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RESEARCH PAPER

Pandemic Crisis, Macroeconomic Expectations and Policy Relevance: A Theoretical Journey with Empirical Quest

Tonmoy Chatterjee[1], Nilendu Chatterjee[2*] and Ramesh Chandra Das[3]

[1]Department of Economics, Bhairab Ganguly College, Belgharia, West Bengal, India
[2]Department of Economics, Bankim Sardar College, South 24 Parganas, West Bengal, India
[3]Department of Economics, Vidyasagar University, West Bengal, India

*Corresponding author: nilubsc87@gmail.com (**ORCID ID:** 0000-0002-8570-0262)

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ABSTRACT

Recent pandemic has laid down its foot on the heart of human civilization through several random shocks that have generated economic crisis. Post pandemic world shall demand for proper and possibly effective state intervention in order to stabilize the downward biased economic fluctuations, at least for short-run. Take this as an opportunity, this paper tries to throw some ray over some hypothetical scenarios and shouts for plausible policy recommendation in a post pandemic world. This paper uses standard macroeconomic models with rational expectations for both supply-side and demand-side shocks in order to examine the effectiveness of policies for hypothetical economies. Further, to quantify the analysis,we employ both econometrics and simulation-based approaches on different economic setup. This is the a which considers rational expectations to examine the short-run fluctuations via pandemic. Consideration of both demand side and supply side shocks along with plausible policy responses under the assumptions of rational expectations also make this study a novel one.

HIGHLIGHTS

- This study considers Macroeconomic Policies on the pandemic Shock.
- Rational Expectation Model has been used for explaining the model.
- Both Demand and Supply sides have been considered
- Econometric Analysis has been applied as well for few major economies
- Robustness analysis has been done.

Keywords: Pandemic, Economic policies, Rational expectations, Economic fluctuations, Simulation

The world, for the past few months, has been shaken and still shivering from the fear and impact of "Pandemic" due to Novel Corona Virus (COVID-19). Initiated in Wuhan province of China in late December of 2019 (26 December, 2019), the disease has spread over 195 nations and well over 30 crore people have suffered[1], the numbers are expected to go up (Michie, 2020) as no proper medicine is invented till now. Complete shutdown or partial shutdown, the effective ways of curbing the disease, of a nation puts itself in the bucket of economic isolation. As the pandemic endorses economic contagiousness along with health contagiousness, economic isolation from rest of the world is quite obvious. Again, complete or partial lockdown claims fall in output in short-run and hence the clubbing of lesser output with economic isolation generates economic crisis.

One must know that such economic crises are not going to last forever, certainly the"Pandemic" caused Novel Corona Virus (NCOV-19). But sudden short-periodic spurt can happen every

[1]*Over 5 million people have already died.*

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now and then because of the changing nature of this virus (Chatterjee and Chatterjee, 2023). After the first wave, we have seen the second wave due to "Delta" variant of this virus and again after six-seven months, we have been witnessing the third wave due to "Omicron" variant. As worldwide economic consequences of this disease, few nations are going to face a severe demand shock, whereas others are going to face a supply shock. Even a nation might suffer from both demand and supply shocks simultaneously. Demand shock, in this scenario, is surely going to be positive, especially for health products and day-to-day necessary goods but not too many nations have been able to match up to that increased demand, as a result of which it is quite possible that bulk of the nations have been already facing a negative supply shock. Few nations may have enough supply to meet this sudden rise in demand but it is highly impossible for them to help others in a situation of uncertainty where every nation first wants to secure itself from the spread of this virus. But we all know that this crisis is not going to last forever or it is not a long-run phenomenon. But we all can go through several short-periodic waves and corresponding multiple short-periodic economic fluctuations can be required to deal with. Therefore, during short-run, economic agents should deal with it by applying rational expectations (Bocchal & Durai, 2019). We know that in case of rational expectations, people use the best available information in the market to make their decisions. Since, such a sudden crisis has not been witnessed worldwide before with such huge impact, the issue of adaptive expectations does not apply here because for that we know that the economic agents use past events to predict about future. Since we do not know how many short-periodic crises we have to face in the coming days as well as for how long a certain short-periodic crisis would sustain, it becomes appropriate to use the concept of rational expectation. It is expected that the economies will take steps accordingly, on every occasion, based on the spread and severity of Covid as suggested by WHO. Three waves have proved that we have to stay prepared for a sudden shock and follow tightening of economic activities. On every occasion, policies could differ, both in their intensity as well as in longevity (Chatterjee and Adhikari, 2023). Nations will look forward to combat the price-output fluctuations either by demand or supply-side based policies (Das, 2020). Here lays the rationality to employ rational expectations, where nations would behave with rational expectation arguments and their demand and supply functions would contain the random error segment in it, the economies would look forward to deal with the price-output fluctuation in the presence of this ongoing pandemic as well as post-pandemic economic conditions.

The pandemic cursed over both developed and developing part of our world. Economic consequences are also acute; however its effect is heterogeneous among cross-sections. It is evidentthat such pandemic may affect advanced economy through supply side channel (in general), while developing countries may be affected through demand side channel. Hence, in this paper we have considered the shock of pandemic to both supply and demand sides separately and examined the possible consequences of the government policies which can be adopted for a particular nation.

The main application of rational expectations approach hovers around price-output fluctuations. But, in a situation of sudden crisis such as COVID-19 the application of rational expectations approach has not been witnessed, since such a worldwide health problem has hardly been faced before. This has been done in this paper.

