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G.K., Chetan Kumar and K.B., Rangappa and S., Suchitra

Department of Studies in Economics, Davangere university,
Department of Studies in Economics, Davangere University,
Department of Studies in Economics, Davangere University

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Normative Analysis of the Impact of COVID-19 on Prominent Sectors of Indian Economy by Using ARCH Model

G.K. Chetan Kumar, Research Scholar, Department of Studies in Economics, Davangere University
Dr. K.B. Rangappa, Professor, Department of Studies in Economics, Davangere University
Dr. Suchitra S, Professor, Department of Studies in Economics, Davangere University

Abstract: *Covid-19 has adversely affected all the nations and all the sectors of all nations. However, the effect of the same on all the sectors of the economy need not be uniform. Moreover, the severity of impact need not be the same across consequent waves. Knowing the severity of the impact across the waves as well as across the time periods shall be quite useful for the purpose of policy formulation. ARCH Modelling helps us to gauge the intensity of shocks sustained across the sectors through heteroscedasticity which can be read as a proxy for shock. To understand the severity of shock across the sectors, the share value of the prominent companies across the sectors have been taken as a proxy for their performance. Evaluating the severity of shocks across the sectors shall help the government to note which sector needs greater support so as to create conducive fiscal and monetary initiatives to enable the economy to achieve the state of normality. This paper is designed to bridge the aforementioned research gap.*

Keywords: Covid-19, ARCH Models, Volatility, Share Market Prices, Impact on Sectors, Implications on Government Policies

JEL Classification: C22, F63, F65, F68.

1. Introduction

Covid-19, pandemic has caused severe disruption in the working of entire global economy by creating shocks in demand and supply chain. On one hand, there has been disruption in demand because of the disruption caused to the purchasing power of masses by the pandemic induced lockdown. On the other hand, due to the demand shock, it has created subsequent supply shock in the economy as well. The severity of impact across the globe could be seen in 3 phases. Initially China became the epicenter of the pandemic, Gradually Italy, UK, France became the epicenters of the pandemic. In the next phase the brunt of the pandemic was severely felt by the economies of United States of America and India. Given the scarcity of resources and the severity of the burden of the pandemic, Indian economy implemented lockdown spanning 7 to 8 months in the first wave and 3 to 4 months in the second wave. This, needless to say has adversely affected all the sectors of the economy. Although the scale and intensity may vary across various sectors, it is pertinent to quantify the same, to understand the severity of the shock across the sectors. This has important policy ramifications at various levels. To begin with at macro level, the Central and State Governments can be in a better position to understand the severity of impact of covid-19 across various sectors so as to take measures to mitigate the adverse impact of the same. Moreover, understanding the severity of impact across the sectors can also enable the Government at national level to safeguard the interests of the said sectors while discussing terms of trade at international level in near future.

Our paper at hand focuses on analyzing the adverse effect of covid-19 across Indian Economy. It is widely known and acknowledged that, the pandemic by shutting down the economy has adversely affected the purchasing power of masses which in turn has reduced the aggregate demand, thereby adversely affecting the production and investment cycle across all the sectors. However, at the same point of time having a general idea of how much the pandemic has affected various sectors in terms of intensity in first wave and the second wave is not only going to help the policy makers to identify the resilience of various sectors to demand shock, but it is also going to help them to analyze the effectiveness of the policy initiatives undertaken by the Government to help the sectors to recover. The paper also aims to identify the measures which could be taken by the Government to further enhance the resilience of the sectors so as to make them less vulnerable for the aforesaid type of shocks. The findings of the study are aimed to throw light on the repercussions of covid-19 on the economy which can be used by important stakeholders like policy makers, market participants, portfolio managers and investment bankers to take appropriate decisions.

To measure the volatility across sectors the paper has taken the share prices of the prominent private and public companies across the sectors as a proxy for measuring the adverse impact of COVID-19 on Indian Economy which has been empirically analyzed by ARCH modelling technique.

