Causal Impact of Covid-19 Stimulus on Stock Market Prices

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Abstract

This paper uses VAR based Johansen's co-integration test to examine the possibility of co-integration and Granger causality to estimate the causal relationship between stock market index and monetary and fiscal indicators– namely M2 money supply, interest rate and federal expenditure. To check the validity of the VAR model, an ARDL model was also employed. Failure to find linkage will signify that stock prices do not reflect all available macroeconomic information - violating the Efficient Market Hypothesis. After establishing that variables of monetary and fiscal stimulus were cointegrated with stock prices, it then tries to explain the quantitative effect of Covid-19 monetary stimulus on the current stock market rally through dividing the regressors into anticipated and unanticipated changes. The paper hypothesizes that the monetary and fiscal responses was case of a structural change and defends the conjecture through robust methodology.

Definitive causal impact was found due to intervention, with the size of the impact being estimated at 5% to 32% of market price of Standard and Poor's 500 as on April, 2021.

Keywords: Auto Regressive Distributed Lags (ARDL), V ector Auto Regression (VAR), Causality, Autoregressive Integrated Moving Average (ARIMA) Model, Predictive Modelling.

JEL CODES: B22, B23, C53, E52, E63

Introduction

The capital markets, although often seemingly moving in their own accord, forms the most fundamental of the leading indicators of the economy and assumes significance in examining the future course of the economy. The reasoning behind our investigation is based on the very notion of Informational efficiency- an idea promulgating the view that share prices must always accurately reflect all available information in the market at any given time, fundamentally implying that it is always impossible to "beat the market".

Through carefully defining the relationship an individual investor can reap the benefits of asymmetrical information, thus distorting the

markets' ability to optimally allocate scare resources. The paper assumes significance due to the implications of its finding - it finds empirical evidence of Keynesian economics, in use by most public economists internationally. Concomitantly, understanding the predictability of financial markets, or a lack thereof, and can strengthen past findings by Eugene R Fama (1969) or further the narrative of weakening of predictability due to advancements in investor learning. Thus, identifying the functional relationship can help one to implement, and often, rectify current economic stabilisation policies.

Almost 40% of all Dollar existent was printed in the last year. Wrought by the pandemic, USA and EU, unlike their Asian counterparts- resorted to printing of money and decreasing interest rates. Finding the empirical contribution, quantitative easing on the stock market rise during the Covid-19 pandemic can reveal the efficacy of the policy in relation to its objectives. Although originally intended as a relief measure and for spurring economic activity, if significant cause of the capital market bull run can be attributable to excess in liquidity owing to quantitative easing, this may indicate creation of a market bubble and increase in systemic risk– thus posing a question: what happens when the money tap is turned off?

Theoretical Basis

The importance of money supply on determining the current stock price stems from the concept of discounting (as expounded in behavioural economics) and human tendencies of hyperbolic discounting in relation to current interest rate. Due to this intrinsic relation of an expansionary monetary policy with interest rates, the stock price- representing the present value of future cashflow- must be strongly correlated with money supply.

The clashing viewpoints represent two poles of modern economics- one of Keynesian theory and one of Monetarism. In reference to Peter Sellin (2001), the Keynesians believe that change in current money supply shall only affect the current stock prices if it leads to an anticipation of future tightening monetary policy. Such anticipation will lead to people increasing their current demand for capital [*loanable funds = f (MEC, i)*].

Thus, current interest rate will have to rise. Hence, the current stock prices must decrease, since the discounting factor of a singular cashflow must rise

$$D.F = \frac{1}{(1+i)^n}$$

D.F.= Discount Factor; i = interest rate; n = conversion period. And thus,

$$Current\ Stock\ Price = Future\ Value * \frac{Expectation}{Discounting\ factor}$$

As a result, in Keynesian terms,

$$\boxed{stock\ market\ prices \propto 1/money\ supply}$$

Similar views backing the Keynesian explanation was furthered in Bradford Cornell's book- the Equity Risk Premium.

Unlike the transaction/speculative motive of money demand, Cornell exemplified the precautionary role of holding money. People shall hold more money when they fear turbulent times ahead. Accordingly,

$$\boxed{stock\ market\ prices \propto 1/money\ supply}$$

Thus, risk makes investors stay away from speculative assets like equity. Conversely, the quantity theory of money and liquidity hypothesis argue that increase in money supply must always come as a response to increase in money demand in anticipation of upswing in economic activity- and thus, the idea of higher economic activity leads to optimism leading to a rise in stock indices,

Biniv Maskay (2007).Accordingly

$$\boxed{stock\ market\ prices \propto 1/money\ supply}$$

The relationship between stocks and interest rate is also disputed, yet, as a rule of thumb an inverse relationship maybe found between the two variables. The economic logic behind such a finding can be explained through demand pull effect of investors to the stock market and the supply push way of more extensional investment of companies, Alam et al. (2009).