Model 1: Simple Model of Rational Expectations with Supply-side Pandemic shock

Rational expectation theorists usually assumed that representative consumer has a budget constraint which states that total income equals total consumption, where consumption goods are paid at the general price (P_t). Further it is to be noted that consumers get utility from consumption and get disutility from labour. From such optimization set up we can derive the following Aggregate Demand (AD) equation

$$Y_t^d = A - BP_t \qquad \ldots(1)$$

The general price level of the economy is defined by and individual prices are built up from the general price and specific idiosyncratic pandemic shocks (ε_t). Adjustments on prices are generated either by or and precise information on the source is unknown by the agent. Individual employment generates the

respective output and therefore we only look into the production side of the corresponding economy. We further assume that our stylized economy is a closed one. Therefore, the Aggregate Supply (AS) equation:

$$Y_t^S = Y_N + \gamma(P_t - P_t^e) + \varepsilon_t \quad \ldots(2)$$

Following static equilibrium rule for a representative product market one can derive the general price level as a function of its own expectation, output at natural rate and the great shock owing to pandemic. From expressions (1) and (2) the equilibrium price

$$P_t = (A - Y_N + \gamma P_t^e - \varepsilon_t)/(B + \gamma) \quad \ldots(3)$$

Using rational expectations arguments with equations (1) to (3) and after some simple algebraic manipulation we obtain the following expression:

$$Y_t - Y_N = B\varepsilon_t/(B + \gamma) \quad \ldots(4)$$

Remarks 1: With rational expectations both equilibrium price and output fluctuation depend upon external shock owing to pandemic in the presence of random error augmented aggregate supply and autarky.

Comments to Remarks 1:

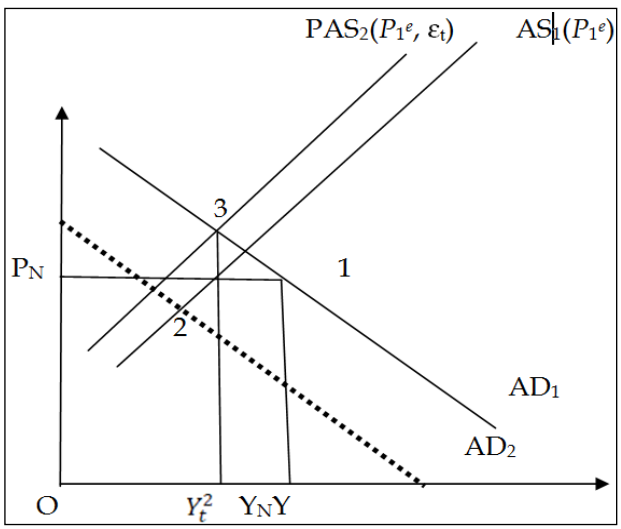


Fig. 1: Determination of economic fluctuations under presence of random shocks

Remarks 1 explicitly tells us that output fluctuations occur mainly owing to the proposed pandemic driven supply side shock. Figure 1 also illustrates the same. Supply shock via pandemic affects production side adversely and as a consequence of which and for given expectation (in terms of P_1^e) Aggregate supply (AS) shifts from AS1 to AS2 in short run. Again, for given expectations and Aggregate Demand (in terms of AD1) the economy reaches to point 3 from point 1. Hence, Fig. 1 describes economic fluctuation via random pandemic shock to supply side in terms of:

$$\left(Y_t^2 - Y_N\right); Y_t^2 < Y_N \text{and} \left(Y_t^2 - Y_N\right) < 0$$

Variant of Model 1 and Policy Implications

Standard rational expectations macro-model is quite enough acceptable to judge the economic crisis via random pandemic shock and it has been established in the last section. Adding to this in this section we wish to derive the effectiveness of both demand-side policy measures and supply side policy measures separately.

Demand-side policy measure and its effectiveness

To focus on demand-based policy measure, here we employ both Fiscal and monetary measures within the periphery of model 1. For the brevity of our economic intuitions we represent fiscal and monetary policies argument in terms of F_t. Note, F_t depends upon both output fluctuation and random error (v_t).

$$F_t = f((Y_t - Y_N), v_t) \quad \ldots(5)$$

Therefore, slide modification of expression (1) and fiscal (or monetary) policy augmentation give us the following AD schedule:

$$Y_t^d = AF_t - BP_t \quad \ldots(6)$$

Given the same AS, the modified static equilibrium generates the following equilibrium price

$$P_t = (AF_t - Y_N + \gamma P_t^e - \varepsilon_t)/(B + \gamma) \quad \ldots(7)$$

Similar to the earlier one, here using rational expectations arguments with equations (2), (6),

(7) and after some simple algebraic manipulation we obtain the following expression (for details see Appendix 1.2)

$$Y_t - Y_N = [A\gamma(F_t - E(F_t))/(B+\gamma)] + [\gamma\varepsilon_t/(B+\gamma)] \quad \ldots(8)$$

Remarks 2: With expansionary demand-based policy measure augmented with rational expectations both equilibrium price and output fluctuation increase as $F_t > 0$, $F_t < E(F_t)$ and $A(F_t - E(F_t)) < \varepsilon_t$.

