

DOES THE COVID-19 HEALTH EMERGENCY IMPACT THE INTEGRATION OF PRECIOUS METALS AND THE INDIAN EQUITY INDEX? A TIME-VARYING APPROACH TO CONNECTEDNESS AND SPILLOVER.

Sujit Paul

Prof. Avijan Dutta

DOI: <https://doi.org/10.64558/bllp/926140nfyysf>

INTRODUCTION

In this current globalised and interconnected world, the fundamentals of the one financial asset may have an impact on the other financial assets. The correlations among the financial assets and its dynamics evolves in time, which has grabbed the attentions of the researchers or fund managers to understand the dynamics, at different time frame. From the ground breaking work of (Markowitz, 1952) Modern Portfolio Theory, it can be understand that negatively correlated assets helps in reducing the overall portfolio risk. This has led to creation of several Market portfolios, however, remained unanswered the systematic risk in this context. During the Global Financial Crisis, none of the insights has able to mitigate the exposure of the portfolios, and Crash impacted all the portfolios. From this instance, the concept of the connectedness and contagion came into existence. The investigations in this domain has increased in the number on Connectedness issues across the different assets in different markets. This venture in exploring the connectedness in one assets or market with another assets or market is the main interest of the researchers of the domain, so that they can hedge the portfolios, or reduce the systematic risk of a portfolio with another asset.

In this quest, several papers investigated the connectedness at the different market level, inquiring about the market integration and connectedness among the asset's systematic and return and volatility spillover such as (Al Hajj et al., 2024; Ali et al., 2024; Antonakakis et al., 2020; Chang, Chang, & Lee, 2023, 2023; Chang, Chang, Ling, et al., 2023, 2023; Das et

al., 2025; Dhingra et al., 2025; El Khoury et al., 2024; Gazi et al., 2024; Gökgöz et al., 2025; Guru et al., 2023; Kumar & Gupta, 2025; Mishra et al., 2024; Panazan et al., 2024; Panda et al., 2023; Younis et al., 2023). Where it has been observed that market connectedness increases during crisis periods such as (Das et al., 2025). In which, Russia and Brazil were the net transmitters of the volatility to the system, while India, China, and South Africa are the net volatility receivers in the system. One study has explored the geopolitical risk and the stock market volatility in the SAARC region. The study concludes that their strong connection between India and Bangladesh stock market, while the connection between geopolitical concerns and Sri Lankan stocks was the strongest and increased in intensity after 2019 (Panazan et al., 2024).

Similarly, several others authors considered the Financial assets connectedness as their area of interest (Babar et al., 2024a, 2024b; Belhassine & Karamti, 2021; Hanif et al., 2024; Mensi et al., 2021, 2025; Mohamed Dahir et al., 2020; Ramesh et al., 2024; Rehman et al., 2023, 2023, 2024; Siddiqui & Roy, 2021; Singh et al., 2024; Sundararajan & Balasubramanian, 2025; Wan et al., 2024; Ye & Geng, 2021). In which, (Chang, Chang, & Lee, 2023) used quantile connectedness approach to investigate the relationships of oil shocks and the BRICS stock market, and Russia and South Africa plays the net transmitting roles, while the Brent oil, India, and Shanghai are net recipients for most time. The connectedness has strengthened when facing the market crisis such as the global financial crisis, European debt crisis,

and Covid-19 periods.

In this market connectedness area, another strand of the studies focuses on the Oil shocks on the markets (Chang, Chang, Ling, et al., 2023; Guru et al., 2023; Hanif et al., 2024; Mensi et al., 2025; Ramesh et al., 2024; Rehman et al., 2023, 2024; Tiwari et al., 2025), and few others on the commodities such as golds, agricultural commodities, energy commodities and commodity futures except the Oil (Babar et al., 2024a, 2024b; Mensi et al., 2021; Younis et al., 2023; Zeng et al., 2023), some are on the ESG stocks indexes (Singh et al., 2024; Wan et al., 2024), and very few are on the health stock indexes such as (Chatziantoniou et al., 2022; Smolo et al., 2022; Ye & Geng, 2021).

From the literature of the Connectedness, we found that most of the studies concludes that during the crisis period, the connectedness of the financial assets increased which due to increased fears, and panic which is precondition to the contagion concept. However, from the portfolio diversification perspective, this connectedness of the assets increases the systemic risk of the invested assets during the crisis period across the globe. The less connected stocks can be used for hedging against target portfolio. Additionally, from the literature it has been observed that very few studies have focused on the Commodities and the Equity market combined, therefore, this aims to add to the connectedness literature insights from the Commodities (e.g., Gold, and Silver) and Equity (Nifty 50 Index). In this study, we aim to investigate the inter-relationships of the Gold, Silver, US dollar index, Nifty50 index and Indian VIX Index in the covid 19 context. Our study has been targeted to know that which assets were the transmitters of shock to the system and how this relationship has impacted during the covid 19 periods? How the connectedness of the financial assets has evolved in the covid 19

periods?

The empirical results from our study unveils that Precious Metals such as Gold and Silver emerged as significant transmitters of the uncertainty of the system during the covid-19 crisis period. The systemic inter-assets connectedness has remained high even after the post-covid periods. Finally, Indian VIX and US Dollar Index was the net receivers of the systematic risks. However, the US dollar index's role of net receiver has heightened during the covid-19 period. The findings highlight the importance of dynamic risk assessment, particularly in times of market stress. Investors and policymakers must account for the fact that inter-market linkages intensify during systemic shocks and may not fully dissipate in the aftermath.

