
A STUDY ON DYNAMIC RELATIONSHIP BETWEEN CRUDE OIL PRICES AND STOCK MARKET PRICES IN INDIA

¹Dr. Naveen Chinni, ²Ms. Amulya.G.T, ³Dr.Nagala Shyam Venkata Nooka Raju

¹Assistant Professor, Department of MBA, Gayatri Vidya Parishad College for Degree and PG Courses, Visakhapatnam

²Assistant Professor, Commerce and management, East West School of Business Management, Bangalore

³Professor & Principal, Department Of Management Studies, Unity Degree College

Abstract

The Indian stock market is highly volatile. The effect of one market on another market is not new. However, the variations in the degree of impact and co-movement between the markets need to be examined. This research aims to study the dynamic relationship between Crude oil price and stock prices from April 2017 to March 2022. In order to establish the relationship between the exchange rate and the stock market price, ADF test is embarked to examine immovability of data and is evident that it is un-movable at initial difference level. The Johansen co-integration test of Johansen is applied to assess long-term balance of Nifty Index analysis with the Banking sector and to define the co-integration of the variables. Granger causality test is used to regulate causal & short-term relationship of the variables with the corresponding bidirectional of the causality among the variables.

Key words: Dynamic relationship, Crude oil, Stock market prices, Granger causality

Introduction

In the globalized era, financial markets had undergone continuous and significant changes. These changes have affected rising and developed economies, especially in terms of eliminating restrictions with regard to capital movements. Further, due to technological advances, individual and institutional investors are allowed to trade worldwide on a twenty-four hours basis in any market. The liberalized and technically advanced markets have become more integrated over time and it is particularly true in the case of financial markets. When the markets experience an increase in their level of integration, shocks and events that happen in one market immediately affects the other interlinked financial markets and it has an impact upon the benefits that

investors obtain from diversifying their portfolios internationally. If this is the case, and the markets are highly integrated, these benefits will be eradicated in the long-term and investors with long horizons may not benefit from their portfolios (Morales, 2009). There will also be a direct effect on the financial stability of the financial market since the negative and positive effects will spread among the co-integrated capital markets.

The stock market index reflects the economic performance of the country and is vital for the economy. Numerous factors like macro influence the stock market and micro economic variables, demand and supply, political factors, tax rate etc., Crude oil is a tradeable financial asset (Joy, 2011) and a centerpiece of the world monetary system. It acts as a haven from losses incurred in the stock and bond markets. Crude oil provides a cushion during the declining purchasing power of money. Globally, crude oil occupies a strategic place as it maintains its purchasing power and is highly reliable in terms of politically and economically uncertain events. The economic reason for the high demand for crude oil is security, maintaining high liquidity during the crisis, and building a diversified portfolio. Gold plays a major role during the economic, financial and political crisis due to its liquidity nature, and it moves in the opposite direction to those of the stocks. Crude oil is an alternative investment in the bearish or highly volatile stock market. Most of the countries use crude oil as security against loans at the time of balance of payment difficulties (Mishra & Singh, 2012).

On the other hand, there is a common belief that the prices of commodities tend to move in unison since they are influenced by common macroeconomic factors like interest rate, exchange rate and inflation (Hammoudeh, Sari, & Ewing, 2008). Among other macroeconomic factors, oil and gold are the two strategic commodities which have received close attention recently due to the surge in their prices and the increase in their economic uses. In the world, the most commonly traded commodity is crude oil and its price is the most volatile in the commodity market. Gold is considered as the leader in the precious metal market and it is also an investment asset commonly known as a 'safe heaven' to avoid the increasing risk in the financial markets. Investors from both developing and developed markets, often switch between oil and gold or combine them to diversify their portfolios (Soytas, Sari, Hammoudeh, & Hacıhasanoglu, 2009).

In 2009, oil prices had risen while the dollar continued to crash down but before oil's price surge, the dollar was strong. Many of the economists and researchers believe that the oil and dollar exchange prices are inversely correlated since oil is driving down the value of the dollar. Prior to 2007, oil and dollar were believed to be positively correlated, oil is bought and sold in US dollars, therefore as oil price goes up, so does the global demand for dollars.

