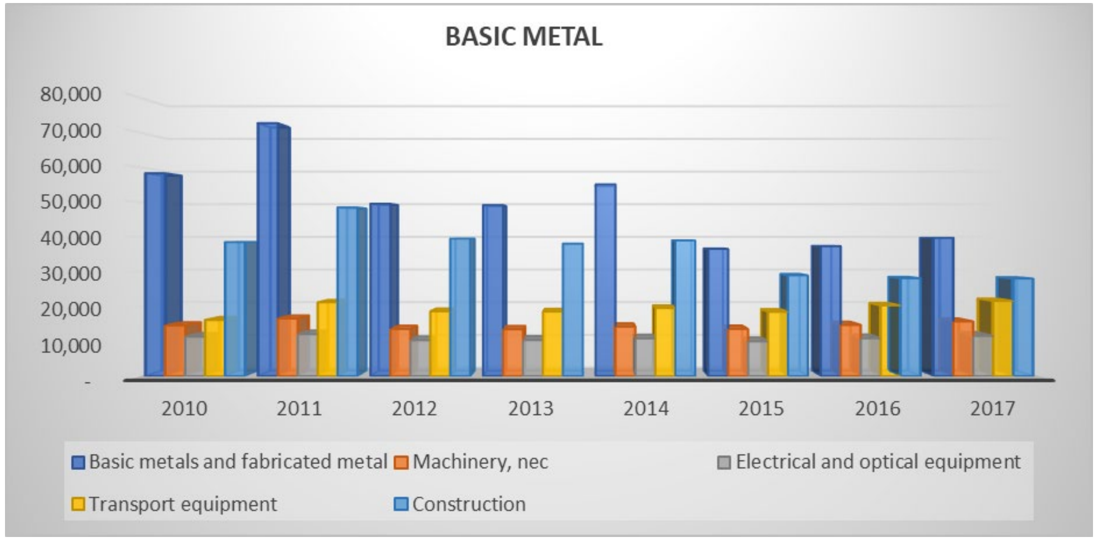


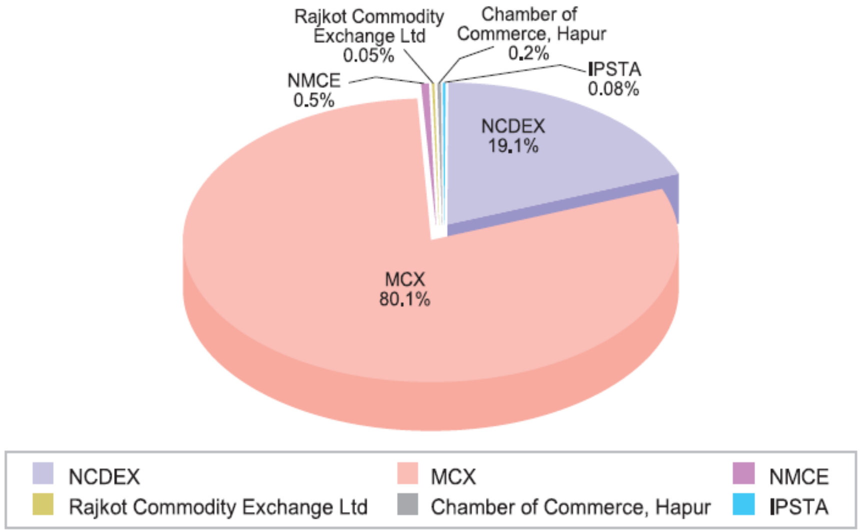
Fig.1(b) Top five users of the output of NIC Division 24 - Manufacture of basic metals, Division 25 - Manufacture of fabricated metal products, except machinery and equipment (in current prices, $ million)

Source: India input-output table (2010-17), Asian Development bank database

Data

Commodity Futures	**NSE Indices**
▪ MCX Aluminium	NSE Automobile
▪ MCX Zinc	NSE Infrastructure
▪ MCX Nickel	NSE Metal
▪ MCX Lead	NSE Realty