DATA AND METHODOLOGY

Data Collection

This study has considered the Gold, Silver (precious metals) as commodities of interest for assets diversification, with Nifty 50 index. In which, to capture the dependence on the US dollar index of the above commodities and Indian VIX to capture the volatility dynamics in between the different assets class. Daily price data has been collected from the Yahoo Finance website using the tickers of the R studio. Then closing prices were transformed to logged returns used for final study for the period starting from 01-07-2016 to 30-06-2025. We divided our sample into three different periods, for capturing the effects of the Covid-19 as major health crisis in this relationship. First, we have started with 01-07-2016 to 29-01-2020, and called pre- covid period. Second period starts from the day when WHO declared COVID-19 as a public health emergency (i.e., 30-01-2020) to end with 31-05-2020, as WHO declared COVID-19 as a Global pandemic on 11th March 2020. Thirdly, post-covid period, period starting from 01-06-2020 to 30-06- 2025.

METHODOLOGY

This study employs the Time-Varying Parameter Vector Autoregression (TVP-VAR) based Connectedness Approach, as developed by (Antonakakis et al., 2020), to examine the dynamic interrelationships among five key financial variables: Gold, Silver, US Dollar Index, Nifty 50, and the India VIX. Our

methodology portion, builds on the foundational spillover index framework proposed by (Diebold & Yilmaz, 2012; Diebold & Yilmaz, 2014) while incorporating time-varying dynamics to better capture structural changes and crisis-induced volatility.

The TVP-VAR Mode

Let y_t be an $N \times 1$ vector of variables. We specify a TVP-VAR(p) as:

$$y_t = \Phi_{t,1}y_{t-1} + \Phi_{t,2}y_{t-2} + \dots + \Phi_{t,p}y_{t-p} + \varepsilon_t, \quad \varepsilon_t \sim N(0, \Sigma_t) \dots \dots Eq. (1)$$

or more compactly:

$$y_t = \Phi_t Z_{t-1} + \varepsilon_t \dots \dots Eq. (2)$$

Where:

$Z_{t-1} = (y'_{t-1}, y'_{t-2}, \dots, y'_{t-p})'$ is an $Np \times 1$ lag vector,

Φ_t is an $N \times (Np)$ time-varying coefficient matrix,

Σ_t is the time-varying covariance matrix of the residuals.

This model allows the coefficients Φ_t, Σ_t to evolve over time and assumed to be follows the law of motions.

From TVP-VAR to Generalized FEVD

To compute connectedness measures, the TVP-VAR model is converted at each time t into its moving average (MA) representation:

$$y_t = \sum_{h=0}^{\infty} A_{h,t} \varepsilon_{t-h} \dots \dots Eq. (3)$$

Where $A_{0,t} = I$, and $A_{h,t}$ are derived recursively from the Φ_t . Then the Generalized Forecast Error Variance Decomposition (GFEVD) at Horizon H is computed:

$$\Theta_{ij,t}^{(H),g} = \frac{\sigma_{jj,t}^{-1} \sum_{h=0}^{H-1} (e_i' A_{h,t} \Sigma_t e_j)^2}{\sum_{h=0}^{H-1} \sum_i (e_i' A_{h,t} \Sigma_t A_{h,t}' e_i)} \dots \dots Eq. (4)$$

Here:

$\sigma_{jj,t}^{-1}$ is the j^{th} diagonal elements of Σ_t .

e_i is a selection vector with 1 at position i and 0 elsewhere.

The numerator captures the influence of shocks in variable j on variable i ; the denominator is the total forecast error variance of i .

Because of non-orthogonal shocks, the row sums $\Theta_{ij,t}^{(H),g}$ need not be unity.

We normalize the decomposition row-wise:

$$\tilde{\Theta}_{ij,t}^{(H)} = \frac{\Theta_{ij,t}^{(H),g}}{\sum_{j=1}^N \Theta_{ij,t}^{(H),g}} \dots \dots Eq. (5)$$

So that,

$$\sum_{j=1}^N \tilde{\Theta}_{ij,t}^{(H)} = 1 \dots \dots Eq. (6)$$

and summing over all i, j gives N .

Connectedness Measures

From the normalized GFEVD matrix $\tilde{\Theta}^{(H)} = [\tilde{\Theta}^{(H)}]$, one derives the standard connectedness metrics.

Directional “TO” (Contribution to others):

$$C^{(H)} = \sum_{j \rightarrow \cdot, t} \tilde{\Theta}_{ij,t}^{(H)} \quad i \neq j$$

Directional “FROM” (Contribution from others):

$$C^{(H)} = \sum_{\leftarrow i, t} \tilde{\Theta}_{ij,t}^{(H)} \quad i \neq j$$

Net Connectedness:

$$NET^{(H)} = C_{i,t}^{(H)} - C_{i,t}^{(H)}$$

Total Connected Index (TCI):

$$TCI^{(H)} = \frac{\sum_{i=1}^N \sum_{j=1}^N \tilde{\Theta}_{ij,t}^{(H)}}{N} \times 100$$

Net Pairwise Directional Connectedness:

For every pair (i, j) :

$$NPDC^{(H)} = \tilde{\Theta}_{ij,t}^{(H)} - \tilde{\Theta}_{ji,t}^{(H)}$$

[This shows whether $i \rightarrow j$ dominated or $j \rightarrow i$ dominated at time t .

NETWORK CONNECTEDNESS:

The network connectedness comes from the NPDC measures, Network connectedness refers to the graphical representation of pairwise directional spillovers between variables in the connectedness framework. It's a network where:

- Nodes represent variables (e.g., Gold, Silver, Dollar Index, etc.),
- Edges (arrows) represent spillovers from one variable to another,
- Edge thickness reflects the strength of the directional connectedness

EMPIRICAL RESULTS:

Preliminary results:

The descriptive statistics given *Table 1*. The correlations heatmap into the *Figure 1*, shows the strength of the Correlations between the Precious metals with Equity variables. *Table 1*, the highest average value has been observed in the Nifty 50 Index, followed by Gold, silver, US Dollar Index and the Indian VIX with a

negative mean value with highest variations (i.e., S.D). All the variables except the Indian VIX is negatively skewed, whereas Nifty 50 index has Highest Kurtosis values. The ADF test shows that series are stationary at levels. The values are only log changes. To get the percentage changes of each variable, we need multiply the 100 with each value. In the *Figure 1*, the correlation heatmap which ranks positively correlation (i.e., +1) coloured as Red whereas negatively correlation (i.e., -1) coloured as Blue. Where Gold and Silver returns exhibit a strong positive correlation (0.77), Gold and USD Index are negatively correlated (-0.43), while Silver and USD Index also share a negative relationship (-0.38). Additionally, NIFTY50 returns have a strong negative correlation with Indian VIX (-0.54), NIFTY50's correlations with Gold (0.03) and Silver (0.14) are close to zero, indicating minimal linear association. This suggests Gold and Silver can function as hedges or diversifiers in equity portfolios, especially during stress periods when correlations may turn negative.