The above features describing capital market, US Dollar exchange rate, oil, and gold justify the economic importance of investigating the relationship between these. Further, their special features make these not only influenced by ordinary forces of supply and demand but also by other forces. Hence, there is a need for expanding and shedding light for a better understanding of the true nature of relationships between the Indian stock market and Crude oil prices.

Review of Literature

Prakasam et al (2017) examined the causal relationship between gold price, Exchange rate, and a stock price of India for the period June 2004 to April 2014 using the Granger causality test and ARDL bounds testing approach. ADF is used to determine the stationary property and order of integration. Gold price fluctuation is explained by its own shock. No stable long term cointegration was found between stock and price of gold. In short run, no causality exists between stock and gold price, which shows that domestic gold price does not hold significant information to forecast the price of stocks.

Parithi (2012) have made a study to examine the relationship between gold price and stock market for the period from June 2009 to June 2010. They prove that there is no relationship with the stock market and gold price and stock market is not a ground for rising gold price. Partalidou et al. (2016) explicitly used daily data for the sample period from March 1995 – May 2014 for examining the influence of economic and financial variables between DJIA with gold, exchange rate, bond, and oil market. The author employed GJR- GARCH method, and the results reveal gold, bond rate, USD/Yen exchange rate had a negative influence on price of stocks. Gold acts a good diversification for the stock, and rising dollar value affects the country's export. However, oil prices are negatively asymmetrical, and the industrial metal index is positively correlated.

Karaca (2014) examined the relationship between ISE 100 Index and a set of four macroeconomic variables using Vector Autoregressive (VAR) model. Variables they used in their model are Exchange, Gold, Import, Export, and ISE 100 Index. ISE 100 Index is a dependent variable and the others are independent variables. In the study they used 190 observations for the sample period from January, 1996 to October, 2011. All variables have seasonal movements. After seasonal adjustments, all series have had stationary in their first difference. After determining optimal lag order, it was given one standard deviation shock for each series and their response. And in variance decomposition carried out subsequently, it has been determined that especially as of the second default of exchange, it was explained 31% by share indices.

Bhunias Anil et al (2013) investigate the influence of financial variables, namely gold price, Dollar Rate between exchange of currencies, and Stock exchange between January 2, 1991, to October 31, 2013. ADF and PP test employed to check the stationarity of the variables and result in show variables are stationery at the first-order difference. No causality exists among the chosen variables except gold price, and the exchange rate shows the bi-directional relationship. Johansen cointegration results confirmed a Sensex had a long-term relation with gold price and Rate between exchanges of currencies.

Totala et al (2014) examined the effects on gold returns by the important and highly traded financial assets - Gold ETFs, Gold Futures, BSE SENSEX, and S&P CNX NIFTY. The research also explores the correlation and their impact on each other individually and collectively with respect to volatility clustering by using GARCH (1, 1) Model. The study shows that while

inefficiency is present in the gold, Gold ETFS, Gold Futures, BSE SENSEX returns and S&P CNX NIFTY returns together affect the volatility of gold returns for the period 2011-2013.

A recent study carried out in Zambia by Sichoongwe (2016) investigated the impact of exchange rate volatility on the stock market performance employing the GARCH econometric model. The findings pointed to a negatively related relationship between the exchange rate and the stock market prices. However, employing a number of statistical techniques such as ADF tests, correlation, OLS regression, cointegration tests, Granger causality tests, VAR model and GARCH, a study conducted by Branidharan (2016) revealed a long-run relationship between the exchange rate and the stock market prices. Their study employed data from the period April 2002 to March 2010.

Objectives

1. To study the co-integration dynamic relationship Crude oil prices and Nifty 50 Index

Hypothesis

The below mentioned hypothesis are set to empirically verified to study the aforesaid objectives

H₁: There is non-stationary exists between the Crude oil prices and Nifty 50 Index

H₂: There is no long-term equilibrium relationship amongst the variables

H₃: There is no causality prevailing amongst the variables

Research Methodology

Dependent variable chosen for the study is Stock prices (Nifty 50 index) and the independent variable is Crude oil prices. Weekly time series data collected for the period April 2017 to March 2022. Like in similar research, Nordin and Ismail (2014), the key statistical tools used in the study are ADF unit root test, Johansen cointegration and Granger causality tests.