(Frequency - Daily , Time Period – January 2006 - December 2019)



Share of Exchanges in Total Volume Traded in Commodity Futures (FY 2016)
Source : Reserve Bank of India

Commodity Usage Analysis

<u>ALUMINIUM</u>
Electricals, packaging, ***construction, transportation***, consumer durables

<u>NICKEL</u>
Two thirds of usage comes as ***steel-alloys construction sector***, machineries, kitchenware, proxy metals for batteries, and coinage

<u>ZINC</u>
Electro-metal spraying, galvanizing steel alloys, battery, paints. ***Automobile, construction industry***

<u>LEAD</u>
Batteries
For ***automobiles***, airports, ***buildings***

Brief Overview of Indices

- **NSE Automobile** reflects the behaviour and performance of the **automobile manufacturing firms listed in India, which includes fifteen four, three and two wheeler manufacturing firms, auto ancillaries and tyres**. Few of the listed firms are Maruti Suzuki India ltd, Mahindra, Tata Motors, Amara Raja, Ashok Leyland, MRF tyres etc.

- **NSE Infrastructure** consists of twenty five firms belonging to **telecom, power, port, air, roads, railways, shipping and other utility service providers.** This index is rather **comprehensive which includes construction, telecom, energy, services and industrial manufacturing sectors. F**ew them are NTPC, L&T, Adani ports, BHEL, Bharti Infratel etc.

- **NSE Metal** reflects the behaviour and performance of the **metals sector including mining** and consists of firms like Coal India, Tata Steel, Vedanta, SAIL, Hindalco etc.

- **NIFTY Realty** reflects the behaviour and performance of **real estate companies**. To name a few, DLF, Oberoi, Godrej, India bulls Real Estate etc.

Sectoral indices’ statistics
Source: Nifty Index Report

NSE Sectoral Index	Total return(%)	Standard Deviation	Correlation with NIFTY 50	Sensitivity to market returns (Beta, NIFTY 50)
NSE AUTO	15.61	24.30	0.82	0.87
NSE INFRA	10.24	26.51	0.90	1.05
NSE METAL	12.74	35.26	0.80	1.23
NSE REALTY	-5.54	41.70	0.75	1.40

Methodology

- Multi-variate BEKK GARCH (Engle and Kroner,1995)

- Returns of all the series are calculated by taking the first differences of the logarithm of the two successive prices i.e. $R_t = \log(\frac{p_t}{p_{t-1}})$

Pre-modelling tests

- ✓ ADF Unit Root Test
- ✓ ARCH effects (LM statistics)

Advantages

- ✓ It overcomes the limitations of diagonal BEKK model to enforce positive-definiteness
- ✓ Its ability to allow for complicated interactions among the variables which was precluded by the structure of the diagonal models, both VECH and BEKK, where the only thing that determines the variance of one series is its own shocks.
- ✓ It provides the direction, magnitude and persistence of volatility spill-overs.

BEKK Recursion

For a 1,1 model, the BEKK recursion for H_t is commonly represented as follows.

$$H_t = CC' + AU_{t-1}U'_{t-1}A' + BH_{t-1}B'$$

where, $C = \begin{bmatrix} c_{1,1} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ c_{5,1} & \cdots & c_{5,5} \end{bmatrix}, A = \begin{bmatrix} a_{1,1} & \cdots & a_{1,5} \\ \vdots & \ddots & \vdots \\ a_{5,1} & \cdots & a_{5,5} \end{bmatrix}, \; U_{t-1} = \begin{bmatrix} u_{1,t-1} \\ \vdots \\ u_{5,t-1} \end{bmatrix}, B = \begin{bmatrix} b_{1,1} & \cdots & b_{1,5} \\ \vdots & \ddots & \vdots \\ b_{5,1} & \cdots & b_{5,5} \end{bmatrix}$

- C is a $N \times N$ lower triangular matrix
- A and B are general $N \times N$ matrices that need not be necessarily symmetric.

