Macroeconomic Shocks and Business Inflation Expectations: Did Covid alter Dynamics?

Janani Rangan[c], Abhiman Das[d]

[c]*Indian Institute of Management Ahmedabad, Gujarat, India*
[d]*Indian Institute of Management Ahmedabad, Gujarat, India*

Abstract

Inflation expectations of firms are critical to price setting. The literature has predominantly focused on the inflation expectations of households and professional forecasters due to a limited number of surveys on the expectations of firms. This study uses new survey data to analyse the formation of inflation expectations of firms. We contribute to the literature by focusing on the impact of macroeconomic shocks on firm inflation expectations. We incorporate three distinct measures of the COVID-19 exogenous shock, to analyse dynamics of inflation expectations. Our empirical specification includes the SVAR and Local Projections models. Shocks to Wholesale Price Inflation, Crude oil inflation and the Exchange Rate have a high impact on Business inflation expectations. The results point to changes in the magnitude and persistence of the influence of shocks on business inflation expectations across the three measures of the COVID-19 exogenous shock.

Keywords: Inflation Expectations, Firms, Macroeconomic Shocks, Covid, SVAR, Local Projections
JEL: E31, E52, E61

1. Introduction

How does a firm's outlook on the economy affect its inflation expectations? This question is significant because inflation expectations have a life of their own and influence actual price levels. Economic agents rely on expected price levels for decision-making. As price setters, firms base pricing, employment and borrowing decisions on their inflation expectations. Hence, anchoring inflation expectations is key to achieving price stability. A credible central bank is well-equipped to anchor inflation expectations in the long run. Credibility, however is built on the central bank's ability to achieve the targeted inflation rate. A better understanding of the dynamics

Email addresses: phd20jananir@iima.ac.in (Janani Rangan), abhiman@iima.ac.in (Abhiman Das)

of business inflation expectations will help central banks navigate this path to price stability.

Despite the well-established significance of firms' inflation expectations, the literature in this area is still emergent. Studies have predominantly focused on inflation expectations of households and professional forecasters because of the plethora of survey data. These datasets were used to proxy for firm inflation expectations due to a dearth of surveys on firm inflation expectations. However, empirical findings suggest that inflation expectations of households are biased upwards (Weber et al., 2022) and professional forecasters have better knowledge about monetary policy when compared to firms (Coibion et al., 2018). The proxies deviate from firm inflation expectations (Coibion et al., 2020; McClure et al., 2022). The surveys on firm inflation expectations though recent, are growing. Research based on these surveys has primarily outlined findings from the survey and the firm-level sources of inattention (Candia et al., 2021; Savignac et al., 2021; Andrade et al., 2022).

Our analysis is novel since we examine the impact of macroeconomic shocks on firm inflation expectations. This paper identifies macroeconomic indicators dominant in influencing changes to firm inflation expectations. Additionally, we account for the implications of COVID-19 on the dynamics by incorporating three measures of control. Our results point to interesting phenomena. We observe that the magnitude and persistence of the impact of shocks change with the pandemic-induced uncertainty.

Macroeconomic shocks can provide information to firms in two ways – Firstly, economic conditions inform firms about potential changes in demand for their goods. If households foresee an increase in the price level in the economy, they will shift their future planned spending to the current period. The demand pressures will lead to an increase in the price level.

Second, they inform firms about the potential changes to their cost levels. Negotiators of labour contracts will demand higher wages if inflation levels are expected to increase since higher price levels may lead to lower purchasing power. Consequently, firms foresee an increase in their input costs through higher wage levels. In terms of borrowing, if firms expect inflation to go up, they anticipate an increase in the policy interest rate and lending rates.

We have chosen macroeconomic indicators based on three criteria - influence on the perception of the macroeconomic scenario of managers, impact on input costs of firms and cost expectations, indicators capturing managers' personal shopping experience and thereby impacting their judgement of inflation expectations.

This paper uses the survey data from the Business Inflation Expectations Survey (BIES) of the Indian Institute of Management Ahmedabad. The survey elicits responses in the form of probabilistic distributions, thereby accounting for the uncertainty in expectations. According to Bernanke, 2007, survey expectations lead to more robust estimations than traditional rational expectations models since they incorporate the changes in expectations as the structure of the economy evolves. We provide the details of the BIES in the upcoming sections. The questions are framed in

a pattern similar to the Business Inflation Expectations survey of the Federal Reserve of Atlanta (Bryan et al., 2015).

We use the SVAR (Leduc et al., 2007; Wong, 2015; Kilian and Zhou, 2021) and Local Projections models (Jordà, 2005; Falck et al., 2021) to analyze the impact of macroeconomic shocks on firm inflation expectations. The main variables are Crude Oil inflation, Wholesale Price Index inflation and survey measure of firm expectations. We also estimate models with indicators output gap, Food and Beverages inflation, INR-USD Exchange rate and Repo rate. Repo rate and output gap influence the firms' perception of economic conditions (Moessner, 2022; Coibion et al., 2018). Crude oil inflation (Wong, 2015; Aastveit et al., 2023) and Wholesale Price Index inflation are indicative of input cost changes. Shocks to energy prices create uncertainty about input costs for firms and are crucial to determining the cost expectations. From the demand angle, they reduce the discretionary income of consumers (Kilian, 2008). An increase in both increases firm inflation expectations because firms anticipate a cost rise. Food and beverages inflation influences the managers' perception of the actual price levels in the economy. D'Acunto et al., 2021 and Cavallo et al., 2017 empirically show that personal shopping experience of individuals. Kumar et al., 2015 arrive at similar findings for managers. A positive output gap means that the actual GDP is greater than the potential GDP. The increase in the aggregate demand will lead to an increase in the inflationary levels in the economy. Hence, if there is a positive output gap, the firms expect inflation and thereby inflation expectations to increase.