Comments to Remarks 2:

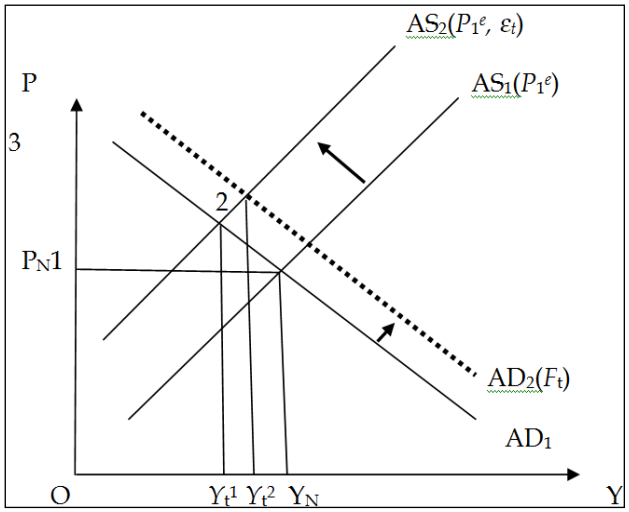


Fig. 2: Expansionary demand-based policy and determination of economic fluctuations under presence of pandemic shocks on supply side

Fig. 2 explains the effectiveness of demand-based policy measure to control the output fluctuation. Similar to Fig. 1, point 1 in Fig. 2 also shows the commodity market equilibrium in the absence of pandemic shock. Random pandemic shock on supply forces a shift in AS schedule in the leftward direction and following this economy reaches to a new short run equilibrium for given expectation. Such movements from point 1 to 2 illustrates fall in output from Y_N to Y_t^1 and generates economic gap with volume $(Y_t^1 - Y_N)$ and $(Y_t^1 - Y_N) < 0$. As a policy measure policymakers can adopt expansionary fiscal or monetary policy and following equations (5), (6) and (8) we find the effectiveness of such policies to reduce the volume of output gap in short run, that is, we reach to point 3 with (Y_t^1) and $F_t > 0$. As an outcome we find $(Y_t^1 - Y_N) < (Y_t^1 - Y_N)$ owing to $F_t - E(F_t) < 0$. Following the same logic, equations (7) and (8), and working principle of the model under the given set of expectations we get the following results.

$$\begin{cases} \hat{P}_t/\hat{F}_t > 0, \hat{Y}_t/\hat{F}_t > 0, \\ (\hat{Y}_t - \hat{Y}_N) < 0, \\ if\,[F_t - E(F_t)] < 0 \;\&\; \hat{F}_t > 0 \end{cases}$$

Supply-side policy measure and its effectiveness

To examine the efficacy of possible supply-side policy measure on economic fluctuation we adopt production-subsidy (S). More specifically, we use production subsidy in ad-valorem form. Subsidy-augmented aggregated supply schedule:

$$Y_t^S = Y_N + \gamma(P_t(1-S) - P_t^e) + \varepsilon_t \quad \ldots(9)$$

Using expressions (1), (9) and equilibrium condition we can obtain the equilibrium price under supply shock with production-subsidy:

$$P_t = (A - Y_N + \gamma P_t^e - \varepsilon_t)/(B + \gamma + \gamma S) \quad \ldots(10)$$

Again incorporating rational expectations arguments with equations (1), (9), (10) and after some simple algebraic manipulation we obtain the following expression (for details see Appendix 1.3):

$$Y_t - Y_N = [\gamma AB/(B+\gamma-\gamma S)(\gamma+\gamma E(S))] - [\varepsilon_t/(B+\gamma-\gamma S)] + \varepsilon_t \quad \ldots(11)$$

Remarks 3: With expansionary demand-based policy measure augmented with rational expectations both equilibrium price and output fluctuation increases as $S_t > 0, S_t \cong E(S_t)$ and $\gamma AB/(B+\gamma-\gamma S)(\gamma+\gamma E(S))] > [\varepsilon_t/(B+\gamma-\gamma S)]$.

Comments to Remarks 3: Let us start with mathematical outputs and hence using equations (10) and (11) we have the following results:

$$\begin{cases} \hat{P}_t/\hat{S}_t > 0, \hat{Y}_t/\hat{S}_t > 0, \\ (\hat{Y}_t - \hat{Y}_N) < 0, \\ if\,[(AB - \varepsilon_t)/\varepsilon_t] < E(S) \;\&\; \hat{S}_t > 0 \end{cases}$$

Here, Fig. 3 illustrates the efficacy of supply-based policy measure to control the output fluctuation.

Here we start with point 1 in Fig. 3 which again shows the product market equilibrium in the absence of pandemic shock. Random pandemic shock on supply compels a shift in AS schedule in the leftward direction and reaches to new short run equilibrium for given P_1^e and ε. Such movements from point 1 to 2 shows reduction in output level from Y_N to Y_t^1 and generates economic gap with volume $(Y_t^1 - Y_N)$ and $(Y_t^1 - Y_N) < 0$. As a policy measure policymakers alternatively can provide subsidy on final goods as an expansionary supply based policy and following equations (5), (9) and (10) we find the effectiveness of such policies to reduce the volume of output gap in short run (in terms of equation 11), that is, we reach to point 3 with Y_t^2 and $S_t > 0$. As an outcome we find $(Y_t^2 - Y_N) < (Y_t^1 - Y_N)$ owing to $E(S_t) > \Gamma(\varepsilon_t)$.

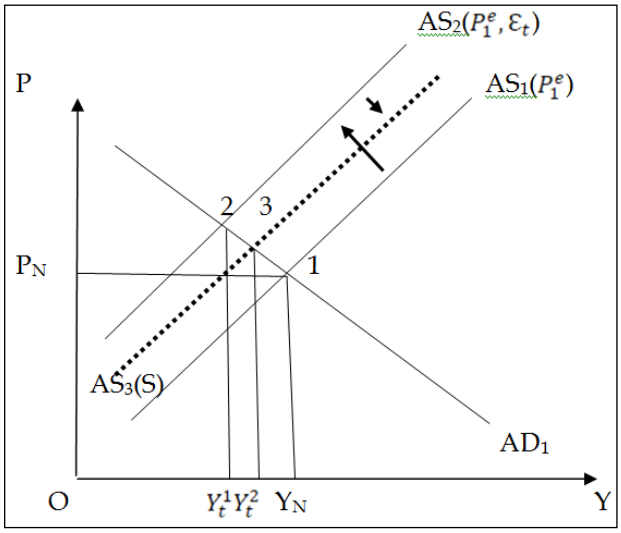


Fig. 3: Expansionary supply-based policy and determination of economic fluctuations under presence of pandemic shocks on supply side

Inequality $E(S_t) > \Gamma(\varepsilon_t)$ describes that if expected subsidy on final goods is higher than the random pandemic shock on supply, government subsidy on final product can be an effective measure to control the output fluctuation following present pandemic.