2. Literature Review

COVID-19 has created a severe financial and health crisis across the Globe (Mario Arturo Ruiz Estrada, 2020, Gao, X., Ren, Y., & Umar, M., 2021). Some of the literature has likened the impact of the pandemic to be of a magnitude similar to that of great depression of 1930s. While the comparison may be debatable, one cannot shy away from the fact that, the pandemic has adversely affected all the sectors. Understanding the impact of the same would be pertinent in relevant policy formulation. Share market has been seen as a barometer for the movement of economic activities at macrolevel. The performance of share prices of prominent companies in Industries can be used as a proxy to understand the health of the given sector. (F. Black, 1976., L. R. Glosten, R. Jagannathan, D.B. Nelson, 1991 and D. Runkle, 1993) In the context of Indian economy, fluctuations in share values across the sectors can be inferred by analyzing the trends in stock indices like National Stock Exchange (Nifty) or Bombay Stock Exchange-Sensex.

ARCH and various variants of GARCH models have been widely used by previous studies for understanding the impact of COVID-19 on share market. (Alfaro, L., Chari, A., Greenland, A. N., & Schott, P. K., 2020, Ashraf, B. N. ,2020, Baig, A. S., Butt, H. A., Haroon, O., & Rizvi, S. A. R. ,2021) Some studies have also tried to understand the impact of natural disasters on the performance of share market by constructing various variants of ARCH and GARCH models (Ruiz Estrada, M. A., 2020, Schoenfeld, J., 2020, Fomby T, Ikeda Y, Loayza NV, 2013, Susana Ferreira and Berna Karali., 2015). Needless, to say such studies which have been undertaken at earlier level have shown that the natural disasters have adversely affected the performance of share markets. (Skidmore M, Toya H., 2002; Ramelli, S., & Wagner, A., 2020) Even recent studies have used similar econometric tools to understand the impact of Covid-19 on performance of share markets of China, which of course has been negative.

There can be no second thought that, the effect of COVID-19 has adversely affected on various sectors on the world economy (Ruiz Estrada, M. A., 2020, Schoenfeld, J., 2020). In no uncertain terms, the prominent capital markets were adversely affected by the global pandemic which was duly reflected in respective indices of capital market worldwide. However, knowing the

problem exists is one thing and knowing the severity of the problem is other. Since the effect of the pandemic across the sectors will not be even, the measures which needs to be taken by the government across the sectors need not be even as well. Moreover, when it comes to Indian Economy, the contributions of the sectors are highly skewed. The most prominent sector in Indian economy is the Service Sector which contributes nearly 54 percent of the gross domestic product while employing 32.28 percentage of the workforce, while Industry contributes nearly 26 percent to the nation's GDP while employing 25.12 percentage of workforce while Agriculture contributes nearly 20 percent to the nation's GDP while employing 42.6 percent of India's workforce. Agricultural sector has been relatively robust and immune to the adverse impact of the pandemic. However, it was the Industrial and service sector which were severely affected from the pandemic, which together contributes to nearly 80 percentage of Gross Domestic Product. The blatant contraction of the two sectors is reflected in the contraction of Indian GDP by nearly 24 percentage in the wake of first COVID-19 wave which was severely experienced from the period of March 2020 to mid-September 2020, in which the entire nation was under lock down. This severely affected both service sector and Industrial sector. The second wave's impact was profoundly felt from the month of beginning of March 2021 to the late of August 2021. However, the second wave in terms of devastation on human life was more severe, particularly due to shortage of medicines and hospitals. The impact was profoundly felt in industrial and service sector. This shock in the macroeconomic variables is reflected in the finance market indices as well.

3. Research Gap

Although it is evident that the pandemics effect has been severely felt across all the sectors, it will be pertinent to know the intensity of shock across the sectors. This shall enable the Government to formulate appropriate policies to utilize the scarce resources to promote necessary sectors so as to help the economy recover. The research tries understand the intensity and severity of shock spread across the sectors so as to bring out implications concerning policy formulation.