Review of Literature

As expressed in Sprinkel (1964), Homa and Jaffee (1971) and Hamburg and Kochin (1972), past money supply was accurate in predicting future stock returns in stark contradiction to the theory of efficient markets, Fama(1970).Unilateral causality in granger sense was established.

Contemporary papers, however, dispute this established financial ideal. Alatiqi& Fazel (2008) reported the absence of a causal relationship from money supply on stock prices which may be attributed to uncertainties over whether interest rates may fluctuate due to money supply instabilities. Gupta & Modise (2013), using monthly data from 1990-2010 reported that macroeconomic and financial variables do not seem to contain much information in predicting South African stock returns in a linear predictive regression framework. However, further findings by Cooper (1974) and Pesando (1974) showed no predictive ability of past changes in money supply.

To conclude, in the words of Sellin - "while the earlier literature is ambiguous as to the effect of monetary policy on real stock returns, most recent studies have found strong evidence of such an effect". In terms of its findings, this study will closely follow Husain and Mahmud's study on Pakistan (KSE) Stock Market Prices.

Objectives of the Study

The study took to finding: (a) whether determinants of monetary policy, i.e. 'Money Supply' and 'Interest Rate' had impact on stock market prices (b) whether fiscal policy measures like government spending can affect stock market prices (c) which hypothesis, among those proposed by the quantity theory/liquidity theory or Keynesian economists hold true?

Having determined statistical significance of the regressor variables, the study attempted to find the quantifiable impact on Stock Market Price (S&P500) due to Monetary and Fiscal shock in the form of the COVID-19 stimulus package.

Research Methodology: Data and Variables

The following variables were used at a monthly frequency. Since total fiscal expenditure was reported quarterly, data was linear scaling to cover from lower frequency (6 months) to higher frequency (1 month). The period under study was from 1990M01 to 2021M06.

Variables Name	Frequency	Source
Standard and Poor's 500 ***	Monthly	Federal Reserve Bank of St. Louis
GDP	Monthly	Federal Reserve Bank of St. Louis
Money Stock (M2)	Monthly	Federal Reserve Bank of St. Louis
Consumer Sentiment, University of Michigan	Monthly	University of Michigan
Unemployment Rate	Monthly	Federal Reserve Bank of St. Louis
Federal Funds Rate (used to denote interest rate)	Monthly	Federal Reserve Bank of St. Louis
Total Federal Expenditure	Quarterly- Linear scaling to monthly	Federal Reserve Bank of St. Louis

Note: ****has been used to denote the dependent variable. Other variables were used as explanatory factors.*

Analysis, Interpretation and Results

Figure-1 presents the descriptive statistics and the plot of the variables under study. As noted in the plots, a noticeable and sharp change was observed in all variables at the onset of the Covid-19 pandemic. The decline in consumer sentiments and rise in unemployment levels highlighted the real impacts of the pandemic on the general populace. Similarly, a detectable drop was observed in the Gross Domestic Product. The fiscal and monetary responses to the pandemic crisis can be seen in the Money Stock and Federal Expenditure Plots, both were increased as a relief measure to the economy. The interest rate was rapidly decreased to incentivize investment and spur real demand in the economy.

Table-1: Descriptive Statistics and Plot of Variables under Study

Statistic	GDP	Money stock	SP500	Customer sentiment	Unemployment rate	Federal Funds Rate	Total Federal Expenditure
Minimum	6315.892	2305.100	403.670	96.160	3.500	0.050	1493.079
Maximum	22825.016	7586.000	4216.520	103.151	14.800	6.540	9234.370
Range	16509.124	5280.900	3812.850	6.990	11.300	6.490	7741.291
1st Quartile	9537.800	2705.300	954.568	98.997	4.600	0.180	1852.827
Median	13950.213	3443.150	1258.240	100.481	5.500	1.965	2869.939
3rd Quartile	17174.579	4733.350	1836.033	101.183	6.775	4.803	3971.409
Sum	4815883.772	1351932.600	508067.240	35451.508	2087.000	884.990	372314.855
Mean	13604.191	3819.019	1435.218	100.146	5.895	2.514	3155.211
Variance (n)	21133504.077	1723697.603	620398.787	2.588	3.129	4.682	2111848.469
Standard deviation (n)	4597.119	1312.897	787.654	1.609	1.769	2.164	1453.220
Skewness (Pearson)	0.152	0.852	1.120	-0.423	1.261	0.320	1.374
Kurtosis (Pearson)	-1.113	-0.004	0.982	-0.330	1.982	-1.433	2.983
Standard error(Skewness (Fisher))	0.130	0.130	0.130	0.130	0.130	0.130	0.223
Standard error(Kurtosis (Fisher))	0.259	0.259	0.259	0.259	0.259	0.259	0.442
Mean absolute deviation	3955.490	1087.031	595.101	1.313	1.370	1.949	1164.828
Median absolute deviation	3908.826	958.300	349.080	1.016	1.000	1.835	1077.549