Since our empirical exercise deals with five variables in an equation at a time (one sectoral index return and four base metal futures' returns), we have illustrated a representation of BEKK system of equation with N=5. Here 'i', 'j', 't' represent the sectoral NSE indices, commodity futures and time-period respectively.

For such an equation,

$$H_{i,j,t} = \begin{bmatrix} \sigma^2_{1,1,t-1} & \cdots & \sigma^2_{1,5,t-1} \\ \vdots & \ddots & \vdots \\ \sigma^2_{5,1,t-1} & \cdots & \sigma^2_{5,5,t-1} \end{bmatrix}$$

$$C = \begin{bmatrix} c_{1,1} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ c_{5,1} & \cdots & c_{5,5} \end{bmatrix}, A = \begin{bmatrix} a_{1,1} & \cdots & a_{1,5} \\ \vdots & \ddots & \vdots \\ a_{5,1} & \cdots & a_{5,5} \end{bmatrix}, \quad U_{t-1} = \begin{bmatrix} u_{1,t-1} \\ \vdots \\ u_{5,t-1} \end{bmatrix}, B = \begin{bmatrix} b_{1,1} & \cdots & b_{1,5} \\ \vdots & \ddots & \vdots \\ b_{5,1} & \cdots & b_{5,5} \end{bmatrix}$$

The matrix form of the same equation is elaborated as follows,

$$H_t$$
$$= \begin{bmatrix} c_{1,1} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ c_{5,1} & \cdots & c_{5,5} \end{bmatrix} \begin{bmatrix} c_{1,1} & \cdots & c_{5,1} \\ \vdots & \ddots & \vdots \\ c_{1,5} & \cdots & c_{5,5} \end{bmatrix} + \begin{bmatrix} a_{1,1} & \cdots & a_{1,5} \\ \vdots & \ddots & \vdots \\ a_{5,1} & \cdots & a_{5,5} \end{bmatrix} \begin{bmatrix} u_{1,t-1} \\ \vdots \\ u_{5,t-1} \end{bmatrix} \begin{bmatrix} u_{1,t-1} & \cdots & u_{5,t-1} \end{bmatrix} \begin{bmatrix} a_{1,1} & \cdots & a_{5,1} \\ \vdots & \ddots & \vdots \\ a_{1,5} & \cdots & a_{5,5} \end{bmatrix}$$
$$+ \begin{bmatrix} b_{1,1} & \cdots & b_{1,5} \\ \vdots & \ddots & \vdots \\ b_{5,1} & \cdots & b_{5,5} \end{bmatrix} \begin{bmatrix} \sigma^2_{1,1,t-1} & \cdots & \sigma^2_{1,5,t-1} \\ \vdots & \ddots & \vdots \\ \sigma^2_{5,1,t-1} & \cdots & \sigma^2_{5,5,t-1} \end{bmatrix} \begin{bmatrix} b_{1,1} & \cdots & b_{5,1} \\ \vdots & \ddots & \vdots \\ b_{1,5} & \cdots & b_{5,5} \end{bmatrix}$$

$$= \begin{bmatrix} c_{1,1} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ c_{5,1} & \cdots & c_{5,5} \end{bmatrix} \begin{bmatrix} c_{1,1} & \cdots & c_{5,1} \\ \vdots & \ddots & \vdots \\ c_{1,5} & \cdots & c_{5,5} \end{bmatrix} + \begin{bmatrix} a_{1,1} & \cdots & a_{1,5} \\ \vdots & \ddots & \vdots \\ a_{5,1} & \cdots & a_{5,5} \end{bmatrix} \begin{bmatrix} u^2_{1,t-1} & \cdots & u_{1,t-1}u_{5,t-1} \\ \vdots & \ddots & \vdots \\ u_{5,t-1}u_{1,t-1} & \cdots & u^2_{2,t-1} \end{bmatrix} \begin{bmatrix} a_{1,1} & \cdots & a_{5,1} \\ \vdots & \ddots & \vdots \\ a_{1,5} & \cdots & a_{5,5} \end{bmatrix}$$
$$+ \begin{bmatrix} b_{1,1} & \cdots & b_{1,5} \\ \vdots & \ddots & \vdots \\ b_{5,1} & \cdots & b_{5,5} \end{bmatrix} \begin{bmatrix} \sigma^2_{1,1,t-1} & \cdots & \sigma^2_{1,5,t-1} \\ \vdots & \ddots & \vdots \\ \sigma^2_{5,1,t-1} & \cdots & \sigma^2_{5,5,t-1} \end{bmatrix} \begin{bmatrix} b_{1,1} & \cdots & b_{5,1} \\ \vdots & \ddots & \vdots \\ b_{1,5} & \cdots & b_{5,5} \end{bmatrix}$$