4. Hypotheses

In the hindsight, it seems that the severity of shock will be more on Industrial sector as compared to financial or Service sector as Industrial sector depends prominently on domestic demand as opposed to service sector whose demand would seem to be more resilient due to diversified markets and relatively higher global presence. Hence the hypotheses for the given research is formulated as under:

1. Severity of shock will be more pronounced in Industrial Sector as opposed to Service sector.
2. Severity of Shock due to adverse effect of COVID-19 will be more pronounced in case of Companies which are less diversified than the companies which are more diversified.

5. Research Methodology

The objective of the research paper is to analyze the intensity of the adverse impact of the pandemic on various sectors of the Indian Economy. For reaching the aforesaid objective, to begin with we acknowledge that the Financial Market Indices like NSE-NIFTY or Bombay Stock Exchange SENSEX, can be considered as barometers for the performance of the economy. Based on the market capitalization, we identified three prominent companies in Industrial Sector, Financial Sector and Service sector for the purpose of analyzing the trends in

their share values over a period spanning two years from March 10th 2018 to March 10th 2021 which was collected on daily basis. In Industrial Sector the three companies which has been chosen based on their share value and market presence were Maruti Suzuki which is the largest car manufacturer in India (Mukherjee & Sharmistha 2020), Ultra Tech Cement which is the largest grey cement manufacturer in India and Tata Steel which is the second largest steel producer in India. To assess the repercussions on the pandemic on Financial sector the chosen banks were State Bank of India which is the largest Public Sector Bank in India which also the only public sector bank which is listed in fortune 500 companies., Canara Bank which is the third largest Nationalized Bank in India, Bank of Baroda, which is the second largest Nationalized Bank in India (Business Today,2019). Finally, to assess the impact on Service Sector the prominent companies which were chosen were Tata Consultancy Services which is the largest Information Technology Service company in the world by Market Capitalization, Tech Mahindra which has its presence in 90 countries and which is also the 5th largest IT company in the world, HCL Tech, which is in the Forbes Global 2000 list and which is among the top 20 traded public companies in India with a market Capitalization of 50 billion dollars as of September 2021.

To analyze the impact of pandemic's shock in the course of two waves we have been built stable ARCH models for the 9 companies chosen across the three sectors. Before dwelling into the intricacies and stability of the model, a brief introduction to the Concept of volatility and ARCH Model becomes relevant.

A. Volatility

Volatility being one of the measures of dispersion, helps in assessing returns for a given particular security or market index. The concept of volatility in terms of financial market can be understood as measurement of risk. If volatility is more, it means the security is subject to greater amount of risk and vice-versa. (McAleer. M. and M.C. Medeiros,2008) The macroeconomic indicators play a vital role in affecting the volatility in Bombay Stock Exchange or National Stock Exchange. Since pandemic has adversely affected the macroeconomic indicators, the effect of the same is going to be reflected in BSE and NSE as well, hence for the purpose of research they are regarded as barometers of economic performance. Now, when we assess the volatility of prominent companies across the chosen sectors, juxtaposing them during the period of pandemic, we will be able to assess the adverse shock created by Nation Wide lockdown which was imposed in the backdrop of pandemic waves in the span of two years. To assess the impact of shock in the chosen Time Series ARCH Model has been used.

B. Auto Regressive Conditional Heteroscedasticity Model

ARCH is an econometric tool used to analyze the residual result which is left unexplained by other econometric models which is represented by the error term. ARCH models are effectively used to model time varying volatility and volatility clustering in financial time series (Bollerslev, T.,1986, Engle, R.F. ,1982, Caporin, M. and M. McAleer, 2008, Mishra, S.,2017) Before constructing ARCH models, first we have to ensure that there is presence of ARCH effect in the chosen time series. The ARCH effect basically implies that periods of low volatility tends to be followed by periods of low volatility over a prolonged period of time and period of high volatility is followed by the period of high volatility over a prolonged period of time. It is to be noted that ARCH type models are different from stochastic volatility models

