

Economic Impact of Covid-19 on Indian Economy: Gravity Model Analysis

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Abstract

The Covid-19 pandemic has resulted in a global catastrophe in a shockingly short period of time that severely affected the lives and livelihoods of the people. The health crisis metamorphosed into an economic crisis with contraction in global demand and supply of the commodities. The global health crisis has critical impact on India's health and economy as well. Stringent lockdowns were placed throughout India to contain the Corona virus as a crucial policy response. Resultantly, economic activities almost came to a halt. Since workplaces and manufacturing processes temporarily stopped, the production of goods and services decreased. Supply chains got hugely disturbed. This gave rise to a fall in the aggregate effective demand. These disturbances to the real economy cascaded over to external and financial sectors as well. In this backdrop, this study is an analysis of the economic impact of the pandemic on the Indian economy. The research is grounded on the state-of-the-art augmented gravity model applying the Poisson Pseudo Maximum Likelihood (PPML) technique to capture empirically, the economic outcome of the pandemic on the Indian economy. This study has applied bilateral monthly exports as response variable and number of Corona positive cases & deaths and Free Trade Agreement (FTA) partnership dummies as explanatory variables. The study has used the price indices as an alternative measure for Multilateral Trade Resistance (MTR) which explains the supply and demand impacts of the pandemic on bilateral exports. The findings of this study show that there is a drastic decline in India's exports, GDP, and employment among others because of the global health crisis. The results are significant and have evident policy implications. The study

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recommends increasing public expenditure to restore and increase production capacities, employment opportunities, and invest in physical infrastructure.

Keywords: Covid-19; Pandemic; Exports; Gravity Model; PPML; Multilateral Trade Resistance (MTR)

JEL Classification Codes: F10, F13, F14, I10

1. Introduction

The Corona virus induced pandemic has resulted in a global catastrophe in a startlingly short span of time which severely impacted the lives of the masses and eventually their livelihoods. Covid-19 severely affected the global economy. The pandemic hit the world in the early months of the year 2020. To curb the rapidly spreading Covid infections, it became necessary to impose lockdowns globally. During winters, a second lockdown was also imposed. The economic crisis stimulated by the Covid-19 pandemic was evident by an autonomous and contemporaneous fall in demand and supply globally (Ramakumar and Kanitkar, 2021). The health crisis transformed into an economic crisis with contraction in global demand and supply of commodities other than medicines, health-hygiene & toiletries. Covid-19 generated an economic crisis that affected all the areas of the economy. Drastic disruptions in global supply chains, shutting down of shops, weak demand for non-food commodities and declining production prices have visualized and deepened the cracks in the economic system.

The global health crisis has grave impact on India's health and economy as well. Stringent lockdowns have been placed through India to contain the Corona virus as a crucial policy response. Resultantly, economic activities almost came to a standstill. Since, workplaces and manufacturing processes temporarily stopped, the production of goods and services decreased. Supply chains got hugely disturbed. Simultaneously, the demand side also got affected. Numerous people lost their jobs and livelihoods because of the closing of the commercial entities. This gave rise to a decrease in the aggregate effective demand too.

These disturbances to the real economy cascaded over to external and financial sectors as well. In a nutshell, the pandemic which has started as a health crisis, enlarged into a global economic crisis (Dev and Sengupta, 2020; Beyer, Franco-Bedoya and Galdo, 2020).

This study tries to encapsulate the effect of the Corona pandemic on the Indian economy through exports, gross domestic product (GDP), and employment. The major objective of this study is to understand the economic impact of the pandemic on Indian economy and suggest measures for long term economic growth and development.

The rest of the paper has the following structure. Relevant literature has been reviewed in Section 2. Methodology is discussed in section 3 and data sources in Section 4. Section 5 highlights the findings and analysis. Conclusion of the paper is summed up in section 6.

2. Literature Review

Recent works during pandemic and in the aftermath of the pandemic, estimating the impact of Covid-19 can be classified in mainly two categories. Some studies have analyzed the economy wise impact, while another set of studies have observed the impact at the commodity level or sector wise (Petryle, 2022).