Proposition 1: Utilization of rational expectations argument under short-run autarky can increases the output of a nation in post pandemic supply crisis under following conditions;

1. if $F_t > 0, F_t > E(F_t)$ and $A\gamma(F_t - E(F_t)) > \gamma\varepsilon_t$; and
2. if $S_t > 0, S_t \cong E(S_t)$ and

$$\gamma AB/(B + \gamma - \gamma S)(\gamma + \gamma E(S))] > [\varepsilon_t/(B + \gamma - \gamma S)]$$

Proof: The economic intuitions behind the results obtained from Model 1 are quite usual and can be explained in the following manner. Supply side shock via ongoing crisis leads to a fall in short-run supply. Since the shock is random, within short run as the economic agents are almost unaware and thereby they can't revise their expectations so promptly. Following this an unexpected excess demand situation may occur in the product market. Excess demand can generate an upward pressure to the price and hence inflation may arise. To overcome this issue policy-makers can adopt either demand-based policy measure or supply-based policy measure as a tool of mitigation (Chatterjee and Chatterjee, 2021).

Model 2: Simple Model of Rational expectations with demand side Pandemic shock)

Advancing over the Model 1, in this model we have slightly changed our choice of thinking by introducing random shock owing to pandemic crisis on demand side of the economy. We offer Model 1 to those economies where economic shock due to pandemic affects supply basket, whereas Model 2 is only for those economies where said shock affect demand basket of the corresponding economy. Therefore, the new and modified AD equation:

$$Y_t^d = A - BP_t + \varepsilon_t \qquad \ldots(12)$$

So far it is clear that in this model our stylized facts are insisted to omit random error term from our usual AS function and hence the new AS equation:

$$Y_t^S = Y_N + \gamma(P_t - P_t^e) \qquad \ldots(13)$$

Following static equilibrium rule for a representative product market one can derive the general price level as a function of its own expectation, output at natural rate and the demand shock owing to pandemic. From expressions (12) and (13) the equilibrium price:

$$P_t = (A - Y_N + \gamma P_t^e + \varepsilon_t)/(B + \gamma) \qquad \ldots(14)$$

Using Rational expectations arguments with equations (12) to (14) and after some simple

algebraic manipulation we obtain the following expression:

$$Y_t - Y_N = [A\gamma/(B+\gamma)] + [\gamma\varepsilon_t/(B+\gamma)] \quad \ldots(15)$$

Remarks 4: With rational expectations both equilibrium price and output fluctuation depend upon external shock owing to pandemic in the presence of random error augmented aggregate demand and autarky.

Comments to Remarks 4: Similar to Remarks 1, Remarks 4 clearly entails that output fluctuations can also occur owing to the present pandemic even under demand side shock. Fig. 1 draws the same. Demand shock via pandemic affects preference pattern adversely and as a consequence of which and for given expectation (in terms of P_1^e) Aggregate demand (AD) shifts from AD_1 to AD_2 in short run. Again, for given expectations and hence for given AS (in terms of AS_1) the economy reaches to point 2 from point 1. Hence, Fig. 1 describes economic fluctuation via random pandemic shock to demand side in terms of $(Y_t^2 - Y_N)$; $Y_t^2 < Y_N$ and $(Y_t^2 - Y_N) < 0$.

Variant of Model 2 and Policy Implications

Similar to the earlier model here we also examine the efficacy of both demand-side policy and supply side policy measures separately on the output fluctuations under the backdrop of demand side shock.

Demand-side policy measure and its effectiveness

Using the same functional form of fiscal and monetary policies what we have used in model 1, i.e., F_t in equation (12) we obtain AD equation:

$$Y_t^d = AF_t - BP_t + \varepsilon_t \quad \ldots(16)$$

Given the equation (13), the modified static equilibrium generates the following equilibrium price;

$$P_t = (AF_t - Y_N + \gamma P_t^e + \varepsilon_t)/(B+\gamma) \quad \ldots(17)$$

Inserting rational expectations arguments within equations (13), (16), (17) and after some simple algebraic manipulation we obtain the following expression (for details see Appendix 1.5).

$$Y_t - Y_N = [A\gamma(F_t - E(F_t))/(B+\gamma)] + [\gamma\varepsilon_t/(B+\gamma) \ldots(18)$$

Remarks 5: With expansionary demand-based policy measure augmented with rational expectations both equilibrium price and output fluctuation to increases as $F_t > 0, F_t > E(F_t)$ and $A\gamma(F_t - E(F_t) > \gamma\varepsilon_t$.