since at any given point of time ‘t’, the volatility is pre-determined, given, the previous values (Asai, M., M. McAleer and J. Yu, 2006) ARCH (1,1) model has two equations. One is the Conditional Mean Equation which is represented as:

$$Y_t = \alpha + \beta X_t + \varepsilon_t \quad \dots\dots\dots (1)$$

$$\text{Wherein } \varepsilon_t | \varepsilon_{t-1} \sim N(0, \sigma_t^2)$$

And the variance Equation is represented as:

$$\sigma_t^2 = \omega + \sum_{i=1}^p \delta_i \varepsilon_{t-i}^2 \quad \dots\dots\dots (2)$$

In Equation 1, ε_t is the error generated from the mean equation at time t and σ_t^2 is the conditional variance equation. The conditional mean equation shall be helpful in forecasting, whereas the conditional variance equation shall be helpful in observing the volatility or shocks in the given time series.

Residual Diagnostics to Check the stability of the model: In order to ensure that the ARCH model which is built for the given time series is stable, there are 2 important conditions which needs to be satisfied. The first and foremost being absence of autocorrelation in the model. This can be verified with the help of Durbin-Watson Statistic whose value must be close to two and Q statistic. In Q statistic, the probability of standardized residual value must be insignificant, implying there is white noise in the model. The next important residual diagnostic for ensuring the stability of the model is to ensure absence of heteroscedasticity. For ensuring absence of heteroscedasticity in the final model, we can go for ARCH-LM test. The null hypothesis for the test is that there is absence of heteroscedasticity in the model. If the probability value of the relevant test statistic is insignificant, then we will not be having enough evidence to reject the null hypothesis and we can infer that there is absence of heteroscedasticity in the final model.

6. Results and Discussion

The objective of the research paper was to examine the intensity of the volatility with the help of ARCH modelling across financial, service and industrial sectors by analyzing the volatility of share prices among prominent three companies chosen in each sector based of their market capitalization.

A. Financial Sector:

To understand the repercussion of the pandemic wave on financial sector, 3 prominent banks were chosen, which were namely State Bank of India, Canara Bank and Bank of Baroda. The ARCH equation and conditional variance graph for the respective banks are illustrated in Tables 1,2, and 3 along with Figures 1,2, and 3 respectively.

Table 1: Representing the ARCH (1,1) model for State Bank of India

Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(2)	0.029	0.038	0.76	0.44
MA(5)	0.076	0.034	2.19	0.02
Variance Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0005	2.96E-05	19.00	0.00
RESID^2(-1)	0.1715	0.042	4.00	0.0001

Figure 1: Representing the volatility in Closing Prices for State Bank of India along with conditional Variance



Table 2: Representing the ARCH model for Canara Bank

Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(5)	0.114	0.027	4.07	0.00
MA(6)	-0.146	0.026	-5.59	0.00
Variance Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0006	3.05E-05	22.19	0.00
RESID^2(-1)	0.2874	0.042	6.72	0.00

Figure 2: Representing the volatility in Closing Prices for Canara Bank along with conditional Variance

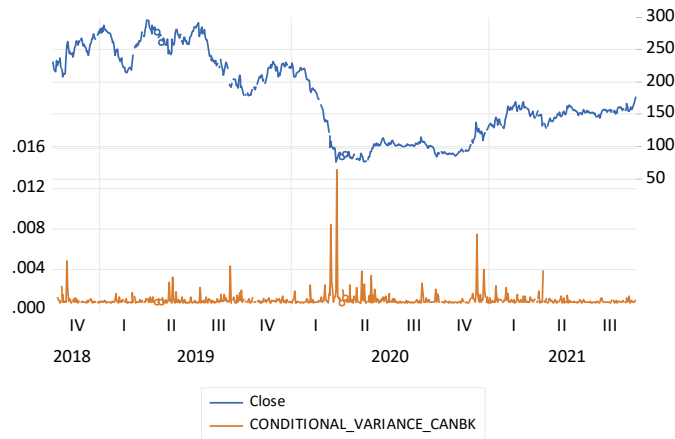


Table 3: Representing the ARCH model for Bank of Baroda

Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(5)	0.063	0.033	1.90	0.05
MA(6)	-0.077	0.029	-2.61	0.00
Variance Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0007	3.24E-05	23.69	0.00
RESID^2(-1)	0.0839	0.022	3.66	0.00