Testing for Unit root test

The ADF unit root test is applied to check the immobile of the present study along with it to find the direction of integration between the variables.

The Augmented Dickey – Fuller unit root test is grounded on the Null hypothesis (H_0): Unit root is existent in yt this point outs that yt is not $I(0)$, i.e., is not integrated of order at level (0), which implies yt is un-stationary. If the premeditated Augmented Dickey – Fuller unit root test statistics is fewer than null hypothesis is prohibited, or else null hypothesis is acknowledged. If the facts is identified non-stationary at a level, the Augmented Dickey – Fuller unit root test is to be testing a unit root. In the above situation, stationary data to be co-integrated at first level $I(1)$.

Johansen's Cointegration Test

Johansen cointegration test is an econometric variables test that predicts the long-term affiliation amongst 2 or more variables based on ADF test. The co-integration of Johansen defines the number of co-integrated vectors for whichever number of non-stationary variables of parallel level order and most cases at $I(1)$. This implies that two or more variables are co-integrated if either of time series variables is immobile

The key point here is that if the variables are in long-term affiliation amongst Y_t and X_t , the variables will grow in due moment and there will be a general tendency to link them. What we need is a linear blend of Y_t and X_t that is a stationary variable ($I(0)$) for a balance or long-run relationship to occur.

Johansen advises 2 trials statistics that is, λ_{\max} statistics and λ_{trace} statistics to regulate the co-integrating rank (number of co-integrating associations). The trials statistics institutes the rank of the π matrix built on its Eigen standards (and henceforth the number of co-integrating associations)

$$(r) = -T(1 - \lambda_i) \quad ki = r+1 \quad (1) \quad \lambda_{\max}(r, +1) = -T \ln(1 - \lambda_{r+1}) \quad (2)$$

A resolution concerning the presence of a long-term affiliation is built on the price of the trial statistic gained from model.

Granger Causality test

The Granger causality test is statistical hypotheses it calculates 1 variable have sufficient to predict other variable in a given period of time. Its capability to forecast the forthcoming values of the variables by using time series data of additional time series (Granger 1988). The current learning trails the Granger causality model in VAR framework.

$$Y_t = \alpha_i Y_{t-i} + \beta_i X_{t-i} + \varepsilon_{1t}$$

$$X_t = \lambda_i X_{t-i} + \delta_i Y_{t-i} + \varepsilon_{2t}$$

Data Analysis and Interpretation

Descriptive statistics

Table 1 show the descriptive statistics results. Study demonstrates that, a major gap is evident amongst minimum and maximum Nifty 50 index and Crude oil prices variables. The skewness is negative (-0.0425) for Nifty 50 suggesting that the distribution's long left tail is thicker than the upper tail and Crude oil prices's skewness is positive (0.35895), indicating that the long right distribution tail is thicker than the lower tail.

Nifty 50 index and Crude oil prices's Kurtosis coefficient values are positive and found to be less than 3, suggesting platykurtic distribution. The Jarque-Bera test statistics indicate that every variable is abnormally disseminated. **Hypothesis 1**, thus, discharged and concluded that Nifty 50 and Crude oil prices s are not usually distributed. Results are considered to be consistent with (D. Bhuvanshwari et al 2017).

Table 1: Descriptive statistics of NSE Nifty 50 Index and Crude oil prices

PARTICULARS	NSE NIFTY 50 INDEX	CRUDE OIL PRICES
Mean	9169.89	10851.71
Median	9878.55	9928
Maximum	12362.3	13470
Minimum	6970.6	6432.3
Std. Dev.	1438.83	1475.948
Skewness	-0.0425	0.35895
Kurtosis	1.72277	2.319068
Jarque-Bera	77.181	67.29878
Probability	0.0000	0.0000
Observations	1052	1052

Testing the data for Staionarity

The results for the ADF unit root test for checking stationarity of the facts obtained in Table 2.