Methodology

The null hypothesis here is $a_{(i,j)} = b_{(i,j)} = 0$

$$a_{(j,i)} = b_{(j,i)} = 0$$

Acceptance of the above conditions indicates at no shock and volatility transmission between the two return series whereas rejection will confirm the presence of shock and volatility spill-over between the two series.

However the rejection can lead to two alternate cases.

- Unidirectional spill-over : $a_{(i,j)} = b_{(i,j)} \neq 0$, but $a_{(j,i)} = b_{(j,i)} = 0$ or vice versa
- Bidirectional spill-over : $a_{(i,j)} = b_{(i,j)} \neq 0$, and $a_{(j,i)} = b_{(j,i)} \neq 0$ or vice versa

- The rejection of the null hypothesis for two tests, i.E., $a_{(i,j)} = b_{(i,j)} = 0$ and $a_{(j,i)} = b_{(j,i)} =0$, indicates that the spill-over between market i and market j is bidirectional.
- The rejection of the null hypothesis of either of the two tests indicates that the spill-over is unidirectional

Table 3.Full BEKK	C							A					B				
Coeff. (c)	*Auto*	*Alu*	*Zinc*	*Nickel*	*Lead*	*Coeff. (a)*	*Auto*	*Alu*	*Zinc*	*Nickel*	*Lead*	*Coeff. (b)*	*Auto*	*Alu*	*Zinc*	*Nickel*	*Lead*
Auto	0.002*** (0.000)	0.000** (0.000)	0.000* (0.000)	0.000*** (0.000)	0.000** (0.000)	*Auto*	0.266*** (0.017)	0.008* (0.004)	0.002 (0.005)	0.016** (0.006)	0.006 (0.006)	*Auto*	0.943*** (0.007)	-0.004** (0.001)	-0.003 (0.002)	-0.007*** (0.002)	-0.004** (0.002)
Alu		0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	*Alu*	0.011 (0.019)	0.223*** (0.015)	0.029** (0.015)	0.066*** (0.017)	-0.003 (0.018)	*Alu*	-0.005 (0.006)	0.967*** (0.004)	-0.010** (0.004)	-0.015*** (0.004)	0.001 (0.005)
Zinc			-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	*Zinc*	0.009 (0.021)	-0.035*** (0.012)	0.147*** (0.016)	-0.053*** (0.017)	0.004 (0.018)	*Zinc*	0.001 (0.004)	0.007*** (0.002)	0.988*** (0.003)	0.007** (0.003)	-0.004 (0.004)
Nickel				0.000** (0.000)	0.000 (0.000)	*Nickel*	0.043** (0.020)	0.017** (0.007)	0.036*** (0.009)	0.162*** (0.010)	0.048*** (0.009)	*Nickel*	-0.010*** (0.004)	-0.003** (0.001)	-0.004** (0.001)	0.985*** (0.001)	-0.007*** (0.001)
Lead					0.000 (0.000)	*Lead*	-0.029 (0.022)	-0.001 (0.010)	-0.019 (0.015)	0.017 (0.013)	0.136*** (0.015)	*Lead*	0.005 (0.005)	-0.001 (0.002)	0.004 (0.003)	-0.002 (0.002)	0.990*** (0.002)