Dev and Sengupta (2020) investigated the likely impact of Covid-19 pandemic on the Indian economy. The financial health of the economy is likely to be hugely disruptive. However, the actual damage to the economy will depend on the severity of the pandemic and might be worse than current estimations. Moreover, it's too early to conclude the impact of the pandemic, the government's role become decisive and effective implementation of the policies are crucial given the severity of the pandemic. Barbate, Gade and Raibagkar (2021) studied the probable short term and the long-term effect of Covid-19 on the Indian economy by adopting a decision-tree² approach for the predictions. Major economic variables are projected to decline sharply during 2020-21 including GDP growth, base lending rate and

² In decision tree approach usually three possibilities are assumed as 'best', 'middle' and 'worst'. Combining values of the three scenarios, probabilities are estimated and expected values are calculated considering equal chance for all the three scenarios.

industrial production index. Unemployment and inflation are likely to increase during the same period. The study concludes that recovery will be dependent on the approach towards recovery -strong, moderate, and weak.

Khorana, Martínez-Zarzoso and Ali (2022) examined the impact of the Corona pandemic on intra Commonwealth³ exports as well as world exports. The research has employed the gravity model for estimating the effects considering the new cases and death by Covid-19. The findings confirm the adverse impact of the pandemic on Commonwealth exports. Zainuddin, Khairuddin, and Hamidi (2022) investigated the impacts of Corona pandemic on bilateral exports of Malaysia in three commodity categories-consumption goods, capital goods and intermediate goods. In case of capital and consumption goods, the increasing number of Corona positive cases in the trading partners of Malaysia resulted in increased bilateral exports. However, in case of capital goods, strict policy stringency index⁴ in the partner country has played significant role in lowering the bilateral exports. Barbero, de Lucio, and Rodríguez-Crespo (2021) explored the effects of Corona pandemic on bilateral exports applying the gravity modelling. The study has included 68 countries exporting to 222 countries based on monthly exports data availability. The observation confirmed that regional trade agreement (RTA) partner countries were affected more negatively on the bilateral trade front. The study also found that government measures negatively affected the trade flows, and it is more severe in situations where exporting and importing nations have similar levels of income. A study by Masood, Ahmed, and Martínez-Zarzoso (2021) assessed the effect of the pandemic on bilateral imports and at the commodity level for fruits and vegetable products applying the structural gravity modelling technique with PPML estimator. The study confirmed the negative effect of Covid-19 for OECD countries on both measures of imports. Davidescu, Popovici, and Strat (2022) examined the trade patterns of Romania with the world and with China employing the gravity model. It is concluded that export from Romania is susceptible to the reduction of demand on the markets of its 12 major European Union partners. Moreover, the effect of the global health crisis has been analyzed by utilizing

³ Commonwealth countries include 56 countries currently, however, at the time of this study 54 countries are part of it.

⁴ The stringency index is a composite measure based on nine response indicators including school closures, workplace closures, and travel bans, rescaled to a value from 0 to 100 (100 = strictest).

simulation forecasting situations considering character of the recovery and type of shock spread throughout countries.

Mostly, the studies are limited to either trade or exports and imports in aggregate or at the selected commodities level. Moreover, studies are confined to the world. The study on the impact of the pandemic on Indian economy remains scanty and limited to the potential likely impact of Covid-19. This study is an attempt to fill this gap by encapsulating the real effect of the pandemic on Indian economy.

3. Methodology

The gravity model has been used in this study for estimating the impact of Covid-19 on India's exports. The gravity modelling employed for economic interactions is homologous to Newton's law of physical attraction. It states that any two bodies in this universe attract each other, the magnitude of this force is directly associated with the product of their masses and inversely to the square of the distance between their centers. Taking extracts from Newton's equation for gravitation, Tinbergen (1962) employed Newton's gravitational concept for forecasting international trade. Mathematically, this force of mutual interaction can be expressed by:

$$X_{ij} = \beta_0 \frac{Y_i^{\beta_1} Y_j^{\beta_2}}{D_{ij}^{\beta_3}} \dots \dots \dots (1)$$