Figure 1: Plot of Variables

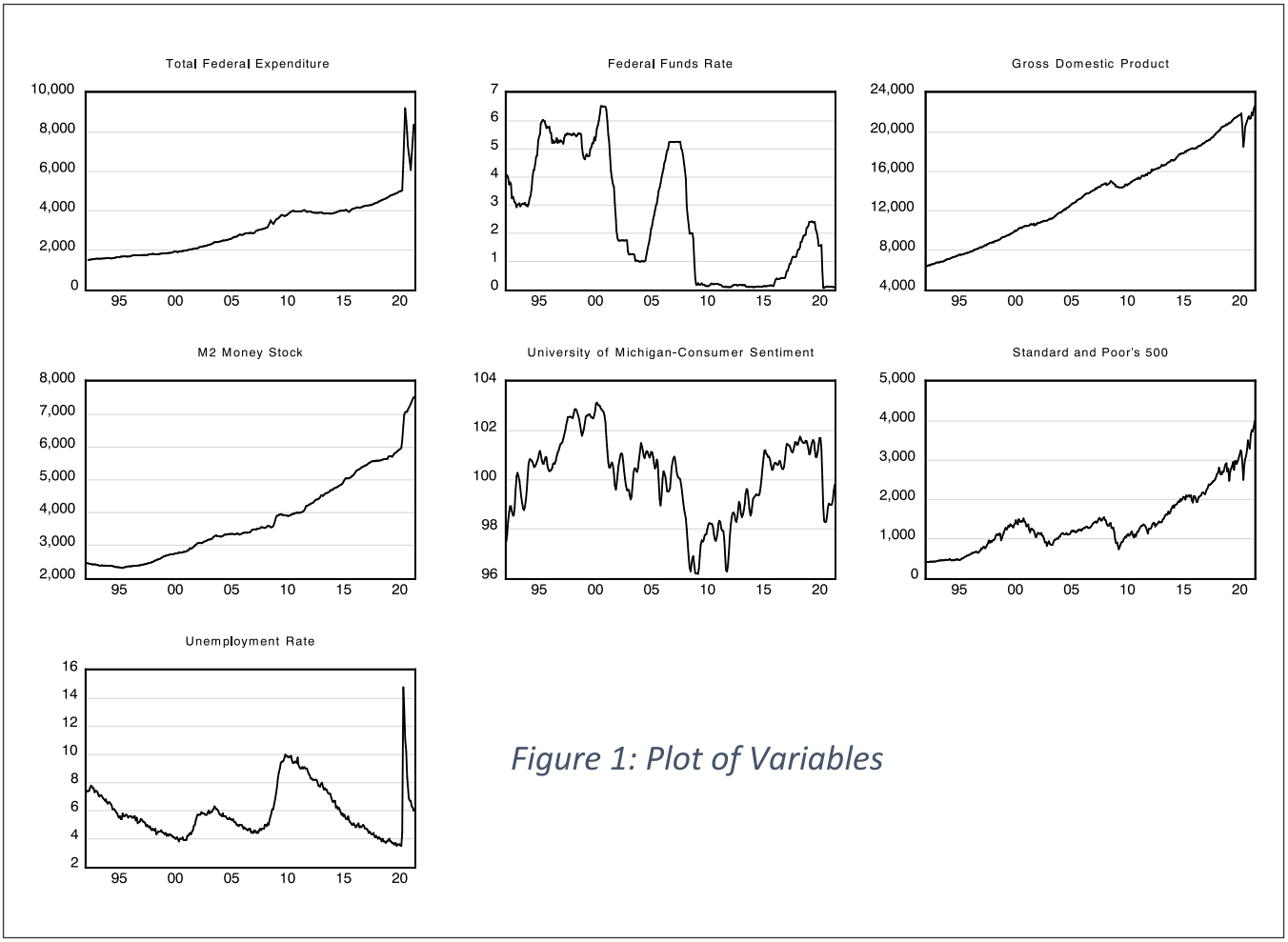


Figure 1: Plot of Variables

The very basis of our hypothesis lies on the groundwork that money stock, interest rates and federal expenditure can trigger real effects in the stock market prices. For fulfilment of the purposes of the study, we needed to prove the non-stationarity of the variables in order to perform checks for cointegration and causal relationships. In Table-2, the stationarity of the variables was tested through ADF and KPSS tests. Since KPSS test's null hypothesis mirrors that of ADF, it strengthened the robustness of the finding.

Table-2: Non-Stationarity of Variables

Test	GDP	Money Stock	S&P500	Consumer Sentiment	Un-Employment Rate	Federal Funds (Interest) rate	Federal Expenditure
ADF	Non-Stationary	Non-Stationary	Non-Stationary	Non-Stationary	Non-Stationary	Non-Stationary	Non-Stationary
KPSS	Non-Stationary	Non-Stationary	Non-Stationary	Non-Stationary	Non-Stationary	Non-Stationary	Non-Stationary

Once non-stationarity was established, we performed a cointegration test to find whether a long run equilibrium relationship existed between the selected variables. For that purpose, a VAR model was specified using the optimal lag length given by AIC or SC criteria. Where both tests disagreed, the lower lag length was selected.

