

## Chapter 4

# Nonlinear Correlation of Stock and Commodity Indices in Emerging and Developed Market

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### ABSTRACT

*The interrelationship between stock and commodity markets has been an issue of interest for both the academia and practitioners in the field of investment and wealth management. Traditionally, commodity has been a popular avenue for diversification in a mixed portfolio. However, this works well as long as there is little or no correlation between the two markets. This chapter presents an empirical investigation of the daily movement of stock and commodity index of two different countries to throw some light on the interrelationship between stock and commodity market. The uniqueness of this study lies in the choice of markets as also the methodology. The authors have chosen a developed market, viz., the US market, and an emerging market, viz., the Indian market. This study uses the major stock and commodity indices respectively for both countries for a period of three years. For analysis the authors have used the tools from nonlinear dynamics like recurrence analysis, power spectrum analysis, and delay based cross-correlation function. The investigation revealed that the dynamics of the time path of daily movement of Indian stock and commodity exchanges are much similar in nature while those of the US market are quite different. This chapter also models the respective time series using Geometric Brownian Motion and finds that the Indian data set performed much better than the US ones. This has a strong impact on strategy for designing mixed portfolios in Indian market.*

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## **INTRODUCTION**

The impact of complex and multidimensional factors on the behaviour of financial time series calls for a systematic detailed analysis of the underlying dynamics of the time series. Systematic investigation and analysis of financial time series as deterministic chaos using state space evolution framework has come up as an emerging area of research in the last few years in addition to advanced econometric techniques available these days. Study of the underlying structure of financial time series like a stock market index or a commodity market index requires specific inputs like daily price fluctuations which are again necessary to predict the market trend in both securities and commodities market. Whether the dynamics of one market resembles the dynamics of other market or not is an area of utmost interest to investors. Commodity offers a diversification choice to investors. This will work if and only if the equity and stock markets are not inter-related. This interrelation can only be indicated by the dynamics of temporal evolution of stock and commodities market indices. To increase the effectiveness of diversification strategy using commodity and stock, the correlation between the two markets must be minimal. The purpose of this study is to capture the dynamics of stock and commodity markets of two in two different economic and geographic domains.

Our aim in this work was to understand the similarity/dissimilarity in the underlying dynamics of the commodity and stock indices. We also decided to conduct our study on two different categories of markets, i.e. one emerging and another developed market. . We selected the DOW JONES indices for stock and commodities, USA and the NIFTY indices and commodities indices of National Stock Exchange and Multi Commodity Exchange, India for our investigation. The next important decision was to select proper tools of empirical investigation which will clearly bring

out the characteristics of the time series to be compared and evaluated.

There are two distinct yet broadly equivalent modes of traditional time-series analysis which may be pursued. On the one hand there are the time-domain methods having their origin in the classical theory of correlation. Such methods deal predominantly with the auto-covariance functions and the cross-covariance functions of the series, and they lead inevitably towards the construction of structural or parametric models of the autoregressive moving-average type for single series and of the transfer-function type for two or more causally related series. Many of the methods which are used to estimate the parameters of these models can be viewed as sophisticated variants of the method of linear regression.

On the other hand are the frequency-domain methods of spectral analysis. These are based on an extension of the methods of Fourier analysis which originate in the idea that, over a finite interval, any analytic function can be approximated, to whatever degree of accuracy is desired, by taking a weighted sum of sine and cosine functions of harmonically increasing frequencies.

Over the last quarter of a century, apart from these two traditional schools, a new school has emerged due to influence of the paradigm of deterministic chaos. As a mathematical framework it shows rich and powerful structures. Most appealing part about deterministic chaos for the applied sciences researchers has been its ability to provide a remarkable explanation for irregular behaviour and anomalies in systems. The most direct link between the chaos theory and real world problems is the analysis of time series of real systems in terms of nonlinear dynamics. On one hand phenomenal progress in empirical techniques and data analysis has made it possible to observe the most fundamental properties of nonlinear dynamical systems. On the other hand considerable progress have been made in exploiting ideas from chaos theory in cases where the

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