Inflation expectations help link the real side of the economy to the nominal side. This link is described through the canonical New Keynesian Philips curve (Clarida et al., 1999). The NKPC is a forward-looking model for inflation, inflation expectations and output gap. In the NKPC, prices are adjusted based on expected marginal costs. The BIES hence considers the one-year ahead expectations of unit costs of firms as their inflation expectations. The role of the underlying cost pressures on pricing decisions is captured.

Related Literature: Our study contributes to the growing literature on inflation expectations and builds on the relatively nascent literature on firms' inflation expectations. Savignac et al., 2021 use a survey from France to understand the link between price and wage expectations of firms and find that the relation between both is weak. Weber et al., 2022 explore the heterogeneity behind the formation of expectations of firms and households. They note that economic agents observe different signals in the environment to form expectations about prices. Coibion et al., 2018 provide evidence from randomized control trials that firm decisions are shaped by the changes in their inflation expectations.Candia et al., 2021 present results from a U.S.-based survey of firm inflation expectations. They find that firm inflation expectations deviate from that of households and professional forecasters. Bottone and Rosolia, 2019 study the impact of the COVID-19 shock on the pricing behaviour of Italian firms and explore the drivers of firms' inflation expectations. They find that the persistence of the epidemic has a negative impact on firms' inflation expecta-

tions. Conflitti and Zizza, 2021 study inflation expectations by splitting the sample into high and low inflation periods. For the period of study (2009-17), the authors find that firm inflation expectations are significantly affected by the increases in raw material prices. Bryan et al., 2015 examine the inflation expectations of U.S. firms and compare firm inflation expectations to that of professional forecasters. Andrade et al., 2022 use the survey of French manufacturing firms to study how aggregate and industry-specific conditions influence firms' expectations. They study the standard deviation of innovations to industry-level inflation and its persistence. To study the impact of personal experience on inflation expectations, McClure et al., 2022 compare the inflation expectations of managers and non-managers. They find no significant difference in the expectations of managers and non-managers. They also find that the sensitivity of the groups to publicly available information is similar. Coibion et al., 2018 examine firm inflation expectations using survey data from New Zealand. They find that inattention to indicators like inflation and GDP impacts the agreement among firms on inflation expectations.

The literature has primarily focused on examining the dispersion of inflation expectations amongst firms and the micro-level determinants of the expectation formation process. The studies based on the macroeconomic determinants of expectations are largely based on the expectations of households and professional forecasters. Carroll, 2003 proposes a model where household expectations are adapted probabilistically to that experts. According to this study, the deviation of inflation expectations from the benchmark can be attributed to reactions to dynamics of variables like inflation and unemployment. Andrade et al., 2023 find that household inflation expectations significantly impact private consumption. They utilise data on the perception of prices of commodities and assess the impact of expectations of durable consumption as well.

Our contributions extend to the literature on expectations and policy uncertainty (Galati et al., 2011; Istiak and Alam, 2019). We study the implications of COVID-19 on the effect of macroeconomic shocks on firm inflation expectations. We consider a dummy for the year 2020, the first level of control for covid. As the next level, we control for the India-specific impact of covid and the lagged impact of the first and second waves. The period from March 2020 to August 2021 is controlled for. As the third control, we use the covid stringency index by the Oxford Coronavirus Government Response Tracker. The covid stringency index has values from 0 to 100 and has been computed based on "school closures, workplace closures and travel bans". Higher values of the index indicate higher stringency in the lockdown measures.

Anchoring of Firm inflation expectations is critical for effective policy transmission. Our study has implications for inflation forecasting and policy planning of inflation-targeting central banks.

The remainder of the paper is structured as follows. Section 2 presents a theoretical framework for studying cost expectations. Section 3 summarizes the data and data sources. The BIES is discussed in more detail in this section. We outline the Empirical Model in Section 4 and provide the results in Section 5. The findings are summarised

in Section 6 and the concluding remarks are presented in Section 7.

2. Why consider Expectations of Unit Costs?

The forward-looking New Keynesian Philips curve presents a framework for the relationship between forward-looking inflation expectations, output slack and inflation levels. Marginal costs are important for the analysis since firms resetting prices will choose prices over current and expected costs (Galí, 2015). Inflation is hence a result of the price adjustments by firms made when anticipating the cost situation.

(Notations are borrowed from Galí, 2015)
The equation for Inflation:

$$\pi_t = \beta E_t(\pi_{t+1}) + \lambda \hat{mc}_t \tag{1}$$

The equation for output gap:

$$\tilde{y}_t \equiv y_t - y_t^n$$

$$\hat{mc}_t = (\sigma + \frac{\phi + \alpha}{1 - \alpha}(y_t - y_t^n)) \tag{2}$$

$\hat{mc}_t$ is the deviation of the real marginal cost from steady state. It is proportional to the output gap.

The Philips curve is derived by combining equations 1 and 2,

$$\pi_t = E(\pi_{t+1}) + \kappa \tilde{y}_t \tag{3}$$

The firm-wise data on business inflation expectations presents a niche opportunity to understand the impact of unit cost change expectations and the resultant implications for inflationary levels.

3. Data and Summary Statistics

3.1. Business Inflation Expectations Survey

The BIES is a monthly survey conducted by the Indian Institute of Management Ahmedabad. Business leaders are surveyed about their inflation expectations. Respondents are asked questions regarding year-ahead cost expectations, profit margins, sales gap and perception of current cost levels. The survey provides a probabilistic assessment of inflation expectations. This helps measure uncertainty. The survey is conducted through email every month. The included companies are in accordance with the list of companies available with the Ministry of Corporate Affairs (MCA).