Figure 3: Representing the volatility in Closing Prices for Bank of Baroda along with conditional Variance



From the above table 1 to 3 and figures 1 to 3, representing the ARCH models of prominent banks in India, we can see that, the impact of pandemic was more severe in the first wave induced lockdown. Although in terms of life lost, the effect of second wave was more devastating, the shock of the same on the financial sector has been relatively less severe as compared to the first shock. The most prominent reason, for the same is Government was more prepared to handle the second wave from the bitter experience of lockdown initiated during the first wave. Relaxations were given to some prominent sectors like construction and transportation, which in turn created demand for finances in Money and Capital market. Moreover, due to heavy health expenditure incurred by the people in the second wave they were more prone to take credit from the money market.

B. Industrial Sector

To understand the repercussion of pandemic wave on Industrial Sector, 3 prominent companies were chosen for the purpose of analysis. They were Maruti Suzuki, the largest Car manufacturer in India, Ultra Tech Cement which is the largest grey cement manufacturer in India and Tata Steel which is the second largest steel producer in India.

The ARCH equations and Conditional Variance graphs of the three prominent companies representing Industrial sector are illustrated in Tables 4,5 and 6 along with Figures 4,5 and 6 respectively.

Table 4: Representing the ARCH model for Maruti Suzuki

Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(6)	0.46	0.24	1.89	0.05
MA(6)	-0.42	0.24	-1.73	0.08
Variance Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0003	1.42E-05	24.40	0.00
RESID^2(-1)	0.1714	0.0151	11.32	0.00

Figure 4: Representing the volatility in Closing Prices for Car Manufacturer Maruti Suzuki along with conditional Variance



Figure 5: Representing the volatility in Closing Prices for UltraTech Cement along with conditional Variance



Table 5: Representing the ARCH model for UltraTech Cement

Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(1)	-0.059	0.28	-2.08	0.03
MA(6)	-0.043	0.24	-1.76	0.07
Variance Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0002	1.07E-05	25.59	0.00
RESID^2(-1)	0.1714	0.0247	06.91	0.00

Figure 6: Representing the volatility in Closing Prices for Tata Steel along with conditional Variance



Table 6: Representing the ARCH model for Tata Steel

Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(4)	0.069	0.03	2.08	0.03
MA(5)	0.101	0.03	3.01	0.02
Variance Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0006	3.73E-05	16.54	0.00
RESID^2(-1)	0.1715	0.0434	03.94	0.00

From tables and figures 4 to 6, we observe that even Industries too had suffered severe shock in first wave and interestingly in the second wave, industries especially automobile and cement doesn't seem to have born any shock in second wave at all. Even when we analyze the shocks of steel company, we do not see any particular spike in variance during the second lockdown, although we do observe some shock, it is to be noted that it has occurred after the end of second wave which may have been due to some factors other than the pandemic. Hence, Industries seem to have borne the shock of 2nd wave of the pandemic in a more resilient manner as compared to the financial sector. This is not what was expected as, one of our hypotheses was Industries would be more severely affected by pandemic's shock across two waves due to their dependence on domestic demand. However, the resilience may be attributed to the relaxations given by Government to industrial sector during second wave of the pandemic, which have helped them to cope up with the pandemic in a more resilient manner. Hence although the market of the companies under consideration were limited to India and few other countries, due to the relaxation provided by the Government and the predominant share of the domestic market of the industries, the major players of Industrial sector were able to absorb the second wave's shock in a resilient manner.