Where,

X_{ij} = Spatial interaction from i to j

β_0 = A constant

Y_i = Size of the variable i

Y_j = Size of the variable j

D_{ij} = Spatial remoteness between Y_i and Y_j

β_1, β_2 and β_3 = coefficients

Log-linear conversion of equation (1), yields equation (2).

$$\ln X_{ij} = \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln D_{ij} \dots \dots \dots (2)$$

Here, X_{ij} denotes exports from economy i to economy j , Y_i and Y_j are the GDPs of economies i and j , respectively, D_{ij} is the geographical distance separating economies i and j . β_1, β_2 and β_3 are coefficients that are estimated in the model. The estimated value of β_1 and β_2 are positive, however β_3 will be negative.

The gravity modelling has become empirically tested method for assessing trade, free trade agreements, tariff, custom unions, tourism, and migration. Since the application of gravity model by Tinbergen (1962) and afterward Pöyhönen (1963), it has been extensively used for empirical economic research. Linnemann (1966) has been credited for extending the basic gravity model to explain the patterns of trade. Other economists like Anderson (1979) applied the gravity model for estimating and explaining trade patterns. Bergstrand (1985, 1989) empirically utilized gravity formulation for predicting international trade. The gravity model with extended form including time dimension can be expressed by Equation 3.

$$\ln X_{ijt} = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln P_{it} + \beta_4 \ln P_{jt} + \beta_5 \ln D_{ij} + \beta_6 E_{ijt} + \beta_7 Adj_{ij} + \beta_8 CLang_{ij} + \beta_9 FTA_{ijt} + \beta_{10} COVID_{it} + \beta_{11} COVID_{jt} + e_{ijt} \dots \dots \dots (3)$$

Here,

- X_{ijt} = Export from economy i to economy j in time t
- Y_{it} = GDP of economy i in the year t
- Y_{jt} = GDP of economy j in the year t
- P_{it} = Population of economy i in the year t

- P_{jt} = Population of economy j in the year t
- D_{ij} = Distance between capital/major cities of economy i and j
- E_{ijt} = Exchange rate between currencies of economies i and j in year t
- Adj_{ij} = An indicator binary variable called Adjacency having the value of 1/0, in case economies i and j share a common border or not respectively
- $CLang_{ij}$ = An indicator binary variable having the value of 1/0, in case economies i and j having the same official language or not respectively
- FTA_{ijt} = An indicator variable which has binary values 1/0, included to empirically estimate the trade creation and trade diversion between economies i and j (both are partners of the same FTA) respectively in the year t
- $COVID_{it}$ and $COVID_{jt}$ = No. of Covid-19 cases/deaths in the economies i and j respectively, at time t
- β_0 = Slope intercept
- e_{ijt} = Random disturbance term

The ordinary least squares (OLS) approach can be used to estimate the parameters of the gravity model. However, the probable heterogeneity under OLS estimation yields biased coefficient estimates. Likewise, panel data method involves the use of Fixed Effects (FE) or the Random Effects (RE) model for determining the coefficient estimates. Nevertheless, the parameters of the explanatory variables that remain constant cannot be estimated under the FE model. Admitting the fact that trade data includes substantial zero values, and presence of heteroskedasticity, Santos Silva and Tenreyro (2006) suggested using the PPML estimation method. With the purpose of accounting for trade costs, normally distance was used. Subsequently, adjacency, common official language, etc. are also integrated in the underlying gravity model. Anderson (1979) developed the Multilateral Trade Resistance (MTR) approach in the gravity framework. According to Anderson and van Wincoop (2003) using distance, common language, colonial ties, adjacency, etc. are not appropriate substitutes for trade costs. Subsequently, this study has used the monthly Covid cases/deaths as explanatory variables, considering the work by Khorana, Martínez-Zarzoso and Ali (2022), consumer

price index (CPI) has been embodied in the gravity model as a proxy for MTR since the CPI data are available at the monthly basis. The estimated equation using PPML in this study is:

$$X_{ijt} = \exp\{\beta_0 + \beta_1 \ln \text{COVID_NC}_{it} + \beta_2 \ln \text{COVID_NC}_{jt} + \beta_3 \ln \text{COVID_ND}_{it} + \beta_4 \ln \text{COVID_ND}_{jt} + \beta_5 \ln \text{CPI}_{it} + \beta_6 \ln \text{CPI}_{jt} + \beta_7 \text{FTA}_{ijt} + e_{ijt}\} \dots \dots \dots (4)$$