Table 1: The Descriptive Statistics

Variable	Mean	Std Dev	Min	Max	Skewness	Kurtosis	ADF p-value
Gold	4.00E-04	0.0097	-0.0511	0.0578	-0.2172	6.8044	0.01
Silver	3.00E-04	0.0188	-0.1239	0.0888	-0.5247	8.4186	0.01
US Dollar Index	8.48E-06	0.0043	-0.0308	0.0197	-0.2107	5.5359	0.01
Nifty 50	5.00E-04	0.0107	-0.139	0.084	-1.4884	25.0333	0.01
Indian VIX	-1.00E-04	0.0531	-0.3531	0.5046	0.9041	12.2261	0.01

Figure 1: The correlation heatmap



Connectedness Results:

Static connectedness

By employing the (Antonakakis et al., 2020) methodology, we first presented the spillover Table of the Variables in *Table 2*. Where upper

portion of *Table 2* shows the spillover for the pre-covid period, the middle portion, reveals the during the covid period. And lastly, the lower portion, shows that post- covid period, Connectedness.

Table 2 (UPPER) Spillover the pre-COVID period

Variable	Gold	Silver	US Dollar Index	Nifty 50 Index	Indian VIX	FROM
Gold	51.2	32.83	14.03	0.91	1.03	48.8
Silver	33.63	53.17	10.54	1.66	1.01	46.83
US Dollar Index	17.91	12.95	67.2	1.12	0.82	32.8
Nifty 50 Index	1	2.27	1.29	69.84	25.6	30.16
Indian VIX	0.8	0.97	0.77	26.32	71.13	28.87
TO	53.34	49.02	26.64	30.01	28.46	187.47
Inc.Own	104.54	102.19	93.84	99.84	99.59	cTCI/TCI
NET	4.54	2.19	-6.16	-0.16	-0.41	46.87/37.49

Table 2 (MIDDLE) Spillover during the COVID-19 period

Variable	Gold	Silver	US Dollar Index	Nifty 50 Index	Indian VIX	FROM
Gold	47.75	34.32	8.75	5.65	3.53	52.25
Silver	34.4	47.59	5.3	4.74	7.98	52.41
US Dollar Index	11.98	10.49	62.67	7.83	7.03	37.33
Nifty 50 Index	7.52	10.39	2.64	58.1	21.35	41.9
Indian VIX	5.1	8.53	3.73	23.02	59.62	40.38
TO	59	63.73	20.42	41.24	39.88	224.27
Inc.Own	106.75	111.32	83.09	99.34	99.5	cTCI/TCI
NET	6.75	11.32	-16.91	-0.66	-0.5	56.07/44.85

Table 2 (LOWER) Spillover the post-COVID period

Variable	Gold	Silver	US Dollar Index	Nifty 50 Index	Indian VIX	FROM
Gold	53.53	33.1	11.51	0.9	0.96	46.47
Silver	32.91	54.06	10.43	1.5	1.11	45.94
US Dollar Index	14.29	13.14	67.73	2.85	1.99	32.27
Nifty 50 Index	1.33	2.14	2.91	69.04	24.58	30.96
Indian VIX	1.04	1.32	1.56	26.02	70.06	29.94
TO	49.56	49.7	26.41	31.26	28.65	185.58
Inc.Own	103.09	103.76	94.14	100.31	98.7	cTCI/TCI
NET	3.09	3.76	-5.86	0.31	-1.3	46.39/37.12

The Table 2, has estimated the spillover effects and inter-connectedness of the investible assets. In this section, we will see that whether US Dollar Index and Indian VIX Index, indeed makes an influence in the relationships of the Commodities with Equity market. This section also unveils the transmitters/ receivers of the spillover in the system, additionally, revealing the net transmitters of the spillover in the system. In which, Table 2 (Upper), presents the spillover of the pre covid periods, where the corrected total connectedness index is 46.87%. It means that nearly 47% of the variance of the system due to the cross variables shocks. In this period, Gold is the largest transmitters of among the others in the system (53.34), next is the Silver (49.02) followed by the Nifty 50 Index (30.01), Indian VIX Index (28.46) and US Dollar Index (26.64). While the largest receiver of the spillover is the Gold (48.8) which is 26% of the overall spillover received. Followed by the Silver (46.83) [24.97%], US Dollar Index (32.8) [17.49%], Nifty 50 Index (30.16) [16.08%] and Indian VIX Index (28.87) [15.39%].

In the Pairwise spillovers, the largest spillover happened between Gold and Silver, where spillover from Gold to Silver (32.83), and the Silver to Gold (33.83). Similarly, Between Nifty 50 Index and India VIX Index spillover from Nifty 50 Index to India VIX Index (25.6) and the India VIX Index to Nifty 50 Index (26.32). However, the US Dollar Index's largest pairwise spillover was to Gold (17.91). In the whole system, the Gold and Silver acts as the net transmitters of the spillover, whereas, US Dollar, Nifty 50 and India VIX Indexes acts as net receiver of the spillover where US Dollar is the highest spillover receiver in the system then the India VIX and followed by Nifty 50 Index.