The question on one-year ahead cost expectations:
Projecting ahead, to the best of your ability, please assign a percent likelihood (probability) to the following changes to costs per unit over the next 12 months.

i. *Unit costs down (less than -1%)*
ii. *Unit costs about unchanged (-1% to 1%)*
iii. *Unit costs up somewhat (1.1% to 3%)*
iv. *Unit costs up moderately (3.1% to 6%)*
v. *Unit costs up significantly (6.1% to 10%)*
vi. *Unit costs up very significantly (>10%)*

$ of the main or most important product in terms of sales. Values should add up to 100%

The one year ahead inflation expectation for a firm is computed as the weighted average of the percentage probabilities assigned to each of the responses (i-vi) by the respondent.

One year ahead Firm Inflation Expectation = -1.5(i) + 0*(ii) + 2*(iii) + 4.5*(iv) + 8*(v) + 10.5*(vi)*

The average of inflation expectations across firms is taken for the macroeconomic analysis. The following figure presents the graph for business inflation expectations for the sample period October 2017 to December 2022.

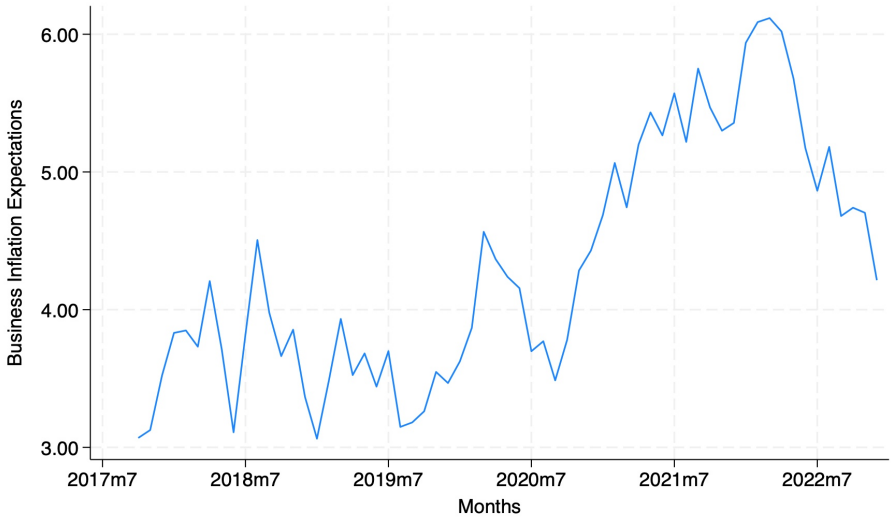


Figure 1: Business Inflation Expectations

3.2. Other Data Sources

The data for the analysis is at a monthly frequency from Oct-2017 to Dec-2022. The data for CPI headline inflation, CPI Food and Beverages inflation, Repo Rate, Real GDP growth rate and the Average Exchange Rate of INR-USD is obtained from

the Database on Indian Economy, Reserve Bank of India. The Real GDP growth rate is available at a quarterly frequency, we hence use the quarter value for all the months in the specific quarter. Repo rate is changed at irregular frequencies. If there is more that one repo rate value for a month, we take the average of the values to represent repo rate for a month. The data for Wholesale Price Index inflation is from the Office of Economic Advisor, Government of India. We got the data for Crude oil prices per barrel from the website of Petroleum Planning and Analysis Cell, Government of India.

The trend output for the sample period is estimated using the Hodrcik Prescott filter, Butterworth filter and Christiano Fitzgerald filter for the Real GDP Growth rate. The average trend output across filters is 4.5%. The output gap is computed as the difference between the real GDP growth rate and the average trend output 4.5%.

3.3. The COVID-19 Shock

The COVID-19 shock is purely exogenous with implications for aggregate demand and aggregate supply. Baqaee and Farhi, 2022 model the COVID-19 shock as a combination of disaggregate demand and supply shocks that have implications for the economy's production. According to Guerrieri et al., 2022, COVID-19 causes a negative supply shock leading to income losses and thereby leading to a drop in the aggregate demand. The shock has short run and long run implications for the macro economy. We focus on the short run angle and examine the impact of the shock on the dynamics of inflation expectations. We use three different measures for the COVID-19 shock. First, we use a dummy for the year 2020. As the second measure we use a dummy from March 2020 to August 2021 to control for the actual and lagged effects of the first and second waves of COVID-19. Thirdly, we use the Covid Stringency Index by the Oxford Coronavirus Government Response Tracker. The index captures the effects of lockdown and movement restrictions owing to the pandemic. The three measures help account for the subsequent stages of the pandemic. We aim to understand the dynamics of variables across the three measures.

3.4. Summarizing the Data

Table 1 displays the summary statistics for Business Inflation Expectations, Crude oil inflation, CPI Food and Beverages Inflation, CPI Headline inflation, INR-USD Exchange Rate, Output Gap, Repo Rate and WPI Inflation. Crude oil inflation has a high standard deviation. This can be attributed to the high volatility of crude oil prices. Table 2 presents the correlation coefficients for the variables.

WPI Inflation, Exchange Rate INR-USD, Repo Rate, Crude oil inflation and CPI Headline inflation are highly correlated to the Business Inflation expectations. The correlation coefficients of Food and Beverages Inflation and Output gap are on the lower side.