Where,

COVID_NC_{it} = No. of new Covid-19 cases in the economy i, in month t

COVID_NC_{jt} = No. of new Covid-19 cases in the economy j, in month t

COVID_ND_{it} = No. of new Covid-19 deaths in the economy i, in month t

COVID_ND_{jt} = No. of new Covid-19 deaths in the economy j, in month t

4. Data Source

With the purpose of calculating the parameters of the gravity model, 10 largest export partners of India are included. Data on bilateral exports are extracted from the International Monetary Fund (IMF) Direction of Trade Statistics (DOTS). Covid-19 new monthly cases and monthly deaths during April 2020 to March 2021 have been retrieved from the World Health Organization (WHO) Covid-19 dashboard. The author has constructed the FTA indicator variables from the data accessible from the World Trade Organization (WTO) Regional trade Agreements (RTA) Database. Monthly consumer price index (CPI) data has been compiled from FAOSTAT.

5. Results and Analysis

Global economy fell sharply with declining GDP, exports, and imports. Indian economy also witnessed huge decline in GDP and trade. Table 1 implies GDP growth and trade GDP ratio globally and for India. Global GDP growth declined to 3% (negative) in 2020, which was positive prior to the pandemic. During 2020, the GDP growth of India declined sharply to 6.6% (negative). Moreover, trade to GDP ratio also declined to 52.2% globally and 37.8% for India in 2020.

Table 1: GDP Growth Rates and Trade GDP Ratio

Year	GDP Growth (World)*	GDP Growth (India)*	Trade GDP Ratio (World)**	Trade GDP Ratio (India)**
2018	3.6	6.5	57.6	43.6
2019	2.8	3.7	56.3	40.0
2020	-3.0	-6.6	52.2	37.8
2021	6.0	8.7	56.5	45.3
2022	3.1	7.2	63.0	49.0

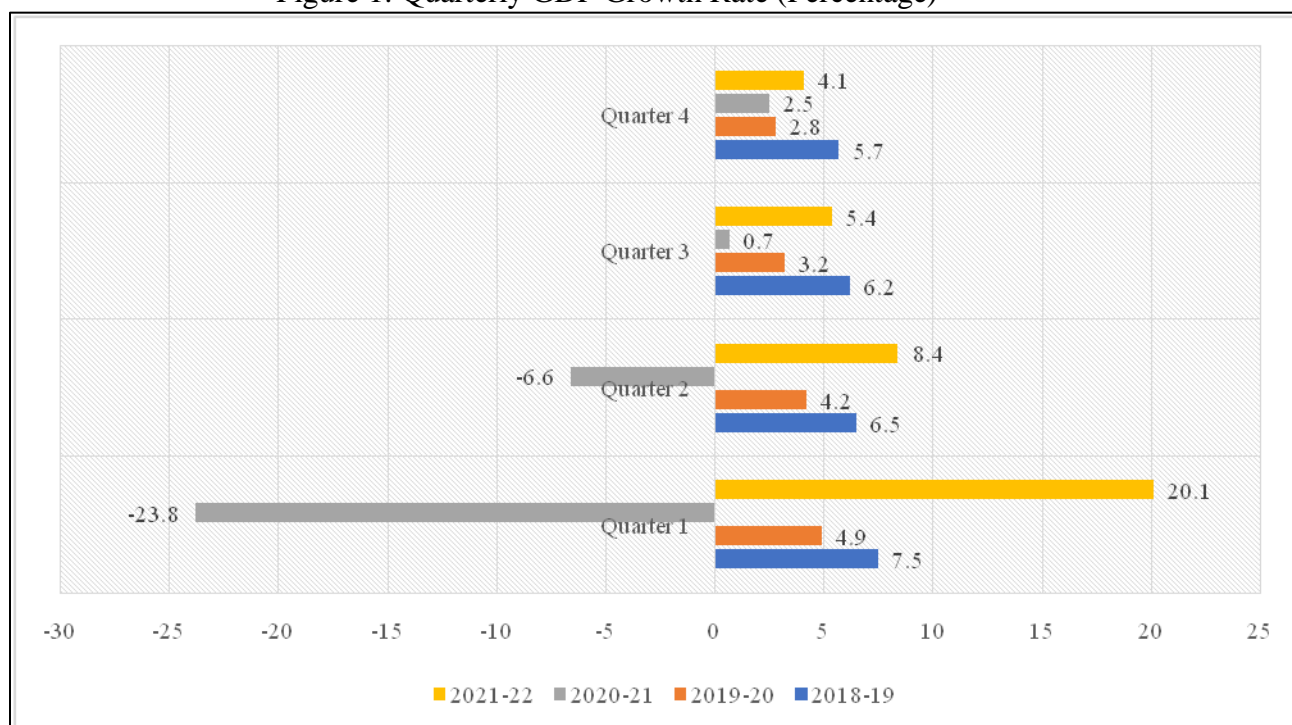
Source: *World Development Indicators (2024); **World Bank (2024)