Table 2: Results of Augmented Dickey-Fuller Test at level

Variables	Interce pt but no trend			Intercept and trend		
	Test statisti cs	Critical value (5%)	Prob.	Test statistics	Critical Value (5%)	Prob.
NSE 50 index	-0.85	-2.86	0.1521	-2.09	-3.41	0.3123
Crude oil prices	-1.71	-2.86	0.4320	-3.92	-3.41	0.0009

Results of Augmented Dickey-Fuller Test at 1st difference

Variables	Intercept	but no trend	Prob.	Intercept and trend	Critical Value (5%)	Prob.
	Test statistics	Critical value (5%)		Test statistics		
NSE	-8.01	-2.86	0.0000	-11.02	-3.41	0.0000
Crude oil prices	-23.30	-2.86	0.0000	-23.39	-3.41	0.0000

From the above table 2, it's identified that Nifty 50 and Crude oil prices to be non-stationary at level form but found that to be stationary at first difference I(1). Hence both variable are integrated at first difference I(1). Therefore, **Hypothesis 2** rejected and it's understood that the variables (Nifty 50 and Crude oil prices) taken for this study are stationary. Co-integration test can be applied on Nifty 50 and Crude oil prices variables, as supported in (Hina Shahzadi 2012).

Testing for being of Long-term equilibrium association

Johansen's co-integration test is smeared to discover the linear relationship or long-term cointegration amid the variables, to be exact, whether there is any long-term affiliation amongst Nifty 50 and Crude oil prices . 2 trials are applied, the Trace and Maximum Eigen value test to regulate the sum of vectors. A lag of 1 to 4 (in 1st differences) is applied to every series, centered on the AIC (Akaike Information Criterion).

Table 3: Results of Johansen's Co-integration Test

Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.025491	10.91669	12.49470	0.0067
At most 1	0.001789	3.970813	2.841461	0.2187

Trace test indicates 1 co-integrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized	No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *		0.025491	17.14679	14.96461	0.0067
At most 1		0.001789	3.970813	2.841461	0.2187

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Outcomes show trace test and maximum value test is more than 5 percent precarious. Consequently, both test standards are noteworthy. **Hypothesis 3** was also rejected, which implies there is long relationship/association between Nifty 50 index and Crude oil prices. It found that the model has one co-integration vector, which means that the variable moves together for a long-term relationship. It can infer that a stationary, long-term affiliation exists between variables as supported in (Saha and Bhunia 2011) and (Amalendu Bhunia 2013). Figure shows the Co-integrating relationship between variables.1.

Testing for Granger Causality

Granger causality investigates to show if one data series variable is having adequate to forecast other data series variable in a specific age of time and also helps in defining the short run affiliation among the variables.

Table 3: Results of Granger causality test

Null Hypothesis:	Obs	F-Statistic	Prob.
Crude oil prices does not Granger Cause NSE	1052	101.1299	1.E-78
NSE does not Granger Cause Crude oil prices		9.934612	0.0000

The outcomes point out that there is causality amongst the Nifty index and Crude oil prices. The direction of causality found to be bi-directional (From Crude oil prices \rightarrow Nifty Index and also Nifty Index \rightarrow Crude oil prices) and noteworthy at 5%. Consequently, **Hypothesis 5** overruled. The \rightarrow outcome of the above investigation is discovered equivalent to the studies by (Kutty 2010) and (D. Bhuvaneshwari et al 2017).

Conclusion

For co-integration study used Nifty Index and the Crude oil prices using daily data April 2017 to March 2022. The research variables data series was I (0) level non-stationary and became stationary series at initial variance (Parthasarathy, S. 2019). All research variables are combined at order level I(1). Johansen's co-integration test showed no long-term affiliation amongst stock values and exchange amount (Kaushal, S., & Ghosh, A. 2017). This implies long-run partnership co-movement amongst the Nifty Index and Crude oil prices. Granger causality test is used to detect if there is causal and short-term Nifty 50 index and Crude oil prices relationship. Granger causality test fallouts in bidirectional causality and having same both directional in both sectors.

References

- Agrawal, D. K. (2022). An Empirical Study On Socioeconomic Factors Affecting Producer's Participation In Commodity Markets In India. *Journal of Positive School Psychology*, 2896-2906.
- Andreoli, A., Ballestra, L. V., & Pacelli, G. (2016). From insurance risk to credit portfolio management: a new approach to pricing CDOs. *Quantitative Finance*, 16(10), 1495-1510.
- Andreoli, A., Ballestra, L. V., & Pacelli, G. (2016). From insurance risk to credit portfolio management: a new approach to pricing CDOs. *Quantitative Finance*, 16(10), 1495-1510.
- Atmaca, M. E. (2022). Portfolio management and performance improvement with Sharpe and Treynor ratios in electricity markets. *Energy Reports*, 8, 192-201.