We test for stationarity of the variables using the Augmented Dicky Fuller test. The results from the Augmented Dicky Fuller test are provided in the appendix. Since

Table 1: Summary Statistics

	(1)				
	count	mean	sd	min	max
Business Inflation Expectations	63	4.310	0.879	3.063	6.117
Crude oil inflation	63	22.422	48.432	-71.972	218.593
CPI Food and Beverages inflation	63	4.863	3.328	-1.689	12.156
CPI Headline inflation	63	5.196	1.568	1.970	7.790
Exchange Rate INR-USD	59	72.077	3.799	63.637	79.602
Output Gap	60	-0.002	8.204	-27.867	17.050
Repo Rate	63	5.086	0.985	4.000	6.500
WPI Inflation	63	5.838	5.303	-3.372	16.629
Observations	63				

Table 2: Correlation Coefficients

	(1)
	Business Inflation Expectations
Crude oil inflation	0.564***
CPI Food and Beverages inflation	0.162
CPI Headline inflation	0.429***
Exchange Rate INR-USD	0.629***
Output Gap	0.244
Repo Rate	-0.627***
WPI Inflation	0.810***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

the sample period for the analysis is relatively small, we also test for stationarity of the variables for a longer period as well. This is to ensure that the series inherently are not explosive. For the sample period, the variables are a mix of stationary and non-stationary.

4. Model and Identification

We use the SVAR and Local Projections models for the analysis. The identification strategy in this paper presents an innovation to the models in Wong, 2015 and Leduc et al., 2007. We assume there is a contemporaneous relationship between inflation and inflation expectations. Wong, 2015 focuses on understanding if inflation expectations act as a transmission channel to inflation and hence assumes that inflation expectations contemporaneously impact inflation. Bachmann et al., 2023 emphasise the role of everyday price signals on inflation expectations. They assign significance to the observed prices on the expectations of inflation. We hence assume that inflation impacts inflation expectations contemporaneously. The observed price signals

translate into the different inflation indicators and the sub-components. Agents use prices observed in daily life to form expectations about aggregate inflation.

Impulse responses from the local projections model are robust to misspecification of the Data Generating Process. They use direct forecasts to arrive at the coefficients for the impulse response functions (Jordà, 2005). Considering the advantages of the local projections model, we use local projections to assess if the results are robust to recursive ordering.

The baseline model has the variables Crude oil inflation, Wholesale Price Index inflation and Business inflation expectations. The exogenous variable is a measure of COVID-19. Amongst the three endogenous variables, crude oil inflation reflects changes in the external sector. We substitute this with the INR-USD exchange rate in the next model. We present additional results where we incorporate the Food and Beverages inflation, Repo Rate and Output gap.

4.1. SVAR

The Structural Vector Autoregression model for the analysis is:

$$A_0 y_t = \sum_{i=1}^{p} A_i y_{t-i} + \epsilon_t \tag{4}$$

where $y_t = [\pi^{crudeoil}, \pi^{wpi}, \pi_t^e]$ consists of the endogenous variables Crude oil inflation, Wholesale price inflation and a survey measure of inflation expectations from BIES formed at time t. ϵ is the vector of orthogonal structural shocks with mean 0 and covariance matrix $\sum_\epsilon$. The structural shocks capture the contemporaneous relationships between the endogenous variables. The reduced form SVAR model is of the form

$$y_t = \sum_{i-1}^{p} B_i y_{t-i} + u_t \tag{5}$$

where u_t is the vector of reduced form errors

4.1.1. Identification Strategy

As the first step, we estimate an SVAR model with the variables Crude Oil inflation, Wholesale Price Index inflation and Business inflation expectations. The objective of this model is to capture the input cost channel of inflation expectations. Aastveit et al., 2023 and identify two channels through which oil prices impact inflation - direct and indirect. A Reserve Bank of India study (Ghosh and Tomar, 2019) identifies these two key channels in the Indian context. In the direct channel, international crude oil prices impact domestic crude oil prices, thereby leading to an increase in headline inflation. An increase in crude oil prices leads to an increase in the input costs of firms. Oil prices as an input, and next through the wage bargaining mechanism where labour bargains for higher wages. This will impact the price-setting decisions of firms. This is then reflected in through the Wholesale Price

Index inflation. Both of these variables have an impact on the inflation expectations of firms.

The lags are chosen in accordance with the Akaike Information Criterion (AIC).

$$\begin{pmatrix} u^{\pi^{crudeoil}} \\ u^{\pi^{wholesale}} \\ u^{\pi^{e}} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ b1 & 1 & 0 \\ b2 & b3 & 1 \end{pmatrix} \begin{pmatrix} e^{\pi^{crudeoil}} \\ e^{\pi^{wholesale}} \\ e^{\pi^{e}} \end{pmatrix}$$

4.2. Local Projections

In addition to the SVAR analysis, we use the local projections model by Jordà, 2005 to analyse the impact of the macroeconomic shocks on business inflation expectations (as in Mian et al., 2015). Estimations with the local projections model are used to test for the robustness of the results. A general representation of local projections is given below (Notations borrowed from Jordà, 2005)

$$y_{t+p} = a^p + B_1^{p+1} y_{t-1} + B_2^{p+1}{}_{t-2} + ... + B_k^{p+1}{}_{t-k} + u_{t+p}^p \tag{6}$$

where s = 0,1,2,...p; a^p is a vector of constants and B_i^{p+1} are matrices of coefficients for each lag i and horizon s+1.

5. Results and Discussion

This section presents results from the SVAR and the Local Projections model and an SVAR model for a longer horizon. The local projections model acts as a robustness check. A critique of SVAR has been misspecification through assumption of the ordering of the variables. The local projections model does not assume a recursive ordering of variables and hence acts as a robustness check to the estimations from SVAR.