Table 2 (Middle), shows the spillover during

the covid periods, in which, the corrected total connectedness index of the whole system has increased to 56.07% which is nearly 19.5% increase in the connectedness of the total system. In this period, Silver is the largest transmitters of among the others in the system (52.41), next is the Gold (52.25) followed by the Nifty 50 Index (41.9), Indian VIX Index (40.38) and US Dollar Index (37.33). While the largest receiver of the spillover is the Silver (63.73) which is 28.4% of the overall spillover received. Followed by the Gold (59) [26.3%], , Nifty 50 Index (41.24) [18.39%], Indian VIX Index (39.88) [17.78%] and US Dollar Index (20.42) [9.1%].

In the pairwise spillover, the largest spillover happened between Gold and Silver, where spillover from Gold to Silver (34.32), and the Silver to Gold (34.4). Similarly, Between Nifty 50 Index and India VIX Index spillover from Nifty 50 Index to India VIX Index (21.35) and the India VIX Index to Nifty 50 Index (23.02). However, the US Dollar Index's largest pairwise spillover was to Gold (11.98). In the whole system, the Gold (6.75) and Silver (11.32) acts as the net transmitters of the spillover, whereas, US Dollar (-16.91), Nifty 50 (-0.66) and India VIX (-0.5) Indexes acts as net receiver of the spillover where US Dollar is the highest spillover receiver in the system then the Nifty 50 Index and followed by India VIX.

Table 2 (Lower), unveils the spillover post covid period. The corrected total connectedness index (cTCI) of the (Antonakakis et al., 2020) shows that the spillover of the post covid periods, in which, the corrected total connectedness index of the whole system has decreased to 46.39%. In this period, Gold is the largest transmitters of among the others in the system (46.47), next is the Silver (45.94) followed by the US Dollar Index (32.27), Nifty 50 Index (30.96) and

Indian VIX Index (29.94) . While the largest receiver of the spillover is the Silver (49.7) which is 26.78% of the overall spillover received, which is marginally higher than the Gold (49.56) [26.7%], followed by Nifty 50 Index (31.26) [16.84%], Indian VIX Index (28.65) [15.43%] and US Dollar Index (26.41) [14.23%].

In the pairwise spillover, the largest spillover happened between Gold and Silver, where spillover from Gold to Silver (33.1), and the Silver to Gold (32.91). Similarly, Between Nifty 50 Index and India VIX Index spillover from Nifty 50 Index to India VIX Index (24.58) and the India VIX Index to Nifty 50 Index (26.02). However, the US Dollar Index's largest pairwise spillover was to Gold (14.29). In the whole system, the Gold (3.09), Silver (3.76) and Nifty 50 (0.31) acts as the net transmitters of the spillover, whereas, US Dollar (−5.86) and India VIX (−1.3) Indexes acts as net receiver of the spillover where US Dollar is the highest spillover receiver in the system followed by India VIX.

From the static connectedness analysis, it can be seen that the covid-19 health pandemic has increased the systematic risk from 46.87% to 56.07% people investing in this system. However, the linkages of the spillover unveil that specifically, during the covid periods, the shocks of the Precious Metals and the dollar sentiment have increasingly impacted the spillover to the Nifty 50 Index and India VIX Index. And in the post-covid periods these changes went back to the normal status quo. On the other hand, the shocks of the Indian VIX Index reveals that significantly increased

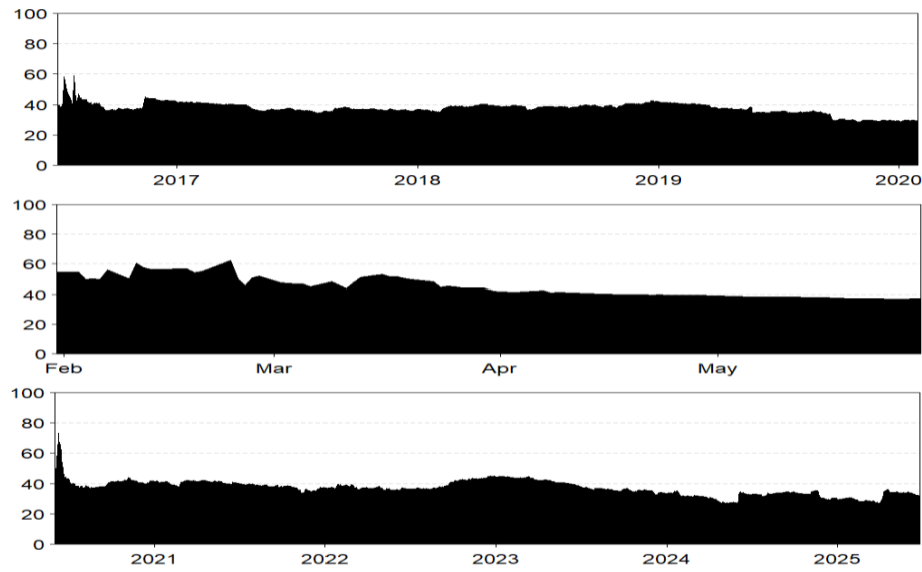
spillover from the Indian VIX to the Gold, Silver and US Dollar Index, while decreased spillover to the Nifty 50 Index (from 26.32 to 23.02 and again went back to normal 26.02). On that this similar front, the shocks of the Nifty 50 Index have the increasingly high spillover to the Gold, Silver and US Dollar Index during the Covid

periods, while decreasing spillover during this period to the Indian VIX Index (from 25.6 to 21.35 again came back to normal 24.58 post covid).

Dynamic Connectedness

The time-varying nature of the connectedness measures has been observed by the (Ferrer et al., 2018), thus the understanding the dynamic connectedness and whether the connectedness has remained same as revealed by the static models, is utmost important in the study of the Connectedness of the Asset literature. We explore the time-varying spillover by using rolling windows of 200 days for pre-covid and post-covid periods. However, this rolling window needed to be changed for the during the covid periods, as during the covid period, our sample was 77 trading days, we respect to this, we used 30 days as the rolling windows. While keeping all the settings same, proceeded with the analysis and completed our dynamic connectedness analysis. Our results were robust with very little changes of the rolling windows and forecast horizons. The *Figure 2*, reveals the Total Connectedness Index for all the three periods, we considered in our study, in which, *Figure 2 (Upper)*, show the pre-covid period connectedness of the system, *Figure 2*.