Table-3, 4 and 5 Presented the Lag Order Determination Criteria

Table 3: Lag Length Determination for VAR Order- Money Supply and S&P500

Lag	AIC	SC
1	31.24869	31.2709
2	21.22709	21.2939
3	20.552	**20.6369**
4	20.43489	20.5908
5	**20.4345**	20.6465

Table 4: Lag Length Determination for VAR Order- Inverse of Interest Rate and S&P500

Lag	AIC	SC
1	20.045	20.06802
2	10.170	10.2396
3	9.67495	9.7900
4	**9.6285**	**9.7897**
5	9.6385	9.8433

Table 5: Lag Length Determination for VAR Order- Federal Expenditure and S&P500

Lag	AIC	SC
1	32.0566	24.51612
2	24.4491	24.1096
3	23.9979	24.10961
4	**23.6624**	**23.86340**
5	23.6647	23.91032

Given the appropriate lag length, we proceeded with a Johansen's Co-integration test. Finding cointegration might suggest long-run equilibrium relationship and conjoint movement of the two variables. Presence of cointegration also evidences at least one causal relationship exists in the model. Expectedly, cointegration was found in the money stock – S&P500 and Federal Expenditure-S&P500 Relationship. The theoretically inverse relationship between interest rate and Stock market prices was used to find cointegrating relationship. The results have been presented in Table-6.

Table-6: Johansen's Cointegration Test

Number of Cointegrating	Money Stock and SP500	Inverse of Interest rate and SP500	Federal expenses and SP500
Trace Test	1	2	2
Lambda Max Test	1	1	2

Presence of at least 1 cointegrating factor allows us to proceed with a VECM model to test short and long run convergences of the model.This indicated similarity in long term trends. To test short run causal relationships, we carried out a Granger Causality test in theVECM environment.

Table 7: VECM Granger Causality Test

Type of Causality in VECM Model	Money Stock and S&P500	Inverse of Interest Rate and S&P500	Federal Expenses and S&P500
Unilateral Causality	**Yes**, Money Stock granger causes S&P500 at 1,5,10% confidence level **(P-Value=0.0059)**	**Yes**, Inverse of Interest Rate granger causes S&P500 at 10% confidence level **(P-Value=0.0969)**	**Yes**, Federal expenses granger causes SP500 at 1,5,10% confidence level **(P-Value=0.0000)**
Bilateral Causality	**No**. Null Hypothesis not rejected in case where dependent variable is Money Stock **(P-Value=0.2808)**	**Yes.** S&P500 granger causes Inverse of interest rate	**No**. Null Hypothesis not rejected in case where dependent variable is Federal Exchange **(P-Value=0.9302)**

Expectedly, Uni-directional causality was found from *Money Supply →Stock Market Prices* and also in the *Total Federal Expenditure→Stock Market Prices* relationship. Bilateral causal relationship was found in the *Inverse of Interest rate↔Stock Market Prices* relationship. This was in line with the Liquidity theory's proposition that increases in current money stock positively impacted the stock market prices. Hence, the Keynesian hypothesis was disproved. The bidirectional relationship between inverse of interest rate and stock market can be explained through Central bank's tendencies to reduce interest rates for spurring investing activities. This may allow companies to refinance debt or expand business, causing stock prices to rise. Similarly, fears of inflation associated with a rising stock market index may force the central bank to increase interest rate.

To further substantiate on the results, we also carried out a F-Statistic based Bounds' Test to increase the robustness of our previous finding. In ever model, S&P500 was regressed upon the variable of interest using an Auto-Regressive Distributed Lag Model. Evidently, the previous results were upheld.