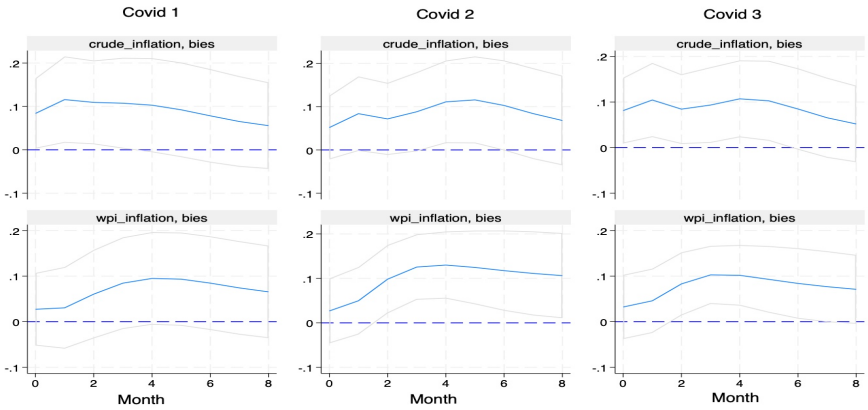
5.1. Baseline Results with Robustness Check

Model 1: Crude oil inflation, Wholesale Price Index inflation, Business inflation expectations

The impulse response functions in Figure 2 capture the response of the business inflation expectations to a one per cent structural shock to the crude oil inflation (Figures in the first row) and to the Wholesale Price Index inflation (Figures in the second row). The three columns represent the three different covid exogenous measures. A shock to WPI leads to a less than 0.1 per cent increase in BIES in panel 1. The increase in BIES, as a response to the WPI shock, in the second and third panels is greater than 0.1 per cent. A shock to the crude oil inflation leads to a 0.1 per cent increase in BIES. The response peaks around horizon one and gradually dampens. The dampening is more apparent in the first panel. However, in panel 2, the peak response is achieved around horizon 5. In panel 3, the peak is achieved in both horizons 1 and 5.

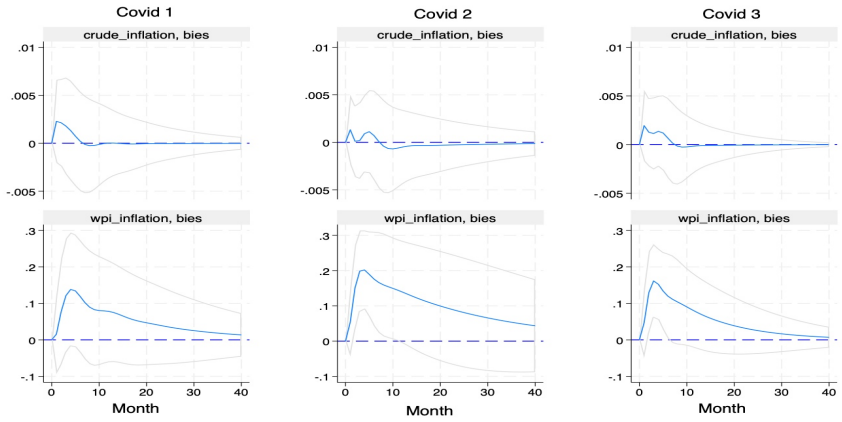
We estimate IRFs for longer horizons for the SVAR specification. Figure 3 presents the Impulse Response Functions for 40 months. The objective of the figure is to demonstrate the eventual convergence of the responses to the shocks. We observe that the persistence of the WPI increases in Panels 2 and 3. The change in persistence is observable in the Impulse response functions of the Local Projections Model in Figure 4. We estimate IRFs using the Local projections model as a robustness check. The IRFs for the VAR and Local projections are similar and indicative of robust results. From the Forecast error variance (see FEVD tables in Appendix), we see that for Covid measures 2 and 3, Crude oil inflation and Wholesale Price Index inflation explain a higher percentage of the variance in BIES when compared to the first Covid measure.

Figure 2: SVAR Model



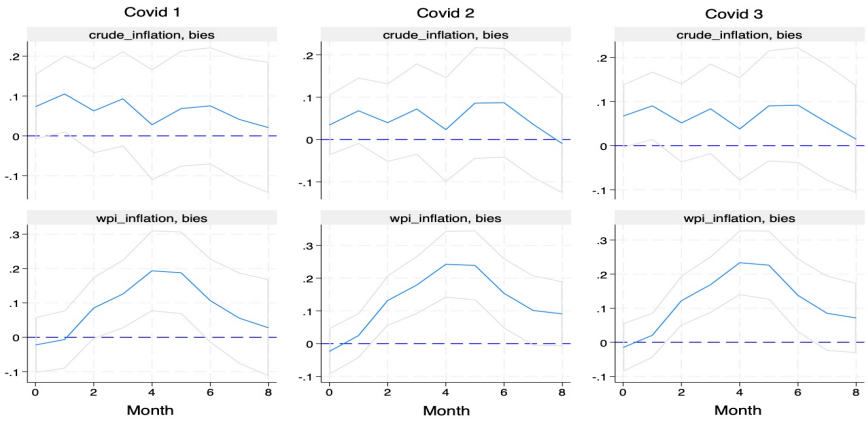
Notes: The variables in the SVAR specification are Crude oil inflation, Wholesale Price Index inflation and BIES. The three panels (columns) represent the three different covid measures. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 2 across the three specifications for the model presented in this section. The IRFs are structural impulse response functions.

Figure 3: SVAR - 40 month horizon



Notes: The variables in the SVAR specification are Crude oil inflation, Wholesale Price Index inflation and BIES. The three panels (columns) represent the three different covid measures. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 2 across the three specifications for the model presented in this section.