Figure 2: The Time-Varying Connectedness of the System



(Middle), show the connectedness of the system during the covid periods, and lastly, *Figure 2 (Lower)*, show the connectedness of the system of post covid periods. At closer look at the *Figure 2* reveals that total connectedness has drastically has increased during the covid period, signalling the higher systematic risk during this period. And the effects of the covid-19 pandemic have annulled at very beginning of the post covid periods. This has happened may be due to the fact that initial phases of the covid-19, has impacted the Indian stock market and other stock market drastically due to the stringent lockdown imposed, led to less economic

activity which has impacted the valuations of the companies in the Indian and other stock market around the globe, leading to the finding a safe heaven like investments which was always a last resorts for the investors in the time of the crisis. But soon after when the fear and panic vanish from the perception of the investors, the total connectedness measure stabilised (See *Figure 2 (Middle)*, the periods starting April 2020). There after post covid periods have seen a sudden pick in the initial periods, however, it drastically, changed its connectedness thereafter, and peaking around the January 2023, indicating the changing the sentiments in the markets.

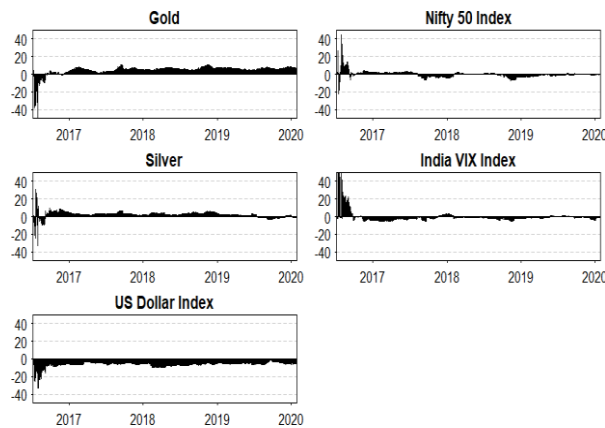


Figure 3 (a): Net spillover of the Assets in the pre-covid periods.

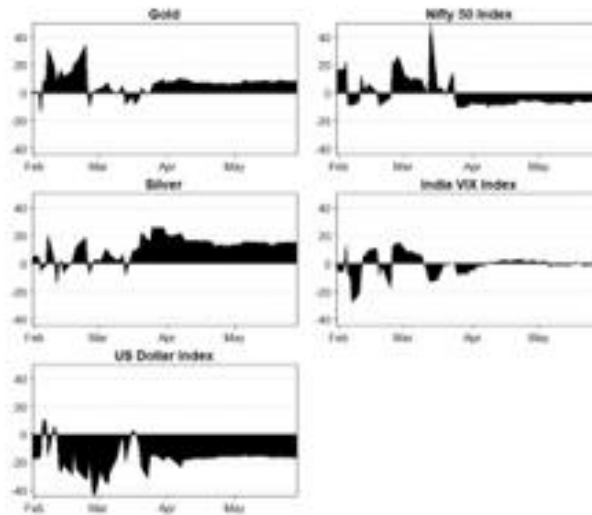


Figure 3 (b): Net spillover of the Assets during the covid periods.

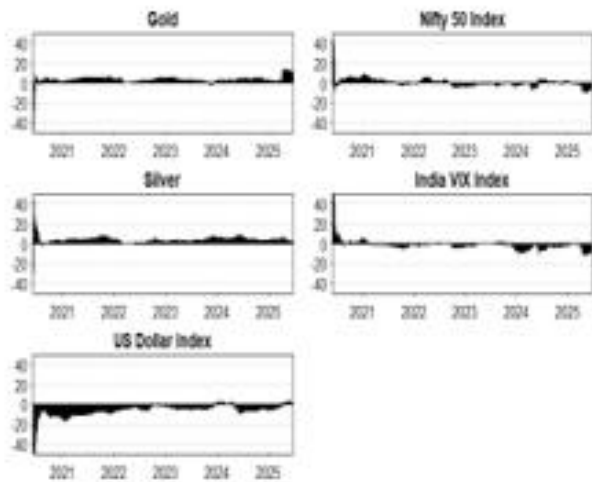
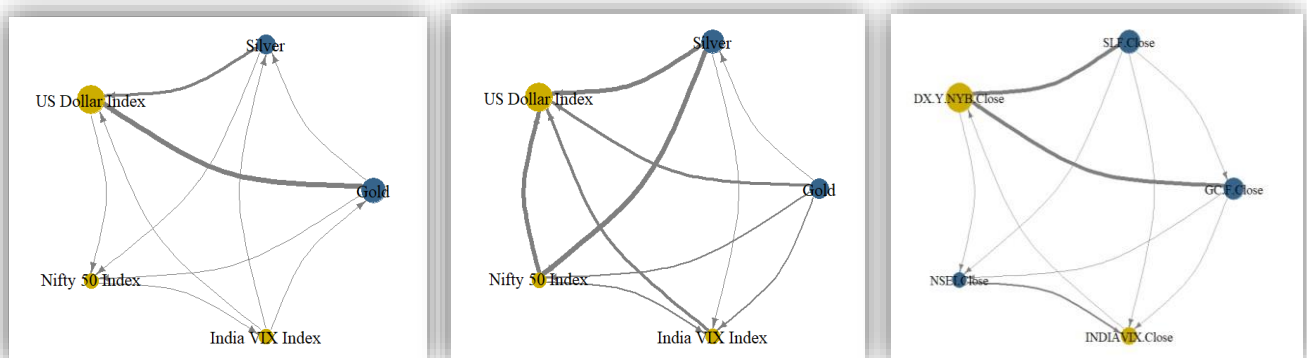


Figure 3 (c): Net spillover of the Assets in the post-covid periods.