Table 1. *Full BEKK estimates for automobile index returns*

Notes: (1) $C = \begin{pmatrix} c_{11} & \cdots & c_{15} \\ \vdots & \ddots & \vdots \\ 0 & 0 & c_{55} \end{pmatrix}$ $A = \begin{pmatrix} a_{11} & \cdots & a_{15} \\ \vdots & \ddots & \vdots \\ a_{51} & a_{53} & a_{55} \end{pmatrix}$, $B = \begin{pmatrix} b_{11} & \cdots & b_{15} \\ \vdots & \ddots & \vdots \\ b_{51} & b_{53} & b_{55} \end{pmatrix}$

(2) The entries for section C, A and section B are the covariance coefficients of constant, residual interaction terms (ARCH) and volatility spill-over GARCH (1,1) respectively followed by the standard errors in parentheses. These coefficients are derived from equations given below

(3) ***, **, * represent the level of significance at 1%, 5% and 10% respectively.

Table 4.full BEKK	C							A					B					
Coeff. (c)	*Infra*	*Alu*	*Zinc*	*Nickel*	*Lead*	*Coeff. (a)*	*Infra*	*Alu*	*Zinc*	*Nickel*	*Lead*	*Coeff. (b)*	*Infra*	*Alu*	*Zinc*	*Nickel*	*Lead*
Infra	0.002*** (0.000)	0.001 (0.000)	-0.002*** (0.00)	-0.000 (0.001)	-0.002** (0.001)	*Infra*	0.350*** (0.019)	-0.005** (0.002)	-0.005 (0.003)	0.005 (0.004)	0.002 (0.003)	*Infra*	0.921*** (0.008)	0.003*** (0.001)	0.002** (0.001)	-0.000 (0.552)	0.000 (0.626)
Alu		0.001** (0.001)	0.001 (0.002)	0.002 (0.001)	0.002 (0.002)	*Alu*	-0.038** (0.016)	0.165*** (0.009)	0.003 (0.009)	0.070*** (0.011)	0.053*** (0.010)	*Alu*	0.009** (0.024)	0.984*** (0.001)	-0.001 (0.001)	-0.009*** (0.002)	-0.012*** (0.002)
Zinc			-0.000 (0.003)	-0.000 (0.002)	-0.000 (0.003)	*Zinc*	-0.003 (0.018)	-0.016** (0.007)	0.166*** (0.008)	-0.099*** (0.012)	-0.012 (0.011)	*Zinc*	0.002 (0.004)	0.000 (0.001)	0.983*** (0.001)	0.025*** (0.002)	-0.003 (0.002)
Nickel				-0.000 (0.001)	0.000 (0.000)	*Nickel*	0.013 (0.015)	0.017*** (0.004)	0.032*** (0.006)	0.133*** (0.007)	0.003 (0.007)	*Nickel*	-0.005* (0.091)	-0.003*** (0.000)	-0.006** (0.001)	0.986*** (0.001)	0.011*** (0.001)
Lead					0.000 (0.000)	*Lead*	0.003 (0.016)	-0.014** (0.006)	-0.043*** (0.009)	0.033*** (0.011)	0.115*** (0.009)	*Lead*	0.004 (0.257)	0.002** (0.001)	0.010*** (0.001)	-0.017*** (0.002)	0.990*** (0.001)

***Table 2**. Full BEKK estimates for infrastructure index returns*

Notes: (1) $C = \begin{pmatrix} c_{11} & \cdots & c_{15} \\ \vdots & \ddots & \vdots \\ 0 & 0 & c_{55} \end{pmatrix}$ $A = \begin{pmatrix} a_{11} & \cdots & a_{15} \\ \vdots & \ddots & \vdots \\ a_{51} & a_{53} & a_{55} \end{pmatrix}$, $B = \begin{pmatrix} b_{11} & \cdots & b_{15} \\ \vdots & \ddots & \vdots \\ b_{51} & b_{53} & b_{55} \end{pmatrix}$

(2) The entries for section C, A and section B are the covariance coefficients of constant, residual interaction terms and volatility spill-over GARCH (1,1) respectively followed by the standard errors in parentheses. These coefficients are derived from equations given below

(3) ***, **, * represent the level of significance at 1%, 5% and 10% respectively.