Figure 4: Local Projections Model



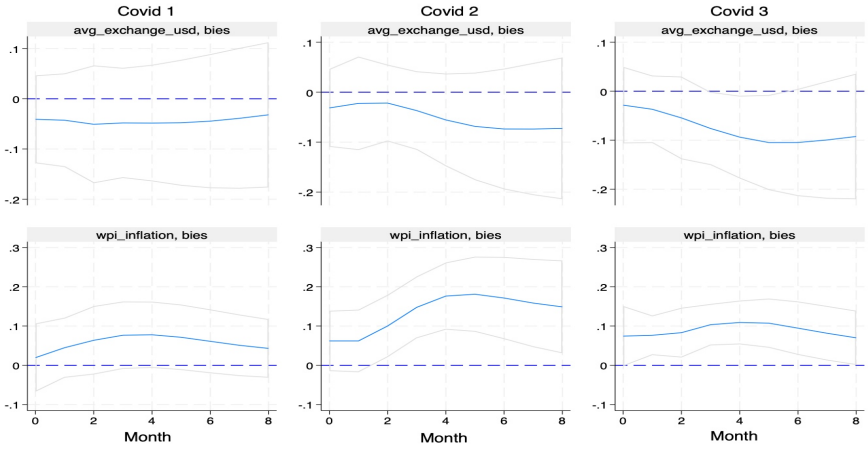
Notes: The variables in the Local Projections model are Crude oil inflation, Wholesale Price Index inflation and BIES. The three panels (columns) represent the three different covid measures. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 2 across the three specifications for the model presented in this section.

Model 2: INR-USD Exchange rate, Wholesale Price Index inflation, Business inflation expectations

We estimate a model with the INR-USD Exchange rate to capture the impact of exchange rate fluctuations on the inflation expectations of firms. The specification

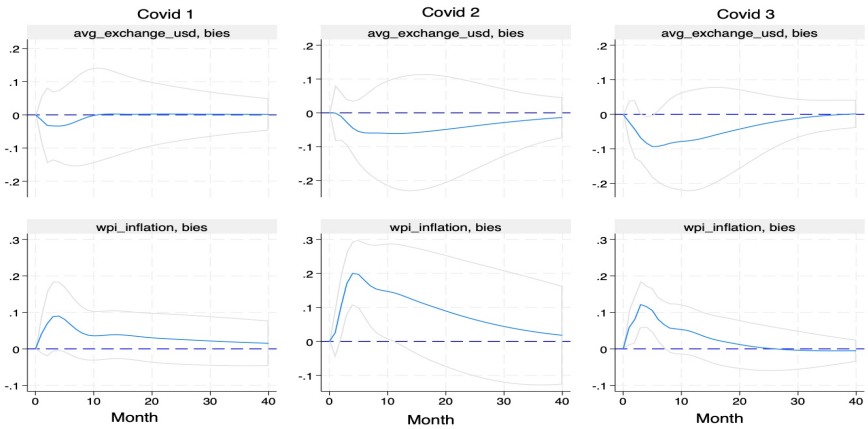
for this model is $(Exchangerate, \pi^{wpi}, \pi^{e})$. The exchange rate has an impact on both the Wholesale Price Index inflation and the business inflation expectations. However, WPI and BIES do not have a contemporaneous impact on the exchange rate. Similarly, we assume WPI has a contemporaneous effect on BIES. However, the impact of inflation expectations on inflation is realised with a lagged effect (insert studies to support this). From the IRFs in Figure 5, we see that the impact of a shock to the exchange rate on business inflation expectations is more pronounced progressively for covid measures 2 and 3. A one-unit shock to the average exchange rate reduces business inflation expectations by 0.1 % in covid measure 3.

Figure 5: SVAR Model



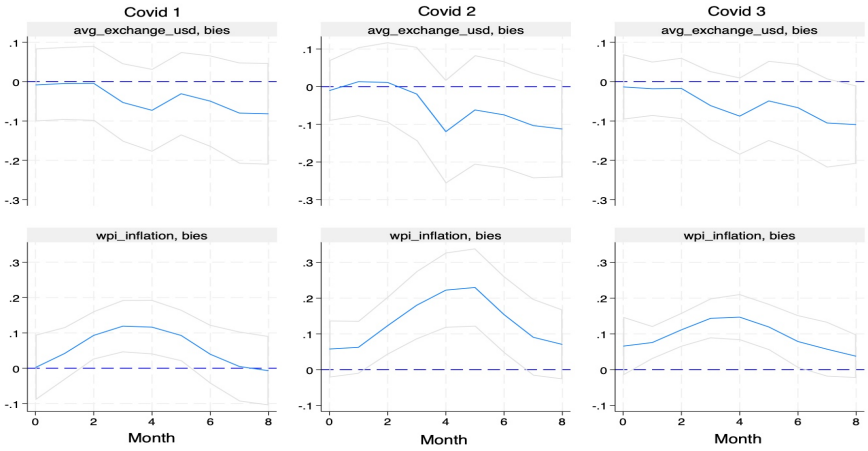
Notes: The variables in the SVAR specification are INR-USD Exchange rate, Wholesale Price Index inflation and BIES. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 3 for the first and third specification, and 2 for the second specification of the model presented in this section.The IRFs are structural impulse response functions.

Figure 6: SVAR - 40 month horizon



Notes: The variables in the SVAR specification are INR-USD Exchange rate, Wholesale Price Index inflation and BIES. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 3 for the first and third specification, and 2 for the second specification of the model presented in this section.