Comments to Remarks 5: Thus, the demand based policy parameter must spikes up further. In our model, it is defined by $\hat{F}_t > 0$. The following effects are obtained for the variables of our interest.

$$\begin{cases} \hat{P}_t/\hat{F}_t < 0, \hat{Y}_t/\hat{F}_t > 0, \\ (\hat{Y}_t - \hat{Y}_N) < 0, \\ if\,[F_t - E(F_t)] < 0 \;\&\; \hat{F}_t > 0 \end{cases}$$

Fig. 4 examines the effectiveness of demand-based policy measure to control the output fluctuation. Here, point 1 in Fig. 4 shows the commodity market equilibrium in the absence of pandemic shock. Random pandemic shock on demand encourages a shift in AD schedule in the leftward direction and following this economy reaches to a new short run equilibrium for given expectation and AS. Such movements from point 1 to 2 illustrates fall in output from Y_N to Y_t^1 and generates economic gap with volume $(Y_t^1 - Y_N)$ and $(Y_t^1 - Y_N) < 0$.

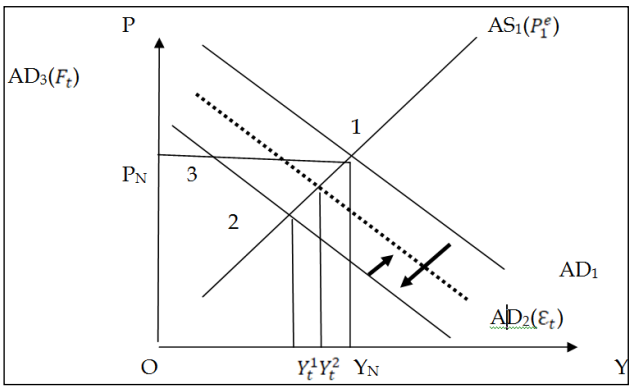


Fig. 4: Expansionary demand-based policy and determination of economic fluctuations under presence of pandemic shocks on demand side

As a policy measure policymakers can implement expansionary fiscal or monetary policy and following equations (13), (16) and (18) we find the effectiveness of such policies following a reduction

in the volume of output gap in short run, that is, we reach a new short run equilibrium, that is, to point 3 (With $AD_3(F_t)$) with Y_t^2 and $F_t > 0$. As an outcome we find $(Y_t^2 - Y_N) < (Y_t^1 - Y_N)$ owing to $F_t - E(F_t) < 0$.

Supply-side policy measure and its effectiveness

To get access to the efficacy of supply side policy measure in terms of production-subsidy, in Model 2 we employ ad-valorem form of S in equation (13). Unlike Model 1, here S is incorporated to an AS function without random shock. Therefore, the modified AS equation can be represented as

$$Y_t^S = Y_N + \gamma(P_t(1-S) - P_t^e) \quad \ldots(19)$$

Equations (12), (19) and corresponding product market equilibrium produce the following equilibrium price

$$P_t = (A - Y_N + \gamma P_t^e + \varepsilon_t)/(B + \gamma - \gamma S) \quad \ldots(20)$$

Again incorporating Rational expectations arguments with equations (13), (19), (20) and after some simple algebraic manipulation we obtain the following expression (for details see Appendix 1.3);

$$Y_t - [BE(S)/(B+\gamma-\gamma S)(E(S)+1)]Y_N = [A\{E(S)+1-B\}/(E(S)+1)] + [\varepsilon_t(1-B)] \quad \ldots(21)$$

Remarks 6: Expansionary demand-based policy measure augmented with rational expectations and subsidy adjusted natural output enhance both equilibrium price and output fluctuation as;

$$S_t > 0, S_t \cong E(S_t), [BE(S)/(B+\gamma-\gamma S)(E(S)+1)] > 0$$

and $[A\{E(S)+1-B\}/(E(S)+1)] > 0$.

Comments to Remarks 6: Fig. 5 illustrates the effectiveness of supply-based policy measure to control the output fluctuation. Here we again start with point 1 in Fig. 5 which again shows the product market equilibrium in the absence of pandemic shock. Random pandemic shock on demand induces a shift in AD schedule in the leftward direction and reaches to new short run equilibrium for given P_1^e, AS_1 and ε. It implies that if the prevailing preference in product market is inelastic, government subsidy on final product can be considered as an effective measure to control the output fluctuation following demand shock via present pandemic.

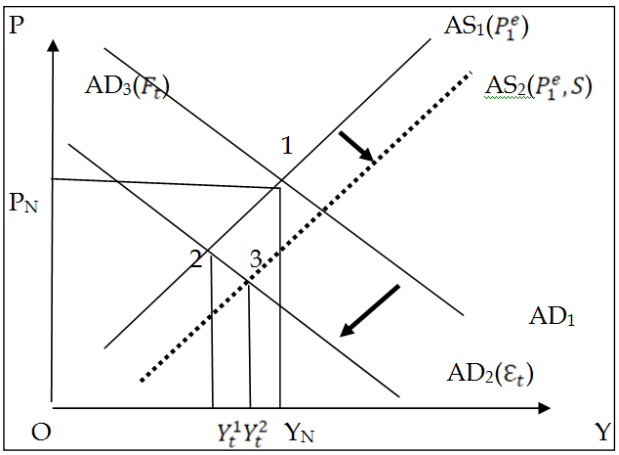


Fig. 5: Expansionary supply-based policy and determination of economic fluctuations under presence of pandemic shocks on demand side

Moreover, mathematically the following effects are obtained for the variables of our interest for $\hat{S}_t$.

$$\begin{cases} \hat{P}_t/\hat{S}_t < 0, \hat{Y}_t/\hat{S}_t > 0, \\ (\hat{Y}_t - \hat{Y}_N) < 0, \\ if E(S) > 0, B > 1 \,\&\, \hat{S}_t > 0 \end{cases}$$

Proposition 2: Utilization of rational expectations argument under short-run autarky can increases the output of a nation in post pandemic demand crisis under following conditions;

1. if $F_t > 0, F_t > E(F_t)$ and $A\gamma(F_t - E(F_t) > \gamma\varepsilon_t$; and

2. if $S_t > 0, S_t \cong E(S_t), [BE(S)/(B+\gamma-\gamma S)(E(S)+1)] > 0$ and $[A\{E(S)+1-B\}/(E(S)+1)] > 0$.