Table 5.Full BEKK	C							A					B				
Coeff. (c)	*Metal*	*Alu*	*Zinc*	*Nickel*	*Lead*	*Coeff. (a)*	*Metal*	*Alu*	*Zinc*	*Nickel*	*Lead*	*Coeff. (b)*	*Metal*	*Alu*	*Zinc*	*Nickel*	*Lead*
Metal	-0.012*** (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	*Metal*	0.666*** (0.028)	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)	*Metal*	-0.410*** (0.089)	0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)
Alu		0.000*** (0.000)	0.000** (0.000)	0.000*** (0.000)	0.000*** (0.000)	*Alu*	-0.112* (0.063)	0.192*** (0.012)	-0.002 (0.013)	0.027 (0.018)	0.104*** (0.014)	*Alu*	0.182** (0.075)	0.980*** (0.002)	0.010*** (0.003)	-0.009** (0.004)	-0.040*** (0.004)
Zinc			0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)	*Zinc*	0.002 (0.059)	-0.016 (0.017)	0.137*** (0.018)	-0.053 (0.055)	-0.104*** (0.019)	*Zinc*	0.081 (0.070)	-0.012*** (0.004)	1.000*** (0.004)	0.008 (0.014)	0.070 (0.004)
Nickel				0.000 (0.000)	0.000 (0.000)	*Nickel*	-0.186** (0.075)	0.033*** (0.010)	0.052*** (0.011)	0.167*** (0.012)	0.030** (0.014)	*Nickel*	0.115** (0.052)	-0.002 (0.001)	-0.004 (0.003)	0.986*** (0.002)	-0.010*** (0.002)
Lead					-0.000 (0.000)	*Lead*	0.108 (0.076)	-0.046*** (0.013)	-0.031** (0.014)	0.004 (0.045)	0.091*** (0.075)	*Lead*	-0.145** (0.059)	0.014*** (0.003)	-0.037*** (0.003)	-0.002 (0.011)	0.963*** (0.003)

***Table 3**. Full BEKK estimates for metal sector returns*

Notes: (1) $C = \begin{pmatrix} c_{11} & \cdots & c_{15} \\ \vdots & \ddots & \vdots \\ 0 & 0 & c_{55} \end{pmatrix}$ $A = \begin{pmatrix} a_{11} & \cdots & a_{15} \\ \vdots & \ddots & \vdots \\ a_{5,1} & a_{53} & a_{55} \end{pmatrix}$, $B = \begin{pmatrix} b_{11} & \cdots & b_{15} \\ \vdots & \ddots & \vdots \\ b_{5,1} & b_{53} & b_{55} \end{pmatrix}$

(2) The entries for section C, A and section B are the covariance coefficients of constant, residual interaction terms and volatility spill-over GARCH (1,1) respectively, followed by the standard errors in parentheses. These coefficients are derived from equations given below

(3) ***, **, * represent the level of significance at 1%, 5% and 10% respectively.