Figure 4



From the definition of the *Section 2.5*, we can infer that the net dynamic spillover unleashes that whether the assets' role in the system as transmitters of the shock or the receiver of the shock. And how this role is changing over time. The *Figure 3* reveals the transmitters and the receiver of the shock in the whole periods. The *Figure 3 (a)* has unveiled the spillovers of the system for the pre-covid periods. *Figure 3 (b)* has shown the effects on the Financial Assets observed in between. The post-covid period, the transmitters' role regained back to the normal. During the covid periods, when WHO declared Covid-19 as Health crisis, investors were in panic mode and reached to the safe heaven like Gold, but when the shock has eroded from the market, the valuable stocks at discounted price was available, which sparked the reversal in the role during covid periods. In case of Silver, the notorious behavior has been observed initially showing few days with transmitter and few days with receiver of the shock. But after December 2016, the Silver mostly contributed to the transmission of the shocks in the system but from the starting of 2020, it again went to the roller coaster ride. During the whole covid-19 period, the Silver has contributed mostly to the Transmission of shocks to the system. While, only with few weeks it has got the receiver of the shocks from the system. Nifty 50 Index is the most notorious of all, it first received the shock and then became a transmitter of the shock, this roller coaster was evident during the whole period of study, however, during the Covid periods, has intensified in magnitude and frequency as well. On the other hand, the US Dollar Index was net receiver of the shock during the whole study period. However, during covid- 19 periods, it has intensified in magnitude. In addition, in the mid of February 2020, it has changed a little showing the impact of Covid-19 health crisis. Finally, Indian VIX Index was transmitters of the shocks for first few months, then it remained the net receiver of

during the covid periods. The *Figure 3 (c)* has revealed the effects in the post-covid periods.

In the study period, Gold has been a net receiver of shock for first one month and so, but the effect has changed dramatically starting from December 2016. Now, the role of Gold was a transmitter more or less. During the covid-19 periods, Gold's transmission has intensified, however, few reversals has been

the shock in the system, except the starting of 2018. During the Covid-19 periods, it has become the notorious one by changing its role from receiver to the transmitter. But soon after the covid-19 period, it again becomes mostly the receiver of the shock, except for the first six months of the post-covid periods. Showing delay in dying out of the effects of the Covid-19 Health Crisis.

Network Connectedness

The Network Connectedness diagram show the pairwise connectedness between the Gold, silver, US Dollar Index, Nifty 50 Index, and Indian VIX Index. The *Figure 5 (a)*: Net Pairwise spillover of the whole system for pre-covid period. The nodes show the different investible assets class and the US Dollar Index and Indian VIX Index. The *Figure 5 (b)*: Net Pairwise spillover of the whole system during the covid period. And similarly, *Figure 5 (c)*: Net Pairwise spillover of the whole system for the post-covid period.

The Network Diagrams reveals that connectedness between the US Dollar index and Silver, and Gold which unveils that the connection between the US Dollar Index and Silver was relatively higher compared (From Silver to US Dollar Index) to Nifty 50 Index or India VIX Index but it started to gain strength from the during covid periods and it remained stronger thereafter. On that similar line, if we see the relationship between the US Dollar Index and Gold, the connectedness was stronger than the Silver in the pre-covid periods (Gold to US Dollar Index), it has weakened during the covid periods, but again came back stronger post-covid periods. During the covid period, the Connectedness strength between Nifty 50 index & US Dollar Index has strengthen strongly while direction of the spillover changed from US Dollar Index to Nifty 50 Index (Pre-covid periods) to the Nifty 50 Index to US dollar Index (During the covid periods), while came back to normal post the covid periods. The relationship between the Nifty 50 Index and Silver & Gold spillover was unidirectional from Silver & Gold to Nifty 50 Index however, strength was higher during the covid periods for the both of the commodities. The Connectedness between the Nifty 50 Index and Indian VIX index has strengthen during the covid periods compared pre-covid periods. And the strength has grown stronger post-covid periods. The dynamics of the US Dollar Index and Indian VIX index spillover was also unidirectional, but the

strength of the connectedness has increased during the covid periods compared to the normal time. On the other hand, Indian VIX Index and Gold had a spillover from Indian VIX Index to Gold (Pre-covid periods) which has changed drastically after covid periods spillover from Gold to Indian VIX Index. In this, the connectedness between this has also strengthen during the covid periods, but came back to normal post-covid pandemic. The

spillover between the Indian VIX Index and Silver was from Indian VIX Index to Silver in the pre-covid periods, it has changed the course, during the covid periods to Silver to Indian VIX Index and remained the spillover in that same way. The relationships between the gold and silver spillover were from Gold to Silver till the covid periods, which has changed post covid periods. This discussion has reiterated the relationships of the assets of the interest, and find some interesting insights at the backdrop of the major health crisis (Covid-19 Pandemic). These insights not only helpful for budding portfolio managers also helpful for the policymakers for allocating strategic resources of the country in these resources.

CONCLUSION

The study of the financial assets and its potential hedging opportunities are in the interest to the researchers and the policy makers. In this study, we mainly focused on the issue of the connectedness of the financial assets, where firstly we have included the static connectedness as well as dynamic connectedness. The results show that the financial assets under investigation was less connected in the pre-covid periods, however, the connectedness has increased significantly during the covid-19 periods. The network diagrams also documents that the contagion between the financial assets has increased significantly during the post covid periods compared to pre and post covid periods. Pointing out that crisis not only alter the direction of the spillover of the financial assets, but redefine the roles in the domestic market with global precious metals by increasing the integration among them. In addition, the *Figure 3 (b)* has reveals that during the Covid-19 periods (Specifically for first 45-50 days), Nifty

50 Index's systematic risk can be minimised by the US Dollar Index, but starting from

April 2020, Commodities such as Gold, Silver can be used as a hedging instrument for the reduction of the systematic risk of the market. The findings reveal significant shifts in net transmitters and receivers of shocks, highlighting heightened systemic risk during the pandemic and structural changes in financial relationships post-crisis. These insights contribute to the broader discourse on market interdependence and risk contagion during periods of financial turbulence.