- Barros, C. P., Gil-Alana, L. A., & Payne, J. E. (2011). An analysis of oil production by OPEC countries: Persistence, breaks, and outliers. *Energy policy*, 39(1), 442-453.
- Basha, M., Singh, A. P., Rafi, M., Rani, M. I., & Sharma, N. M. (2020). Cointegration and Causal relationship between Pharmaceutical sector and Nifty—An empirical Study. *PalArch's Journal of Archaeology of Egypt/Egyptology*, 17(6), 8835-8842.
- Basha, S. M., & Ramaratnam, M. S. (2017). Construction of an Optimal Portfolio Using Sharpe's Single Index Model: A Study on Nifty Midcap 150 Scrips. *Indian Journal of Research in Capital Markets*, 4(4), 25-41.
- Bednarek, Z., Patel, P., & Ramezani, C. A. (2016). Time aggregation of the Sharpe ratio. *Journal of Asset Management*, 17(7), 540-555.
- Chow, V., & Lai, C. W. (2015). Conditional sharpe ratios. *Finance Research Letters*, 12, 117-133.
- DrSanthosh Kumar, V., & Basha, S. M. (2022). A study of Emotional Intelligence and Quality of Life among Doctors in PandemicCovid 19. *International Journal of Early Childhood*, 14(02), 2080-2090.
- EWUBARE, D. B. (2018). EWUBARE, Dennis Brown, MAEBA, Sampson Lucky" Effect of Public Expenditure in Construction and Transportation sectors on Employment in Nigeria. *International Journal of Science and Management Studies (IJSMS)*, 1, 14.
- Ewubare, D. B., & Maeba, S. L. (2018). Effect of public expenditure in construction and transportation sectors on employment in Nigeria. *International Journal of Science and Management Studies*, 1(4), 130-136.
- Filos, A. (2019). Reinforcement learning for portfolio management. arXiv preprint arXiv:1909.09571.
- Gorman, S. A., & Fabozzi, F. J. (2022). Workhorse or Trojan Horse? The Alternative Risk Premium Conundrum in Multi-Asset Portfolios. *The Journal of Portfolio Management*, 48(4), 147-182.
- Basha, S. M., Kethan, M., & Aisha, M. A. A Study on Digital Marketing Tools amongst the Marketing Professionals in Bangalore City.
- Gregoriou, G. N., & Gueyie, J. P. (2003). Risk-adjusted performance of funds of hedge funds using a modified Sharpe ratio. *The Journal of wealth management*, 6(3), 77-83.
- JagadeeshBabu, M. K., SaurabhSrivastava, S. M., & AditiPriya Singh, M. B. S. (2020). INFLUENCE OF SOCIAL MEDIA MARKETING ON BUYING BEHAVIOR OF MILLENNIAL TOWARDS SMART PHONES IN BANGALORE CITY. *PalArch's Journal of Archaeology of Egypt/Egyptology*, 17(9), 4474-4485.
- Krishnamoorthy, D. N., & Mahabub Basha, S. (2022). An empirical study on construction portfolio with reference to BSE. *Int J Finance Manage Econ*, 5(1), 110-114.
- Leibowitz, M. L., & Kogelman, S. (2020). Sharpe Ratios, Target Ratios, and Return Goals. *The Journal of Portfolio Management*, 47(1), 41-50.
- Maree, C., & Omlin, C. W. (2022, May). Balancing Profit, Risk, and Sustainability for Portfolio Management. In *2022 IEEE Symposium on Computational Intelligence for Financial Engineering and Economics (CIFEr)* (pp. 1-8). IEEE.