Proof: We can verbally explain Proposition 2 as follows. In the existing set up an exogenous random shock following ongoing pandemic can affect aggregate demand also. Demand side shock via ongoing crisis leads to a fall in short-run aggregate demand schedule. In view of the fact that the pandemic shock is random, within short run the economic agents are almost oblivious and thus they can't modify their expectations instantly. Following this an unexpected excess supply situation may take place in the product market. Excess supply can raise the unemployment issue further. Similar to the earlier model here we also start with demand-side policy measures to alleviate the economic

fluctuations (Chatterjee & Dinda, 2022). Let us start with the effectiveness of demand-based policy implementation. Expansionary demand side policies can enhance the scope to increase aggregate demand. People with more cash will spend more and as consequence aggregate demand will shift to right to meet the initial goods market equilibrium. However, the role of consumers' confidence, producer's confidence and MPC remain same as what we get in the explanations of Proposition 1.

What Data Suggests? The Case of USA, UK, India and Brazil

Data and Empirical Methodology

Data on the selected variables, GDP, government spending, money supply (broad money) and subsidy, are taken in quarterly basis from January 2011 to July 2021. The pre-pandemic period is January 2011 to October 2019 and the post-pandemic period is January 2020-July 2021. All the data are in billion USD at current prices which are collected from Trading Economics database for four worst hit countries, USA, UK, India and Brazil. The data for the said indicators for the countries other than USA are converted to USD by means of the historical exchange rates of the currencies with the USD. To calculate the GDP fluctuation, we have used the data on capacity utilization rate obtained from the same source and made relate the actual GDP to the existing level of capacity utilization, and then derived the GDP values at the full capacity utilization level to quantify the GDP fluctuation or GDP gap. Subsidy data for India is obtained from different budgets of the Union Government and for Brazil, it is from the World Bank as per cent of total expenses. For the post-pandemic period a dummy value of 1 is imputed for the seven quarters and for the pre-pandemic quarters, it is captured by a zero value.

First of all, the trends of the values of the selected variables whether having any impact of the present pandemic is tested by the mean difference test in line of '*t*' test. Second, to know whether pandemic has any impact upon GDP fluctuation we have run regression of GDP gap upon the dummy series. Finally, to get the impacts of all the four selected variables, GDP, government spending, money supply and subsidy, and the Pandemic dummy upon GDP fluctuation we run multiple regression for the entire period of 43 quarters.

EMPIRICAL RESULTS

Mean difference test results

It is observed from the table (Table 1) that for the USA and UK, GDP Gap, Government Spending, Money Supply, and Subsidy have increased significantly in the pandemic period. For India, GDP Gap, Money Supply, and Subsidy have increased significantly in the pandemic period but Government spending did not increase during the period. But for Brazil,

Table 1: Mean difference test results

		GDP Gap	Govt. Spending	Money SS	Subsidy
Average Values of the Variables-Pre Pandemic	USA	1346.502	3140.82972	11964.439	60.68
Average Values of the Variables-Post Pandemic		1985.352	3360.20714	18499.3	692.04
t (Mean diff.)		3.52	13.83	8.65	4.24
Average Values of the Variables-Pre COVID	UK	165.4734	135.89111	1001.9189	75.36539
Average Values of the Variables-Post Pandemic		283.312	156.81142	1107.96	535.4889
t (Mean diff.)		2.26	11.79	18.28	2.34
Average Values of the Variables-Pre Pandemic	India	196.1165	44.982062	1726.889	10.121
Average Values of the Variables-Post Pandemic		379.4696	46.610667	2414.025	16.93
t (Mean diff.)		3.03	0.21	10.52	4.31
Average Values of the Variables-Pre Pandemic	Brazil	134.5931	32.70897	1660.531	427.2723
Average Values of the Variables-Post Pandemic		106.6252	25.64666	1399.965	425.5339
t (Mean diff.)		-2.10	-2.98	-7.12	-0.046

Note: *All values of the variables are in billion USD.*

Source: *Authors' own calculations*

GDP Gap, Government Spending, Money Supply have decreased significantly in the pandemic period, but Subsidy has decreased insignificantly. The similarity of the post pandemic results is for the two developed economies whereas the differences of results are there for the developing economies during the same period.

Effect of Pandemic on GDP fluctuation

As the subject of discussion of the paper is post covid impacts and the roles of the associated policy variables, it is first examined the impact of the covid shock captured through dummy variable upon the GDP fluctuations of the countries. For this purpose, a regression is run with GDP gap as the dependent variable and dummy variable for pandemic shock as the only independent variable (Table 2).

It is observed from the table that the pandemic shock has positive shock effect upon GDP fluctuation in USA, UK and India but negative effect upon GDP fluctuation in Brazil.

Multiple Regression Results

As the theoretical model of the study compiles demand and supply related policy variables in analysing the fluctuations in the GDP of the countries accompanied by the pandemic shock, it is thus desirable to examine the effects of these factors upon the GDP fluctuations of the countries. A multiple regression is thus run incorporating the selected variables and the results are given in Table 3.

It is observed from the computed 't' statistics of the regression results that the fluctuations in the GDP of USA are positively explained significantly by the demand factor, money supply, and the supply factor, subsidy. But, government spending, the fiscal component, did not work significantly in explaining the fluctuations in the GDP of the country. For the UK, only subsidy has negative influence upon the fluctuations in the GDP. On the other hand, the fluctuations in the GDP of India are positively explained significantly by the demand factor, money supply, and the supply factor, subsidy. But, government spending, the fiscal component, did not work significantly in explaining the fluctuations in the GDP of the country. The results of India are similar to that of the USA. Finally, for Brazil, only subsidy has positive and significantly influence upon its fluctuations in the GDP.