Quarterly GDP growth and employment scenario of India is shown in Figure 1, Table 2, and Table 3. GDP growth in all the four quarters during 2018-19 to 2021-22 is shown in Figure 1, which clearly visualizes the effect of Covid-19. During the first quarter (Q1) of 2020-21 (April-June 2020), there is a humongous decline in the GDP of India to the tune of (-) 23.8%. Further, during the second quarter (Q2), with some easing, the GDP declined to (-) 6.6%. However, in the third (Q3) and the fourth quarter (Q4), the GDP growth was 0.7% and 2.5% respectively.

The job losses in India were huge during the lockdown period. Unemployment increased during the lockdown to the tune of 20.8 percentage points during April-June 2020 (Table 3). There witnessed a sudden spike in employment demand in rural areas as workers/migrant laborers returned to their villages, which is reflected through Mahatma Gandhi National

Rural Employment Guarantee Act (MGNREGA)⁵ work demanded in Figure 2. During the months of May and June 2020, the demand for MGNREGA work increased to 5.4 and 6.4 crores respectively, which were 2 crores in April 2020. This is due to the job losses to daily/informal/contractual wage earners and factory workers owing to the shutdown of factories/production facilities and lockdown imposed throughout India.

Figure 1: Quarterly GDP Growth Rate (Percentage)



Source: MOSPI (2023)

India's external sector witnessed contraction in connection with the global collapse in demand of many products with exception to certain commodities. Table 4 visualizes the cracks in the trade situation of India, with contraction in exports, imports, and total trade during 2019-20 and 2020-21. Total merchandise exports growth declined to a tune of more than 5% in 2019-20 and around 7% during 2020-21. Similarly, imports declined to 7.6% and

⁵ It is an Indian social welfare scheme which guarantees 'right to work' that provide livelihood security of the households in rural areas by providing at least one hundred days of guaranteed wage employment.

16.9% during the same periods. This decline was reflected in the total trade, which dropped to 6.6% and 12.9% during 2019-20 and 2020-21 respectively.

Table 2: Monthly Urban Unemployment Rate

Month	Unemployment Rate
Jun-19	8.9
Sep-19	8.4
Dec-19	7.9
Mar-20	9.1
Jun-20	20.9
Sep-20	13.3
Dec-20	10.3
Mar-21	9.4
Jun-21	12.7
Sep-21	9.8
Dec-21	8.8
Mar-22	8.2