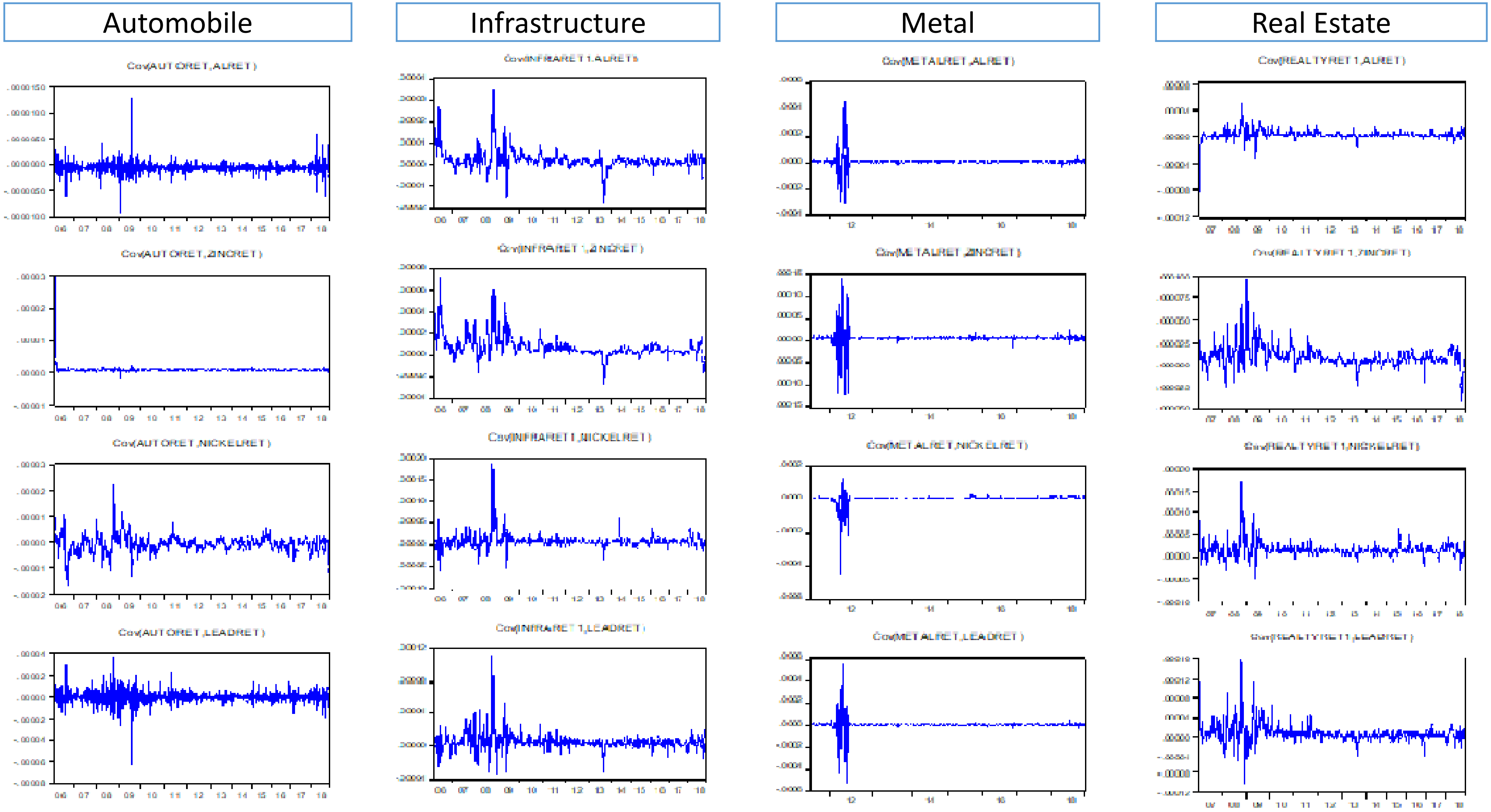
Table 6.Full BEKK	A							A				B					
Coeff. (c)	***Realty***	***Alu***	***Zinc***	***Nickel***	***Lead***	***Coeff. (a)***	***Realty***	***Alu***	***Zinc***	***Nickel***	***Lead***	***Coeff. (b)***	***Realty***	***Alu***	***Zinc***	***Nickel***	***Lead***
Realty	0.007*** (0.000)	-0.000*** (0.000)	-0.000 (0.000)	0.000 (0.000)	-0.000** (0.000)	*Realty*	0.423*** (0.025)	0.001 (0.002)	0.002 (0.002)	0.010*** (0.002)	0.005* (0.002)	*Realty*	0.869*** (0.016)	0.001 (0.001)	-0.000 (0.001)	-0.003** (0.001)	-0.000 (0.001)
Alu		0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	*Alu*	-0.071** (0.032)	0.212*** (0.013)	-0.003 (0.012)	0.055*** (0.015)	-0.004 (0.015)	*Alu*	0.008 (0.009)	0.973*** (0.002)	-0.004 (0.002)	- 0.014*** (0.003)	0.005 (0.003)
Zinc			0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	*Zinc*	-0.052 (0.039)	- 0.037*** (0.011)	0.146*** (0.012)	- 0.056*** (0.019)	0.033** (0.015)	*Zinc*	0.013* (0.007)	0.007** (0.002)	0.985*** (0.002)	0.005 (0.003)	- 0.013*** (0.003)
Nickel				0.000 (0.000)	0.000 (0.000)	*Nickel*	0.006 (0.030)	0.017*** (0.006)	- 0.053*** (0.007)	0.157*** (0.009)	0.054*** (0.018)	*Nickel*	-0.004 (0.007)	-0.002** (0.001)	- 0.006*** (0.001)	0.986*** (0.001)	- 0.008*** (0.002)
Lead					0.000 (0.000)	*Lead*	0.068** (0.033)	-0.008 (0.007)	-0.007 (0.008)	0.018 (0.011)	0.097*** (0.009)	*Lead*	0.007 (0.007)	-0.001 (0.001)	0.005*** (0.001)	0.001 (0.001)	0.997*** (0.001)