Robustness Checks by using Simulation

In this section we have tried to examine the effectiveness of several possible government

Table 2: Effect of Pandemic on GDP fluctuation

Dependent Variable: GDP Gap Independent Variable: Pandemic dummy	Regression Coefficient	Probability	R Square
USA	638.53	0.00	0.53
UK	117.83	0.00	0.39
India	183.35	0.00	0.45
Brazil	-27.96	0.00	0.29

Source: *Authors' own calculations.*

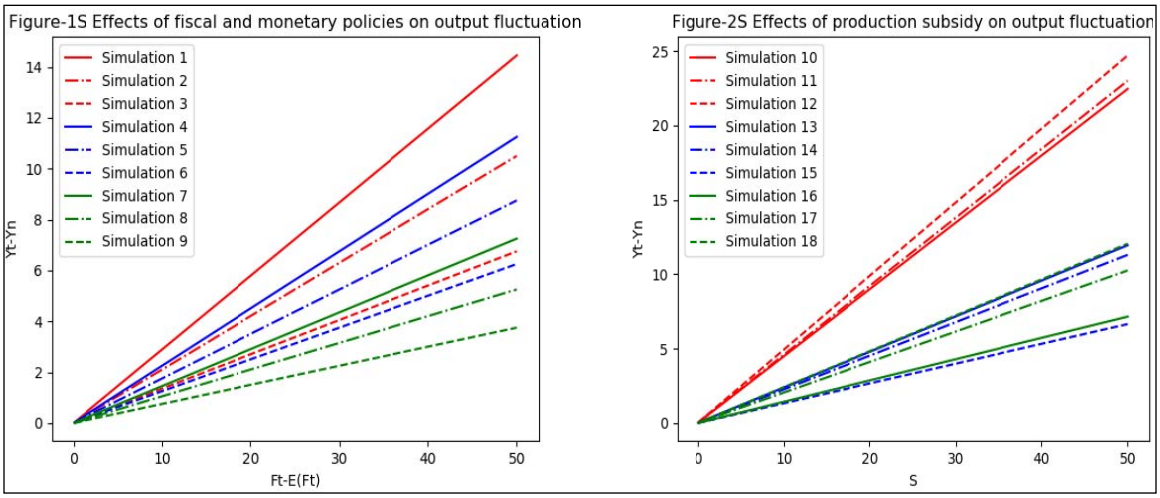
Table 3: Results of multiple regressions

	Dependent Variable: GDP Gap					
Independent Variables	**Constant**	**Govt. Spending**	**Money Supply**	**Subsidy**	**Pandemic Shock**	**Adjusted R Square**
USA	-352 (0.78)	0.40 (0.33)	0.33 (0.04)	0.78 (0.00)	-156.2 (0.38)	0.69
UK	130 (0.26)	0.44 (0.71)	-0.017 (0.95)	-0.10 (0.01)	158 (0.00)	0.43
India	-192 (0.02)	1.24 (0.24)	0.13 (0.00)	10.24 (0.06)	20.6 (0.71)	0.61
Brazil	82.4 (0.01)	-0.23 (0.58)	-0.01 (0.57)	0.18 (0.00)	-32.3 (0.00)	0.40

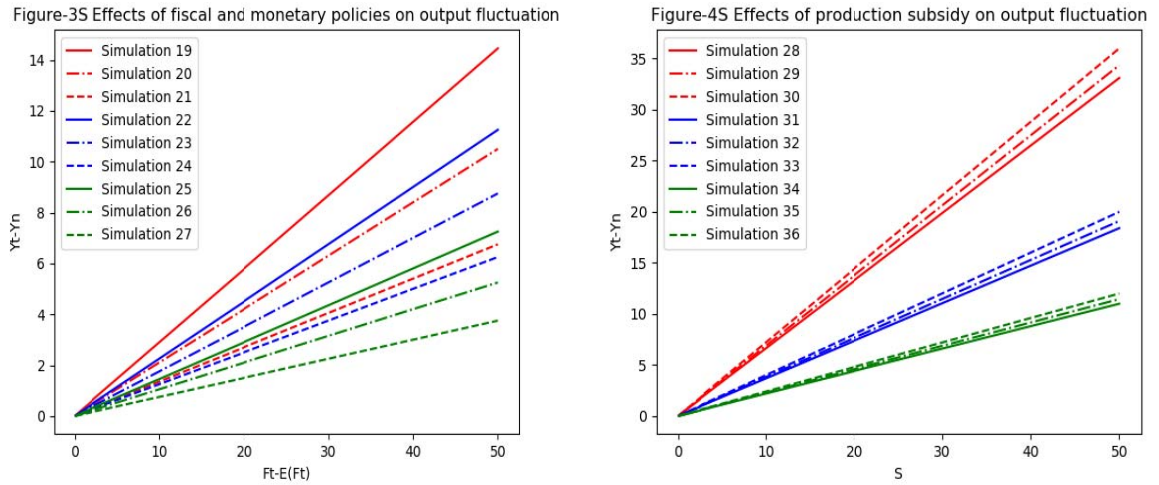
Notes: *Figures in the parentheses represent the probability values of the estimations for the parameters.*