C. Service Sector

To gauge the repercussions of pandemic on tertiary sector, three prominent service sector enterprises were taken into consideration which were namely, Tata Consultancy Services, Mahindra Tech and HCL Tech. The ARCH equations and the conditional variance graphs of these prominent enterprises are illustrated through tables 7 to 9 and figures 7 to 9 respectively.

Table 7: Representing the ARCH model for Tata Consultancy Services

Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(1)	-0.03	0.02	-1.62	0.10
MA(5)	0.08	0.02	-3.11	0.00
Variance Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0001	6.62E-05	30.01	0.00
RESID^2(-1)	0.1714	0.0313	05.47	0.00

Figure 7: Representing the volatility in Closing Prices for Tata Consultancy Services along with conditional Variance



Figure 8: Representing the volatility in Closing Prices for Tech Mahindra along with conditional Variance

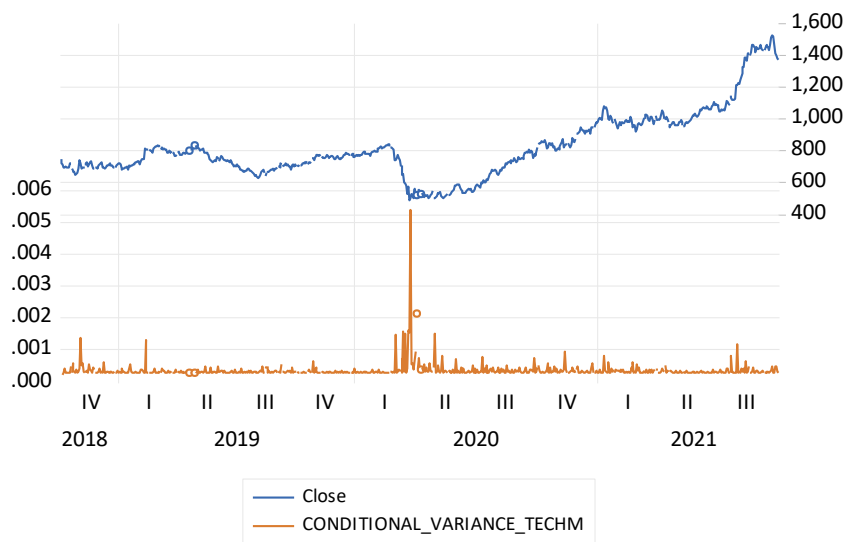


Table 8: Representing the ARCH model for Tech Mahindra

Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(1)	0.06	0.030	-1.62	0.04
MA(6)	-0.03	0.022	-1.67	0.09
Variance Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0002	1.01E-05	27.99	0.00
RESID^2(-1)	0.1714	0.0180	09.49	0.00

Figure 9: Representing the volatility in Closing Prices for HCL Tech along with conditional Variance

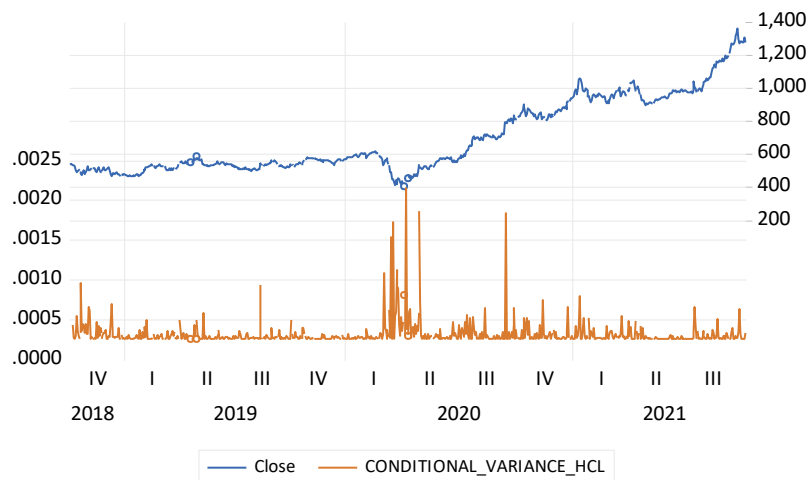


Table 9: Representing the ARCH model for HCL Tech

Variable	Coefficient	Std. Error	z-Statistic	Prob.
AR(2)	-0.04	0.023	-2.14	0.03
MA(5)	0.05	0.023	2.22	0.02
Variance Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0002	8.24E-06	30.53	0.00
RESID^2(-1)	0.1714	0.0277	06.16	0.00