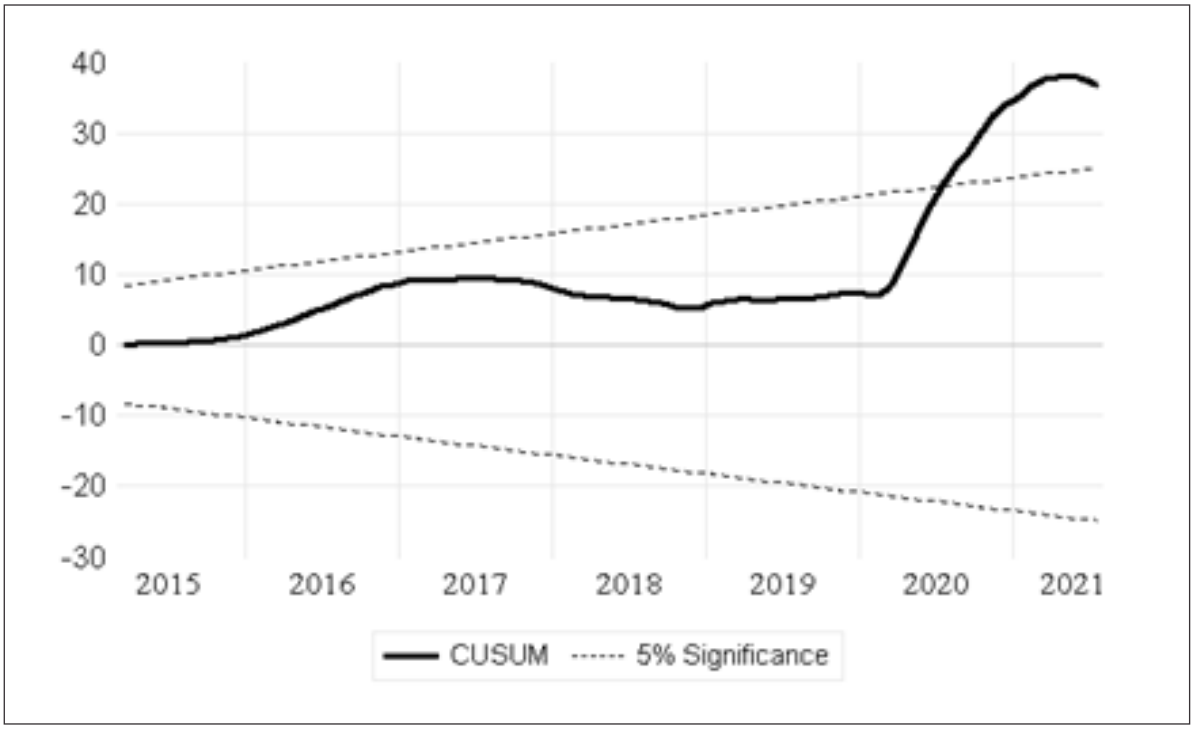
Table-8: F Based Bounds' Test Statistic

Test Statistic	Money Supply and S&P500	Inverse of Interest Rate and S&P500	Federal Rate and S&P500
F Based Bounds'Test	F-Statistic > I (1) critical value at 1,5,10% intervals	F-Statistic > I (1) critical value at 1,5,10% intervals	F-Statistic > I (1) critical value at 1,5,10% intervals
Interpretation	**Cointegration Exists**	**Cointegration Exists**	**Cointegration Exists**

Having established that money stock, federal expenditure and interest rate have quantifiable impacts on the dependent variable i.e. S&P500, we now moved on to investigate whether they were the causal agents for the unnatural rise in stock market price despite a pandemic and an ailing economy. For this purpose, it is cardinal to first check whether the Covid crisis caused a structural change in the stock market prices. Accordingly, we used Chow Breakpoint Test as the Break date – 2020:02 was known apriori. Through the test statistic, a structural break was suggested.

Table-9: Chow Breakpoint Test

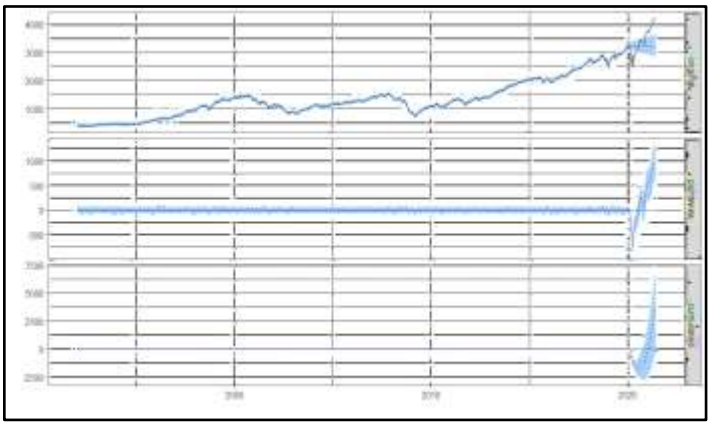
F-Statistic	3.84
Log-Likelihood Ratio	7.68
Bounds Statistic	7.68
Probability value of F-Statistic	0.022
H0=No breaks at specified breakpoint – February,2020	
H1=Breaks at specified breakpoint – February,2020	
Since the P-Value of F-Statistic <=5%, Null Hypothesis is Rejected and Breakpoint is Detected, indicating structural change	



Furthermore, an intervention analysis test was carried out in R-Studio environment to ascertain whether the mean level of S&P500 prices changed after the Covid crisis and the pandemic response. Intervention analysis tests the changes in mean levels to conclude regarding changes in a series due to exogenous changes in the environment.

During the post-intervention period, the average value of S&P500 was found to be 3610.This was compared against the expected average of 2580 whose 95% interval would've been 2360 and 2830. Thus, this positive effect was statistically significant and unlikely to be attributable to random events.