- Mohammed, B. Z., Kumar, P. M., Thilaga, S., & Basha, M. (2022). An Empirical Study On Customer Experience And Customer Engagement Towards Electric Bikes With Reference To Bangalore City. *Journal of Positive School Psychology*, 4591-4597.
- Moody, J., & Wu, L. (1997, March). Optimization of trading systems and portfolios. In *Proceedings of the IEEE/IAFE 1997 computational intelligence for financial engineering (CIFEr)* (pp. 300-307). IEEE.
- Murthy, B. S. R., Manyam, K., & Manjunatha, M. (2018). A Study on Comparative Financial Statement of Hatsun Agro Product Ltd (With Reference Last Five Financial Year 2013 To 2017). *International Journal for Science and Advance Research In Technology JSART*, 4, 2395-1052.
- Murthy, B. S. R., Manyam, K., Sravanth, K., & Ravikumar, M. (2018). Predicting Bankruptcy of Heritage Foods Company by Applying Altman's Z-Score Model. *INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN TECHNOLOGY (IJIRT)*, 4(12).
- Prakash, M., & Manyam, K. (2018). Effectiveness and Efficiency of E-Governance in Andhra Pradesh. *International Journal of Advanced Scientific Research & Development*, 5(01).
- Rajasulochana, D., & Khizerulla, M. (2022). Service Quality In SBI: An Assessment Of Customer Satisfaction On E-Banking Services. *Journal of Positive School Psychology*, 4585-4590.
- Schmidt, A. B. (2022). Optimal ESG portfolios: an example for the Dow Jones Index. *Journal of Sustainable Finance & Investment*, 12(2), 529-535.
- Shaik, M. B., Kethan, M., Jaggaiah, T., & Khizerulla, M. (2022). Financial Literacy and Investment Behaviour of IT Professional in India. *East Asian Journal of Multidisciplinary Research*, 1(5), 777-788.
- Shaik, M. B., Kethan, M., Rani, I., Mahesh, U., Harsha, C. S., Navya, M. K., & Sravani, D. (2022). WHICH DETERMINANTS MATTER FOR CAPITAL STRUCTURE? AN EMPIRICAL STUDY ON NBFC'S IN INDIA. *International Journal of Entrepreneurship*, 26, 1-9.
- Stigler, M. (2010). Threshold cointegration: overview and implementation in R. R package version 0.7-2. URL <http://stat.ethz.ch/CRAN/web/packages/tsDyn/vignettes/ThCointOverview.pdf>.
- Tajdini, S., Mehrara, M., & Tehrani, R. (2019). Double-sided balanced conditional Sharpe ratio. *Cogent Economics & Finance*, 7(1), 1630931.
- Tan, B. W., & Tang, C. F. (2016). Examining the causal linkages among domestic investment, FDI, trade, interest rate and economic growth in ASEAN-5 countries. *International Journal of Economics and Financial Issues*, 6(1), 214-220.
- Tao, Z., & Gupta, G. (2022). Stock Investment Strategies and Portfolio Analysis. In *Proceedings of Academia-Industry Consortium for Data Science* (pp. 397-406). Springer, Singapore.
- van Vuuren, G., & van der Lecq, M. (2022). Global maximal Sharpe ratios for active portfolios. *Applied Economics Letters*, 1-5.
- Vukovic, D., Vykylyuk, Y., Matsiuk, N., & Maiti, M. (2020). Neural network forecasting in prediction Sharpe ratio: Evidence from EU debt market. *Physica A: Statistical Mechanics and its Applications*, 542, 123331.

- Weinmayer, K., & Rammerstorfer, M. (2022). Efficiency of Socially Responsible Investments in the Context of Portfolio Management. Available at SSRN 4039593.
- Wu, M. E., Syu, J. H., Lin, J. C. W., & Ho, J. M. (2021). Portfolio management system in equity market neutral using reinforcement learning. *Applied Intelligence*, 51(11), 8119-8131.
- Xue, L., Hou, Y., Zhao, L., He, G., & Qin, F. (2010, October). Notice of Retraction: Cointegration analysis of energy demand and industrial structure in China. In 2010 International Conference on Computer Application and System Modeling (ICCASM 2010) (Vol. 15, pp. V15-118). IEEE.
- Yildirim, H., & Ayben, K. O. Y. THE EFFECT OF CRYPTOCURRENCIES IN PORTFOLIO MANAGEMENT. *PressAcademia Procedia*, 14(1), 154-155.