Figure 7: Local Projections Model



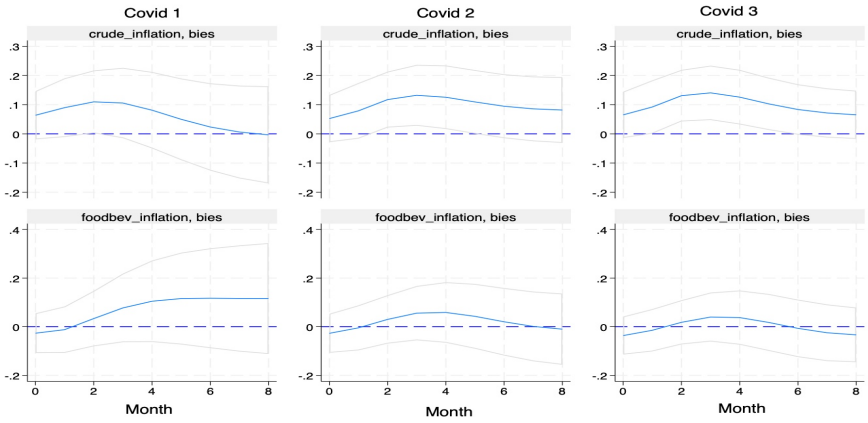
Notes: The variables in the Local projections model are INR-USD Exchange rate, Wholesale Price Index inflation and BIES: $(ExchRate, \pi^{wpi}, \pi^{e})$. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 3 for the first and third specification, and 2 for the second specification of the model presented in this section.

5.2. Additional Results

Model 3: Crude oil inflation, Food and Beverages inflation, Business inflation expectations

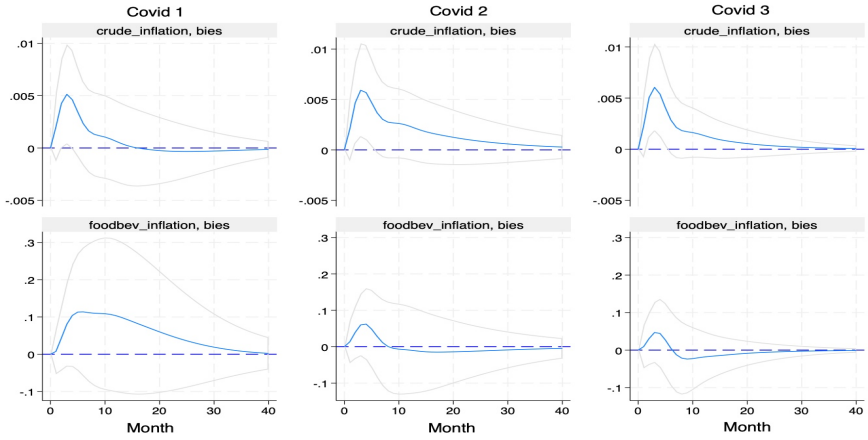
Kumar et al., 2015 find that managers rely on personal shopping experience to form expectations about general price levels. To understand if their price perceptions influence their cost expectations, we incorporate food and beverages inflation as a variable in the SVAR specification. Crude oil inflation translates into energy inflation and can affect food and beverages inflation as input price changes. The model specification is hence $(\pi^{crude}, \pi^{food}, \pi^{e})$. From Figure 8, we see that the impact of a one-unit shock to food and beverages inflation on business inflation expectations is gradual in the Covid 1 measure. It is more persistent than the other two measures of Covid.

Figure 8: SVAR Model



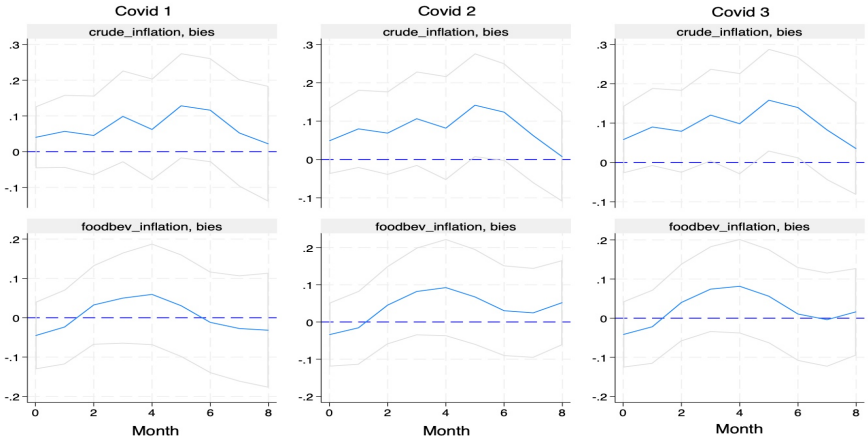
Notes: The variables in the SVAR specification are Crude oil inflation, Food and Beverages inflation and BIES. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 2 for all the specifications of the model presented in this section. The IRFs are structural impulse response functions.

Figure 9: SVAR - 40 month horizon



Notes: The variables in the SVAR specification are Crude oil inflation, Food and Beverages inflation and BIES. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 2 for all the specifications of the model presented in this section.

Figure 10: Local Projections Model

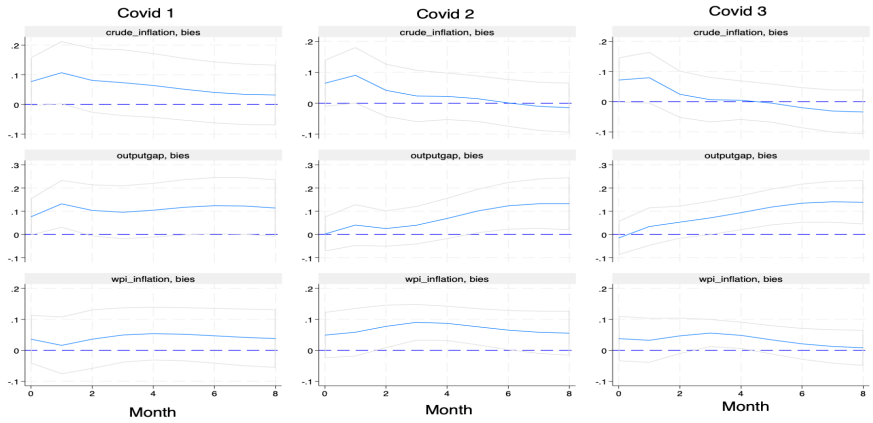


Notes: The variables in the SVAR specification are INR-USD Exchange Rate, Food and Beverages inflation and BIES. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 2 for all the specifications of the model presented in this section.