Table 4. *Full BEKK results for realty sector returns*

Notes: (1) C = $\begin{pmatrix} c_{11} & \cdots & c_{15} \\ \vdots & \ddots & \vdots \\ 0 & 0 & c_{55} \end{pmatrix}$ A = $\begin{pmatrix} a_{11} & \cdots & a_{15} \\ \vdots & \ddots & \vdots \\ a_{51} & a_{53} & a_{55} \end{pmatrix}$, B = $\begin{pmatrix} b_{11} & \cdots & b_{15} \\ \vdots & \ddots & \vdots \\ b_{51} & b_{53} & b_{55} \end{pmatrix}$

(2) The entries for section C, A and section B are the covariance coefficients of constant, residual interaction terms and GARCH (1,1) respectively followed by the standard errors in parentheses. These coefficients are derived from equations given below

(3) ***, **, * represent the level of significance at 1%, 5% and 10% respectively. Source : Author's own calculation



Graphs representing covariances between base metal futures and industrial sectors

Results

- Estimates of our empirical exercise confirm the existence of time-varying linkages between base metal futures and sector specific equity indices but in divergent patterns.

- The return volatility of all equity indices as well as all base metal futures are affected by the past shocks in their returns, both in the short-run as well as long-run.

- Among the base metal futures used in the study, returns of aluminium futures and nickel futures have higher time-varying linkages with sectoral indices' returns than lead futures and zinc futures.

- Moreover, we see maximum short-run volatility spill-over between base metals futures' returns and sectoral index returns in automobiles sector and longest volatility persistence in metal sector.

- Zinc futures' returns have the least time-varying linkages with sectoral indices' returns making them an interesting option for portfolio hedging while investing in commodity-based indices.

Implications

- Commodity futures retain **scope for portfolio diversification** as each of the base metals display **unique linkages** in terms of direction, magnitude and volatility persistence.

- It is evident that negative shocks have greater impact on volatility spill-overs between the market than positive shocks of the same magnitude.

- Shocks to the returns of base metal futures are capable of fuelling persistent volatility in the returns of sectoral equity indices **confirming that supply-side information leads** to the transmission of volatility between equity and commodities.

- Importantly, our study confirms the **economic channel** of **sector-specific demand** and **commodity-specific supply** are possible channels of commodity-equity linkage. Overall our results are aligning with the results obtained by Lee and Ni (2002) and Malik and Ewing (2009).

Base Metals: Copper, Nickel futures dip on soft demand

In the international market, copper was quoting 0.03 per cent higher at $5,780 per tonne in New York.

PTI | Sep 25, 2019, 02.44 PM IST

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Comments

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BCCL

Copper traded 0.29 per cent lower at Rs 440.30 per kg in futures trade on Wednesday as speculators reduced their exposure amid weak demand.

On the Multi Commodity Exchange, copper contracts for September delivery fell by Rs 1.30, or 0.29 per cent, to Rs 440.30 per kg in a business turnover of 1,235 lots.

Thank You ☺