Figure-2: Intervention Analysis Using Pre and Post Periods

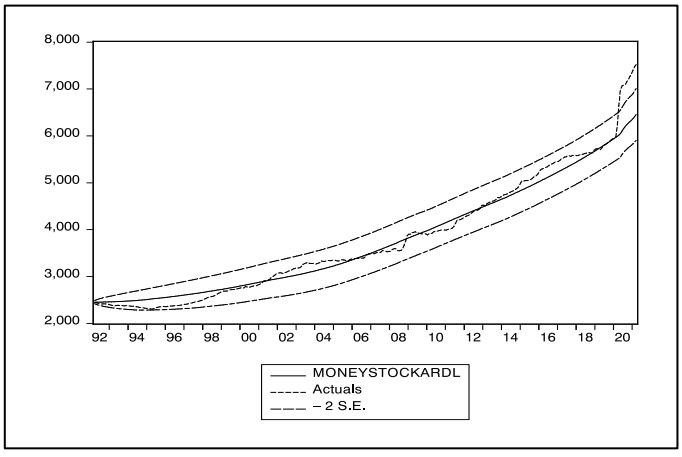


The lack of attributability of the positive change to random events strengthens our case that Monetary and Fiscal relief in response to Covid-19 may have been the causal agents for such a rise. Thus, we will estimate the quantitative effect of this relief on the stock market price through comparing the actual and forecasted S&P500 price.

As a first step of the model, we will prepare the predicted Money Stock in absence of Government Monetary Stimulus. Model to be followed is the Barro's Definition of money supply where money supply is regressed upon Previous Period's Model Supply, Unemployment Rate and Federal Expenditure. The specific model used for the process is:

$$Money\ Supply_t = C + Money\ Supply_{t-1} + a_1 Federal\ Expenditure + a_2 Unemployment\ rate$$

Figure-3: Predicting Money Supply in absence of Monetary Stimulus

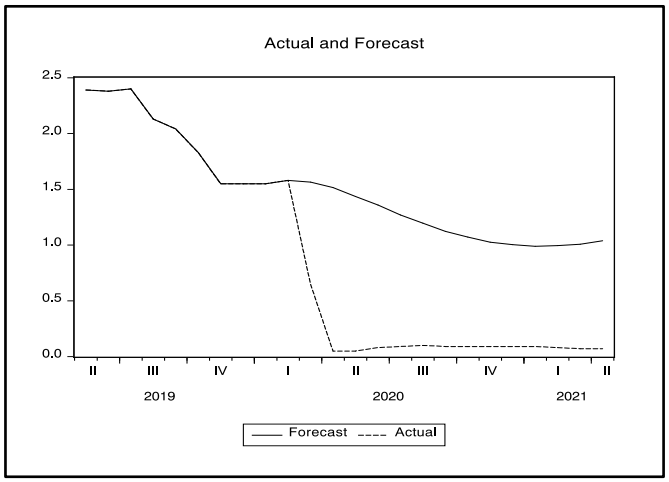


Test Statistic	Value
R^2	0.999782
Adjusted R^2	0.999780
Actual Value after Monetary Response as on April 2021	7520.4
Predicted value from regression coefficient April 2021	6456.943

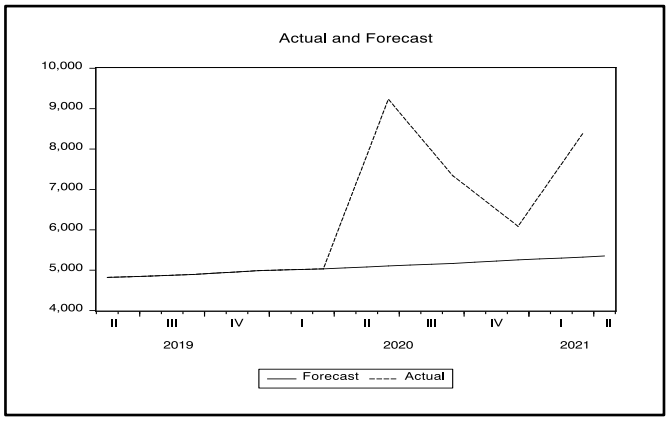
Figure 3: Actual and predicted money stock

For the purposes of predicting the Interest Rate and the Federal Expenditure, an ARIMA model was used as the regressor variable was not known with certainty. In case of Federal Expenditure, GDP was used as an external regressor because of its theoretical implication on government spending.