According to the hypotheses framed, we assumed that, the companies which had diversified markets were relatively more resilient in facing demand shock induced by the pandemic waves as opposed to the companies which had relatively less diversified markets. Diversification of markets was measured in terms of the number of countries in which the enterprises had their subsidiaries. It was also assumed that, service sector would be more resilient as compared to Industrial sector due to their diversified base. From analysing the volatility in the share prices of the prominent enterprises we infer that the intensity of demand shock was quite severe in the first wave. However, the second wave which made its presence felt in from late 1st to early 3rd quarter of 2021 does not seem to have affected the share prices. It seems that the diversified markets of the prominent service sector enterprises have indeed enabled them to stay resilient in the face of second wave of the pandemic. It is to be noted that, the intensity of first wave was severely felt all across the world, so, despite diversification of the market, the intensity of demand shock was also felt by service sector enterprises in a significant manner.

7. Summary and Policy Implications

The objective of the paper was to analyse the intensity and impact of demand shock caused by pandemic across the prominent sectors of the economy. To analyse the same two hypotheses had been framed. One of which being the companies with less diversified markets would be more prone to demand shocks as opposed to the companies which were more diversified. However, this hypothesis although seemed right in context of service sector, did not stand true in context of Industrial Sector. It is true that service sector due to its market diversification seemed resilient in the second. However, in the first wave despite market diversification, we see Indian Service sector receiving severe shock. This may be attributed to the fact that first wave had created a global disruption across all the nations, for which none of the nations were

prepared. Hence diversification of markets, couldn't boost the resilience of service sector in the first wave. However, when it comes to second wave, globally the nations were more prepared and most of the nations had put in place adequate infrastructure to systematically deal with the pandemic. Thus, the service sector was able to leverage the diversification of its market to boost its resilience in the face of pandemic's second wave.

Although the market diversification of Industrial companies in terms of their global presence was relatively very less as compared to the global presence of Service Sector Enterprises, the big Industrial Players were able to sail through the second wave relatively smoothly due to the support which was provided to them through relaxation of rules by the Government. The relaxation of restrictions and concessions given by the Government, particularly for construction, transportation and steel production created cross industrial demand enabling these three prominent sub sectors to stay resilient in the face of second wave.

The other hypothesis of the research was that the Industrial sector would be more susceptible to demand shocks as compared to their service counterparts due to their relatively higher dependence on domestic demand. However, due to timely support and relaxations given by the Government to construction and transportation companies they were not as vulnerable as they were supposed to be during the second pandemic induced lockdown.

It is also to be noted that, across the two waves, intensity of shock to the financial sector was more severe than Industrial or Information Technology Sector.

Thus, keeping in context the backdrop of the health of prominent players of prominent sectors of the economy, the following measures, if taken by the Government shall aid in faster recovery of the economy:

1. Since, the intensity of shock was more severe in financial sector across the two waves as compared to Industrial or IT Sector, the monetary authority could employ expansionary monetary policy. This shall not only help financial sector to revert back to normalcy at a faster pace, it shall also help the economy recover faster through operation of both multiplier and accelerator effect.
2. It is interesting to observe that, due to domestic support provided by the Government in the eve of second Wave, Industry and transportation sector were able to face the demand shock in a more resilient manner. On the other hand, the improving global condition, helped to provide conducive environment for the prominent players in the Information Technology sector to remain resilient in the backdrop of second wave. Thus, in the current position, it would be rational for the Government to follow balanced approach when it comes to framing measures for putting Industrial and Service Sector in path of recovery and Growth.

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