Source: *Authors' own calculations.*

policy recommendations through different order simulation exercises. In fact, to give an empirical flavor to our stylized theoretical models' outcomes we have employed bootstrap simulations with alternatives stylized structure. Under each policy regime we have used first three calibrations to represent developed nations, simulations four to six represent developing economies and last three simulations describe the case of less developed countries. Outcomes of our simulation exercise are depicted in terms of figures 1S to 4S. Fig. 1S depicts the empirical findings of equation (8). As we are moving from simulations 1 to 3 we find that increasing demand elasticity and increasing power of rational expectation generate lower economic fluctuation under efficiently implemented demand-side policy. Under similar background we are getting the effectiveness of demand-side policy measure on both developing (illustrated by simulations 4 to 6) and less developed countries (illustrated by simulations 7 to 9). Comparing all these cases under supply side shock, we can predict that such demand-side policy measure is more effective in less developed set up to accentuate the output fluctuation, while it is less effective in developed economies and show moderate effect for developing nations. Fig. 2S depicts the empirical findings of equation (11). It is to be noted that under increasing demand elasticity and increasing power of rational expectation, both developed (illustrated by simulations 10 to 12) and less developed countries (illustrated by simulations 16 to 18) are illustrated same consequences owing to expansionary supply-side policy measure, that is, lower economic fluctuations. Interestingly, developing set up (illustrated by simulations 13 to 15) is the only instance where supply side policy



Note: *Figs. 1S and 2S illustrate the simulation effects under supply-side shock*



Note: *Figs. 3S and 4S depict the simulation outcomes under demand-side shock.*

Table 4: Simulation table

	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5	Sim 6	Sim 7	Sim 8	Sim 9
A	.9	.9	.9	.5	.5	.5	.3	.3	.3
B	.9	.8	.7	.5	.4	.3	.5	.4	.3
γ	.5	.4	.3	.5	.4	.3	.5	.4	.3
$F_t - E(F_t)$	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 – 50
	Sim 10	**Sim 11**	**Sim 12**	**Sim 13**	**Sim 14**	**Sim 15**	**Sim 16**	**Sim 17**	**Sim 18**
A	.9	.9	.9	.5	.5	.5	.3	.3	.3
B	.9	.8	.7	.5	.4	.3	.5	.4	.3
γ	.5	.4	.3	.5	.4	.3	.5	.4	.3
S	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 – 50
	Sim 19	**Sim 20**	**Sim 21**	**Sim 22**	**Sim 23**	**Sim 24**	**Sim 25**	**Sim 26**	**Sim 27**
A	.9	.9	.9	.5	.5	.5	.3	.3	.3
B	.9	.8	.7	.5	.4	.3	.5	.4	.3
γ	.5	.4	.3	.5	.4	.3	.5	.4	.3
$F_t - E(F_t)$	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 – 50
	Sim 28	**Sim 29**	**Sim 30**	**Sim 31**	**Sim 32**	**Sim 33**	**Sim 34**	**Sim 35**	**Sim 36**
A	.9	.9	.9	.5	.5	.5	.3	.3	.3
B	.5	.4	.3	.5	.4	.3	.5	.4	.3
S	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 - 50	.1 – 50

Note: *Created by Author(s).*

measure claims an increase in economic fluctuation under supply-side shock environment.

Fig. 3S depicts the empirical findings of equation (18). Evaluating all the cases, we can foretell that such demand-side policy measure is more effective in less developed set up to accentuate the output fluctuation, while it is less effective in developed economies and show moderate effect for developing nations. In addition, we can show that under demand-side shock expansionary supply-side policy measure can reduce the effectiveness of fluctuations for all the representative economies. Fig. 4S depicts the empirical findings of equation (21). Note, the effectiveness of such policy measure is less effective in case of less developed economies compared to other categories.

CONCLUDING REMARKS AND POLICY RECOMMENDATIONS

We are very much aware of the fact that few nations have been affected from the demand side whereas few have been affected from the supply side. Here we have assumed that from the macroeconomic perspectives, individuals will behave on the basis of rational expectations and have look to build up different models of rational expectations where both demand side as well as supply side have been taken care of.

Here we have built up two models based on rational expectation arguments. The first model is for those economies that will be suffering from a supply shock in the post pandemic situation and the second one is for those ones that will be suffering from demand shock. Both the models suggest that irrespective of categorical shock both expansionary demand-based and supply-based policy measures can be effective in order to drive out corresponding economy from the present crisis owing to pandemic. Moreover, the theoretical models also reveal that the efficacy of each policy measure are subject to the representative nation's several macroeconomic conditions, such as economic agents' behaviour towards the degree of rational expectations, engagement of state in terms of volume of expansionary fiscal and monetary measures and also on the involvement of government in the production process to continue the supply chain even under the pandemic crisis.

To check the robustness of our theoretical outcomes we have gathered the data on economic fluctuations and also on several plausible policy measures for four major and worst effected economies following pandemics, namely, India, USA, UK and Brazil,

and perform empirical analysis. Empirical findings claim that all the four economies are supposed to be more sensitive to supply side policy measure like subsidy in order to minimize fluctuation. To get more specific and quantitative results of the above-stated theoretical study, we have further employed a simulation exercise.

From the policy making angle we argue that developed economies can adopt either expansionary demand-based or supply-based policy measures or both irrespective of types of shock which affect the economy following pandemic. However, the policymaking is not so simple in case of relatively poor countries like developing and less developed. Developing economies with supply shock and no trade should take utmost caution before adopting expansionary supply-based policy, while same set economies can adopt both demand and supply based policies to control the adverse effect of present crisis following demand shock. Interestingly, less developed economies with demand shock and no trade should be more vigilant before adopting expansionary supply-based policy, while same set countries can implement both demand and supply based policies to control the present economic crisis under supply shock.

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