FUTURE SCOPE OF THE STUDY

This study has added to the literature the significant changes of the role of the transmitters and receivers of the precious metals and Indian Equity Market. Additionally, it has documented the increase of systematic risk during the Covid-19 as Health Crisis, of the financial assets of interest. Our study has shown that evolution of the Connectedness of the Financial Assets in the pre-covid, during the covid- 19 and post-covid periods, which unveils that during the Covid-19 Health emergency the Nifty 50 Index has become more integrated to the Commodities such as Gold, Silver and US Dollar Index. However, it is not possible to cover every aspect of the into one study, therefore, future researchers should focus on the frequency domain of the analysis, additionally, future studies may consider the DCC-GARCH TVP-VAR or etc. models which has incorporated the dynamic correlations into the study. The Hedging efficiency of the Financial Assets can also be calculated for future studies.

REFERENCES

- Al Hajj, F. A., Nguyen, D. N., Omran, S., Çağın, T., & Nahas, V. (2024). An analysis of shock and volatility spillovers among Vietnamese and BRICS equity markets. *International Journal of Economics and Business Research*, 28(3–4), 255–271.
- Ali, S., Umar, M., Naveed, M., & Shan, S. (2024). Assessing the impact of renewable energy tokens on BRICS stock markets: A new diversification approach. *Energy Economics*, 134. Scopus. <https://doi.org/10.1504/IJEBR.2024.141494>
- Antonakakis, N., Chatziantoniou, I., & Gabauer, D. (2020). Refined Measures of Dynamic
- Connectedness based on Time-Varying Parameter Vector Autoregressions. *Journal of Risk and Financial Management*, 13(4), 84. <https://doi.org/10.3390/jrfm13040084>
- Babar, M., Ahmad, H., & Yousaf, I. (2024a). Information transmission between energy commodities and emerging Asian stock markets during crises: An analysis of oil importing countries. *Asia- Pacific Journal of Business Administration*, 16(2), 331–351. Scopus. <https://doi.org/10.1108/APJBA-02-2022-0061>
- Belhassine, O., & Karamti, C. (2021). Volatility spillovers and hedging effectiveness between oil and stock markets: Evidence from a wavelet-based and structural breaks analysis. *Energy Economics*, 102. Scopus. <https://doi.org/10.1016/j.eneco.2021.105513>
- Chang, H.-W., Chang, T., & Lee, C.-C. (2023). Return and volatility connectedness among the BRICS stock and oil markets. *Resources Policy*, 86. Scopus. <https://doi.org/10.1016/j.resourpol.2023.104241>
- Chang, H.-W., Chang, T., Ling, Y. H., & Yang, Y.-L. (2023). Dynamical linkages between the Brent oil price and stock markets in BRICS using quantile connectedness approach. *Finance Research Letters*, 54. Scopus. <https://doi.org/10.1016/j.frl.2023.103748>
- Chatziantoniou, I., Gabauer, D., & Marfatia,

- H. A. (2022). Dynamic connectedness and spillovers across sectors: Evidence from the Indian stock market. *Scottish Journal of Political Economy*, 69(3), 283–300. Scopus. <https://doi.org/10.1111/sjpe.12291>
- Das, N. M., Rout, B. S., & Bal, G. R. (2025). Stock Market Integration, Risk and Spillovers Across BRICS Nations: An Assessment During COVID-19. *Management and Labour Studies*, 50(3), 337–356. Scopus. <https://doi.org/10.1177/0258042X251320797>
 - Dhingra, B., Saini, M., Yadav, M., Kumar, G., & Kumar, P. (2025). Exploring global financial interdependencies among ASEAN-5, major developed and developing markets. *Journal of Economic Asymmetries*, 31. Scopus. <https://doi.org/10.1016/j.jeca.2024.e00398>
 - Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. *International Journal of Forecasting*, 28(1), 57–66. <https://doi.org/10.1016/j.ijforecast.2011.02.006>
 - Diebold, F. X., & Yilmaz, K. (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. *Journal of Econometrics*, 182(1), 119–134. <https://doi.org/10.1016/j.jeconom.2014.04.012>
 - El Khoury, R. E., Alshater, M. M., & Alqaralleh, H. (2024). EXCHANGE RATES AND STOCK MARKET DYNAMICS: ISLAMIC VERSUS CONVENTIONAL FINANCIAL SYSTEMS. *Journal of Islamic Monetary Economics and Finance*, 10(3), 551–586. Scopus. <https://doi.org/10.21098/jimf.v10i3.2096>
 - Ferrer, R., Shahzad, S. J. H., López, R., & Jareño, F. (2018). Time and frequency dynamics of connectedness between renewable energy stocks and crude oil prices. *Energy Economics*, 76, 1–20. <https://doi.org/10.1016/j.eneco.2018.09.022>
 - Gazi, M. A. I., Nahiduzzaman, M., Sarker, S. K., Amin, M. B., Kabir, M. A., Kouki, F., Senathirajah, R. B. S., & Erdey, L. (2024). Should South Asian Stock Market Investors Think Globally?
 - Investigating Safe Haven Properties and Hedging Effectiveness. *Economies*, 12(11). Scopus. <https://doi.org/10.3390/economies12110309>
 - Gökgöz, H., Ben Salem, S., Béjaoui, A., & Jeribi, A. (2025). Connectedness Structure and Volatility Dynamics Between BRICS Markets and International Volatility Indices: An Investigation. *International Journal of Finance and Economics*, 30(3), 2981–3002. Scopus. <https://doi.org/10.1002/ijfe.3053>
 - Guru, B. K., Pradhan, A. K., & Bandaru, R. (2023). Volatility contagion between oil and the stock markets of G7 countries plus India and China. *Resources Policy*, 81. Scopus. <https://doi.org/10.1016/j.resourpol.2023.103377>
 - Hanif, W., Hadhri, S., & El Khoury, R. (2024). Quantile spillovers and connectedness between oil shocks and stock markets of the largest oil producers and consumers. *Journal of Commodity Markets*, 34. Scopus. <https://doi.org/10.1016/j.jcomm.2024.100404>
 - Kumar, M., & Gupta, A. (2025). 17 Months of the Pandemic: A Study of the Stress Spillover Among the BRICS Countries During COVID-19. *Vision*, 29(4), 455–464. Scopus. <https://doi.org/10.1177/09722629221074900>
 - Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance*, 7(1), 77. <https://doi.org/10.2307/2975974>
 - Mensi, W., El Khoury, R. E., & Kang, S. H. (2025). Dynamic connectedness between oil shocks and BRICS stock markets. *Finance Research Letters*, 82. Scopus. <https://doi.org/10.1016/j.frl.2025.107601>
 - Mensi, W., Shafiullah, M., Vo, X. V., & Kang, S. H. (2021). Volatility spillovers between