Figure-4 and 5:ARIMA Predicted Interest Rate and Federal Spending in absence of Fiscal Stimulus



Test Statistic	Value
R^2	0.23
Adjusted R^2	0.21
Actual value after monetary policy as on April 2021	0.07
Predicted value from ARIMA model	1.0377



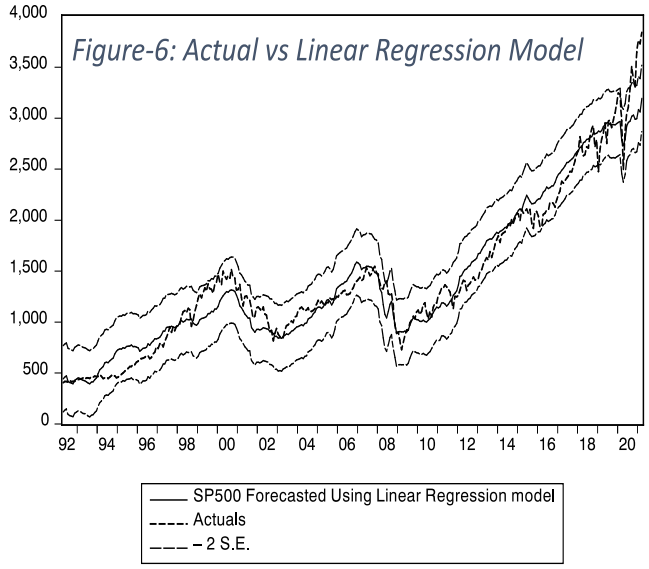
Test Statistic	Value
R^2	0.74
Adjusted R^2	0.73
Actual value after Fiscal Response as on April 2021	8387
Predicted value from ARIMA model with GDP as exogenous variable	5354

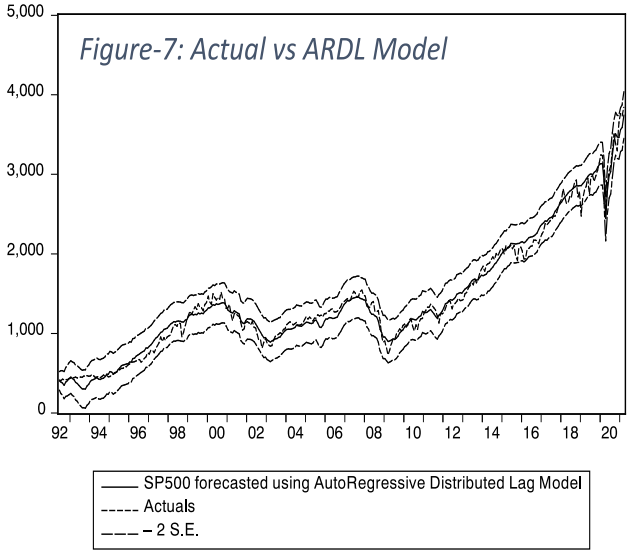
After removing the effects of government intervention from our variables of particular interest- namely, the Money Supply, Interest Rate and Federal Expenditure, we created Linear Regression, VAR, ARDL and ARIMA model of S&P500 where GDP, Consumer sentiment, Unemployment Rate, Money Stock, Federal Expenditure and Interest Rate were used as exogenous variable. Consumer sentiments can have large, swaying effects on the stock prices as when sentiments rise, people are less risk averse and more inclined to invest in riskier assets like stocks.

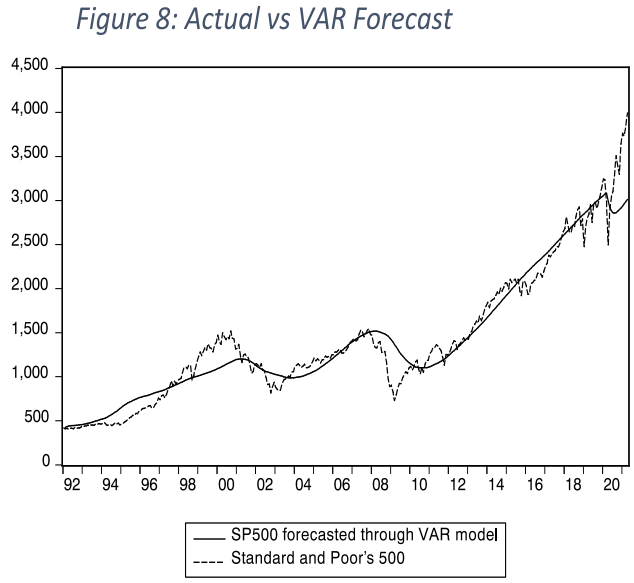
GDP can be of benefit in increasing the forecasting power of our model as most industries are procyclical in nature, doing well when the economy does well. Unemployment rate can affect the purchasing power and investment attitudes of the populace, affecting stock prices. Beyond this, the previously predicted Money Stock, Interest Rate and Federal Spending was used so our models can emblemise the stock market price in absence of intervention.