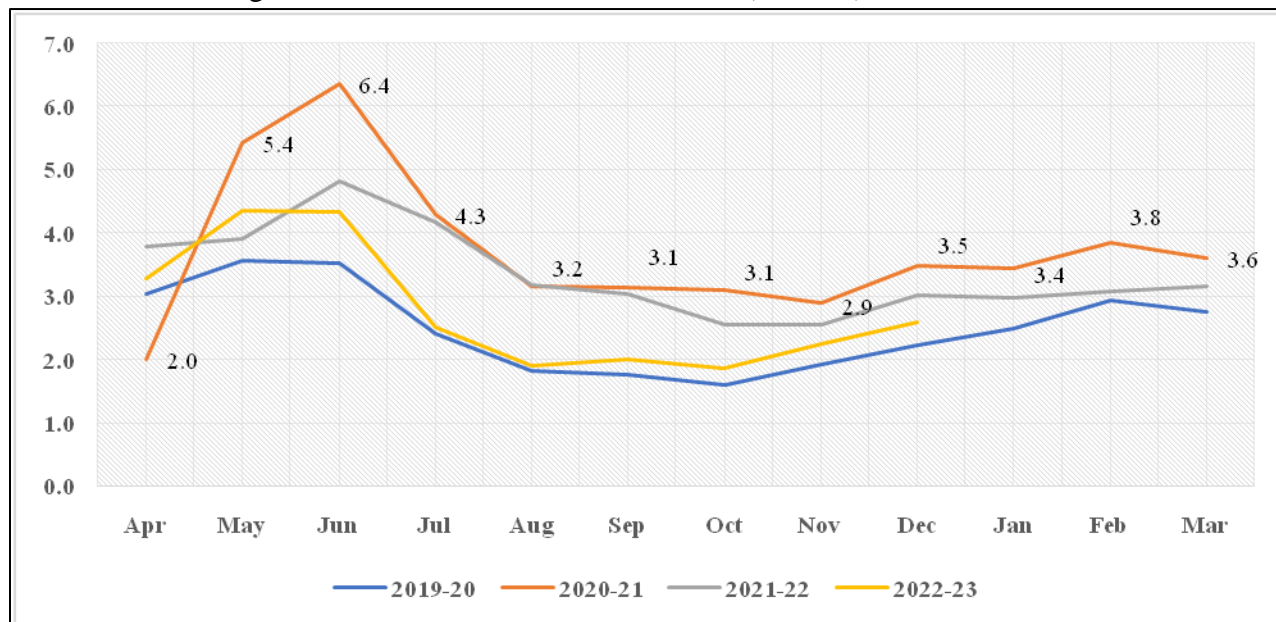
Source: Economic Survey (2022-23)

Table 3: Quarterly Urban Unemployment Rate

Quarters	Unemployment Rate
Jan-Mar 2019	9.2
Apr-Jun 2019	8.8
Jul-Sep 2019	8.3
Oct-Dec 2019	7.8
Jan-Mar 2020	9.1
Apr-Jun 2020	20.8
Jul-Sep 2020	13.2
Oct-Dec 2020	10.3
Jan-Mar 2021	9.3
Apr-Jun 2021	12.6
Jul-Sep 2021	9.8
Oct-Dec 2021	8.7

Source: Economic Survey (2022-23)

Figure 2: MGNREGA Work Demanded (Persons) in Crores



Source: MGNREGA Portal (2023)

Table 4: Trade Growth of India

Year	Total Exports (US \$ Million)	Growth %	Total Imports (US \$ Million)	Growth %	Total Trade [#] (US \$ Million)	Growth % [#]
2017-18	303526.16	10.03	465580.99	21.13	769107.15	16.49
2018-19	330078.09	8.75	514078.42	10.42	844156.51	9.76
2019-20	313361.04	-5.06	474709.28	-7.66	788070.32	-6.64
2020-21	291808.48	-6.88	394435.88	-16.91	686244.36	-12.92
2021-22	422004.40	44.62	613052.05	55.43	1035056.45	50.83
2022-23	451,070.00	6.89	715,968.90	16.79	1167038.90	12.75

Source: Department of Commerce (2024); [#] Author's calculation

Table 5 presents the outcome of estimated parameters of explanatory variables of the gravity model. First, I took into consideration the estimation based on the OLS. To determine

whether or not unobserved heterogeneity pertaining to month and country-pairs guides the results, I also turned to ordinary least squares with fixed effects method. Subsequently, equation 4 is estimated applying PPML method including the month and country-pairs with fixed effects technique. PPML allows for addressing the twin issues of zero trade values as well as heteroskedasticity.