- strategic commodity futures and stock markets and portfolio implications: Evidence from developed and emerging economies. *Resources Policy*, 71. Scopus. <https://doi.org/10.1016/j.resourpol.2021.102002>
- Mishra, A. K., Panda, P., Pradhan, S. K., Panda, A. K., & Smark, C. (2024). Uncertainties and Dynamic Connectedness Among Sectors: A Case of the USA, India, France, Germany and Russia. *Australasian Accounting, Business and Finance Journal*, 18(3), 168–201. Scopus. <https://doi.org/10.14453/aabfj.v18i3.10>
 - Mohamed Dahir, A. M., Mahat, F., Amin Noordin, B.-A., & Hisyam Ab Razak, N. (2020). Dynamic connectedness between Bitcoin and equity market information across BRICS countries:
 - Evidence from TVP-VAR connectedness approach. *International Journal of Managerial Finance*, 16(3), 357–371. Scopus. <https://doi.org/10.1108/IJMF-03-2019-0117>
 - Panazan, O., Gheorghe, C., & Calefariu, E. (2024). Geopolitical Risks and Stock Market Volatility in the SAARC Region. *Economics*, 18(1). Scopus. <https://doi.org/10.1515/econ-2022-0124>
 - Panda, P., Ahmad, W., & Thiripalraju, M. (2023). Better to Give than to Receive: A Study of BRICS Countries Stock Markets. *Journal of Emerging Market Finance*, 22(2), 164–188. Scopus. <https://doi.org/10.1177/09726527231154100>
 - Ramesh, S., Mandal, S. K., & Sadorsky, P. (2024). Does the source of oil price shock matter for Indian sectoral stock returns? A time-frequency approach to analyse dynamic connectedness and spillovers. *Applied Economics*, 56(56), 7469–7486. Scopus. <https://doi.org/10.1080/00036846.2023.2287552>
 - Rehman, M. U., Nautiyal, N., Vo, X. V., Ghardallou, W., & Kang, S. H. (2023). Is the impact of oil shocks more pronounced during extreme market conditions? *Resources Policy*, 85. Scopus. <https://doi.org/10.1016/j.resourpol.2023.103899>
 - Rehman, M. U., Saleem, A., & Sági, J. (2024). Oil crisis vs pandemic: A broader outlook of time- frequency volatility transmission between Islamic and conventional stock markets. *Cogent Economics and Finance*, 12(1). Scopus. <https://doi.org/10.1080/23322039.2024.2365366>
 - Siddiqui, S., & Roy, P. (2021). Stock return dynamics and portfolio hedging: A case of leading oil consuming economies. *SCMS Journal of Indian Management*, 18(2), 91–105. Scopus.
 - Singh, V., Nerlekar, V., & Pate, H. (2024). *Empirical Understanding of the Dynamic Interconnectedness Between ESG/Green Indices and Conventional Indices in the Indian Capital Markets* (S. Mohapatra, P. Padhi, & V. Singh, Eds.; pp. 47–72). Springer Nature; Scopus.
 - Smolo, E., Jahangir, R., Nagayev, R., & Tarazi, C. S. C. (2022). Performances of Islamic and conventional equities during the global health crisis: Time-frequency analysis of BRICS+T markets. *Review of Financial Economics*, 40(3), 259–280. Scopus. <https://doi.org/10.1002/rfe.1152>
 - Sundararajan, S., & Balasubramanian, S. A. (2025). Do the advantages of offshore exchanges enhance hedging effectiveness? - Evidence from Japanese and Indian dual-listed index futures. *Applied Economics*, 57(22), 2922–2939. Scopus. <https://doi.org/10.1080/00036846.2024.2331967>
 - Tiwari, A. K., Dam, M. M., Altıntaş, H., & Victor Bekun, F. V. (2025). The dynamic connectedness between oil price shocks and emerging market economies stock markets:

Evidence from new approaches. *Energy Economics*, 141. Scopus.
<https://doi.org/10.1016/j.eneco.2024.108101>

- Wan, J., Yin, L., & Wu, Y. (2024). Return and volatility connectedness across global ESG stock indexes: Evidence from the time-frequency domain analysis. *International Review of Economics and Finance*, 89, 397–428. Scopus.
<https://doi.org/10.1016/j.iref.2023.10.038>
- Ye, L., & Geng, J.-B. (2021). Measuring the connectedness of global health sector stock markets. *Pacific Basin Finance Journal*, 68. Scopus.
<https://doi.org/10.1016/j.pacfin.2021.101615>
- Younis, I., Shah, W. U., Hkiri, B., Qureshi, F., & Longsheng, C. (2023). Risk co-movements and portfolio strategies between energy, gold and BRICS markets. *Resources Policy*, 82. Scopus.
<https://doi.org/10.1016/j.resourpol.2023.103487>
- Zeng, H., Lu, R., & D Ahmed, A. D. (2023). Dynamic dependencies and return connectedness among stock, gold and Bitcoin markets: Evidence from South Asia and China. *Equilibrium*.
- *Quarterly Journal of Economics and Economic Policy*, 18(1), 49–87. Scopus.
<https://doi.org/10.24136/eq.2023.002>