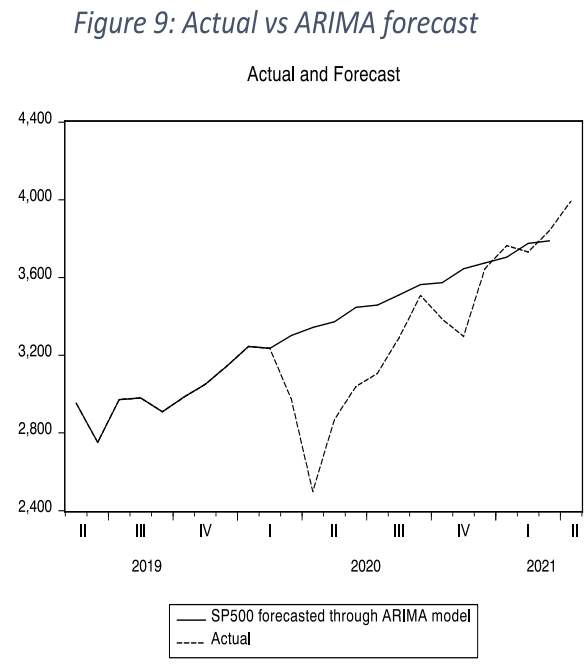
All four models were used for predicting the S&P500 prices from 2020:03 to 2021:04. Subtracting this prediction from the observed responses yields an estimate of the causal effect that the intervention had on S&P500.

Figure-6, 7, 8 and 9: Actual Vs Predicted Value of S&P500 Yielded by the Models









A final comparison of the Actual and Model-predicted S&P500 value was presented in Figure-10. The difference between the predicted and actual prices represented the causal impact. The causal impact ranged from 5% to 32% above the predicted value. Thus, whilst the exact quantitative effect could not be concluded with definite certainty, it can be strongly argued with statistical certainty that at the very least, S&P500 prices were helped in part by the expansionary fiscal and monetary policy.

Figure-10: Comparison of Actual and Model Predicted S&P500 Prices

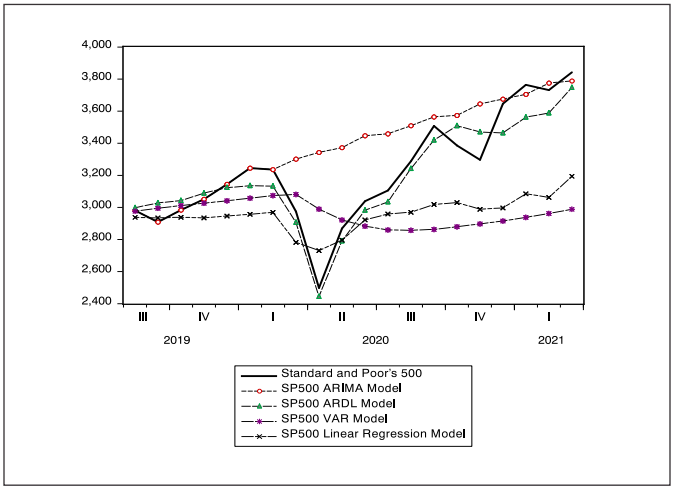


Table-9: Estimation of Causal Effect of Monetary and Fiscal Intervention on Stock Market Price

Model	$R^2$and RMSE	Adjusted R^2	Forecasted Value as On April,2021	Actual Value as On April,2021	Stock Market Price Attributable to COVID19 Stimulus	Percentage Over and Above Forecasted Value
Linear Regression	0.97	0.97	3194	3992	798	**25%**
Auto-Regressive Distributed Lag	0.99 RMSE: 83	0.99	3747	3992	245	**6.45%**
Vector Auto Regression	0.99	0.99	3012	3992	980	**32.5%**
Auto Regressive Integrated Moving Average (5,5,1,0,0)	RMSE: 46.5	-	3788	3992	204	**5.4%**

**Note: The date of April 2021 was chosen as it marked about 1 year from the onset of Covid-19*

Conclusion

The study undertook to test both the conjectures proposed by Keynesian or expected inflation hypothesis and the liquidity theory or quantity theory of money. Traditional instruments of an expansionary monetary policy, namely, increase in money supply and decrease in interest rate, were found to be causal agents of stock market prices. A Vector Error Correction Model based Granger causality revealed presence of unilateral causality from Money Supply and Government Expenditure to Stock Prices. Bilateral causality was established between inverse of interest rates and stock market prices. Similar stochastic trend was found in fiscal expenditure, money supply, and inverse of interest rate through a VAR based cointegration test and ARDL based F-Bounds'test.

Having found long-run and short-run causal relationships, the study set out to find - whether the Covid-19 monetary policy in form of Quantitative easing caused a structural break in the Money Supply ↔Stock market price relationship. Through the Chow's Breakpoint test, a structural break was indicated. Intervention analysis in an R-Studio environment also indicated the mean level of S&P500 prices changed after the Covid crisis and the pandemic response.

Having established macroeconomic variables as causes of Stock market prices, predictive forecasting was carried out through ARIMA, VAR, ARDL and OLS models. All four models were used for predicting the S&P500 prices from 2020:03 to 2021:04. Subtracting this prediction from the observed responses yields an estimate of the causal effect that the intervention had on S&P500.The causal effect ranged from 5% to 32% above the forecasted value. For this reason, whilst the exact quantitative impact couldn't be concluded with definite certainty, it could be strongly argued with statistical backing that S&P500 prices have been helped in component through the expansionary fiscal and economic policy.

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