OLS estimates with the likelihood of heteroskedasticity, and unobserved heterogeneity gives biased estimates, PPML method is used. The F-test is performed to validate the likelihood of unobserved heterogeneity for the combined significance of month and country-pair dummies. Thus, country-pair and time fixed effects are included in the benchmark model to check the problem of unobserved heterogeneity. Results with PPML fixed effects show that $COVID_NC_{it}$ coefficient estimate is negative, however, it is insignificant. In addition to, $COVID_NC_{jt}$ coefficient is positive, and it is significant meaning that the exports increased for the destination where there is an increase in the monthly Covid cases. This may be explained on account of the lockdowns and shutdown of the domestic production capacities, but demand for commodities still prevailed. Again, the coefficient estimates for $COVID_ND_{it}$ is negative and significant and for $COVID_ND_{jt}$ is positive and significant. In connection with the shutdown of the local production facilities (spike in monthly Covid deaths) the domestic production of goods declined, however given the demand for certain goods in the destination (partner country), the export from origin to the destination increased with surge in monthly Covid deaths. The parameter estimate of FTA is positive and significant, indicating a surge in bilateral exports from India through its FTA signatory countries during the pandemic. The estimated parameter of the monthly CPI for exporters is negative but not significant; however, the monthly CPI for export destination is positive and significant. R-squared value (0.98) confirms the fit of the model under PPML with fixed effects.

Table 5: Results from Gravity Model

Explanatory Variables	1	2	3
	OLS	OLS with fixed effects	PPML with fixed effects
	(Dependent Variable: lnExports)	(Dependent Variable: lnExports)	(Dependent Variable: Exports)
$\ln\text{COVID_NC}_{it}$	0.2219458 *** (0.0682)	-0.04513*** (0.013618)	-.00854 (.0085636)
$\ln\text{COVID_NC}_{jt}$	-0.0250096 (0.070305)	0.004916 (0.018379)	.0178199** (.0085728)
$\ln\text{COVID_ND}_{it}$	0.0231375 (0.05497)	0.09357*** (0.013807)	-.0150943** (.0067401)
$\ln\text{COVID_ND}_{jt}$	0.2782363*** (0.058858)	0.012027 (0.014461)	.0147495** (.0072399)
$\ln\text{CPI}_{it}$	-15.48344*** (0.850504)	4.187823*** (1.079873)	-1.336927 (1.15964)
$\ln\text{CPI}_{jt}$	-12.26111*** (0.722109)	5.234743*** (1.081899)	4.401104*** (1.137659)
FTA_{ijt}	2.587152 *** (0.195522)	3.336314*** (0.388271)	2.377373*** (.3138203)
<i>Cons</i>	146.4394*** (5.250953)	-28.35328*** (7.489407)	4.150168 (7.656435)
<i>R-squared</i>	0.3614	0.9885	.98691422
<i>No. of Observations</i>	1318	1318	1318

Note: Standard errors are in parenthesis; *** p<0.01, ** p<0.05, * p<0.1

Source: Author's Estimation

6. Conclusion

This study is an analysis of the economic after effect of the Covid-19 on the Indian economy. Findings of this study established that Indian economy witnessed huge decline in GDP, trade (export and import) and an increase in unemployment with increased demand for local works (MGNREGA). Results from the gravity model show that demand for India's export increased from those partner countries which witnessed surge in monthly Covid cases and deaths during April 2020 to March 2021. This is due to the distortion in the domestic production and thus advanced to greater dependency on import from India. However, India's exports declined (decline in domestic production) with an increase in domestic monthly Covid deaths

(monthly Covid cases are not significant) due to the shutdown of the production facilities domestically.

The study suggests for speedy reviving the Indian economy post-pandemic. This will need huge public spending complemented with private investments. However, the fear of an increase in the fiscal deficit has contained the government in expanding budgetary spending, which escalates the severity of the issue. The study proposes increasing public expenditure to restore and increase production capacities, employment opportunities, and invest in physical infrastructure. This study also recommends investing in human capital and building social infrastructure for sustained growth and development of the Indian economy.

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