Model 4: Crude oil inflation, Output Gap, Wholesale Price Index inflation, Business inflation expectations

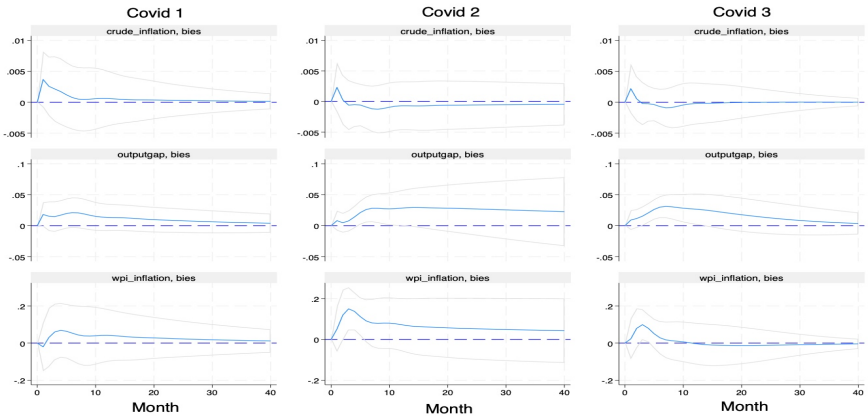
A positive output gap leads to higher inflation and should hence lead to higher inflation expectations. From the graphs below, we note that the impact of a shock-to-output gap on business inflation expectations varies in magnitude across the three covid measures. For measures 2 and 3, the peak is around horizon 5, while for measure 1, the peak is both in horizon 1. The impact of a crude oil shock wanes quickly in Covid measures 2 and 3. From the 40-month horizon graphs, we see that the persistence of the output gap and WPI shock is highest for Covid measure two and then Covid measure three.

Figure 11: SVAR Model



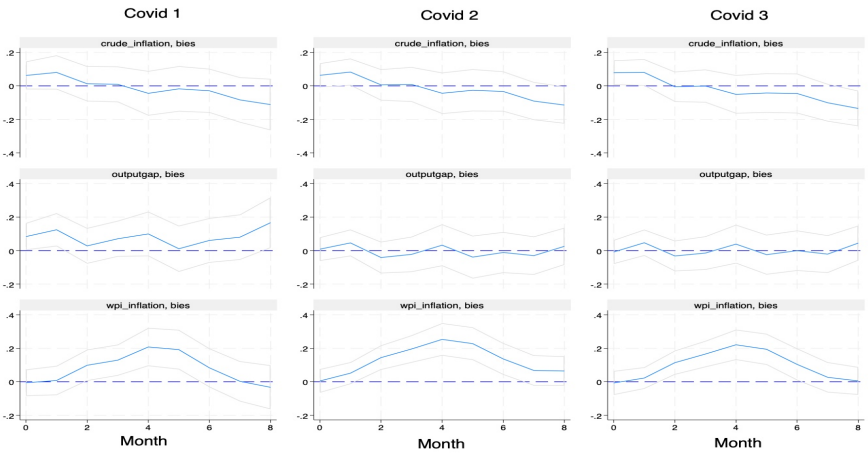
Notes: The variables in the SVAR specification are Crude oil inflation, Output Gap, Wholesale Price Index inflation and BIES. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 2 for all the specifications of the model presented in this section. The IRFs are structural impulse response functions.

Figure 12: SVAR - 40 month horizon



Notes: The variables in the SVAR specification are Crude oil inflation, Output Gap, Wholesale Price Index inflation and BIES. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 2 for all the specifications of the model presented in this section.

Figure 13: Local Projections Model

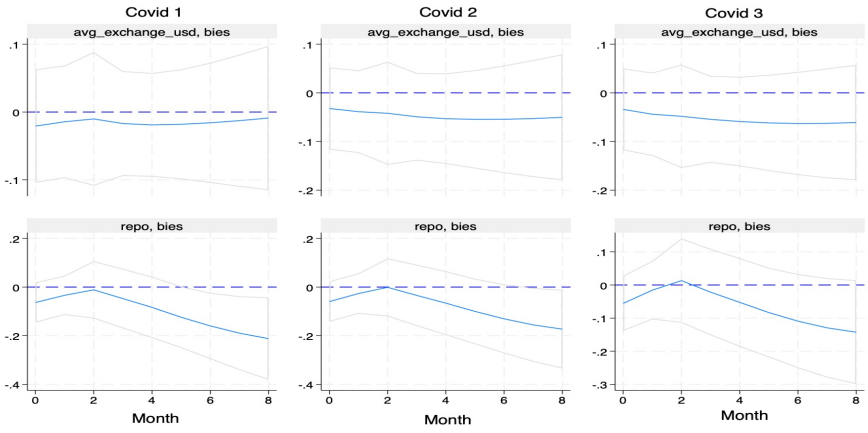


Notes: The variables in the Local Projections model are Crude oil inflation, Output Gap, Wholesale Price Index inflation and BIES. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 2 for all the specifications of the model presented in this section.

Model 5: INR-USD Exchange Rate, Repo Rate, Business inflation expectations

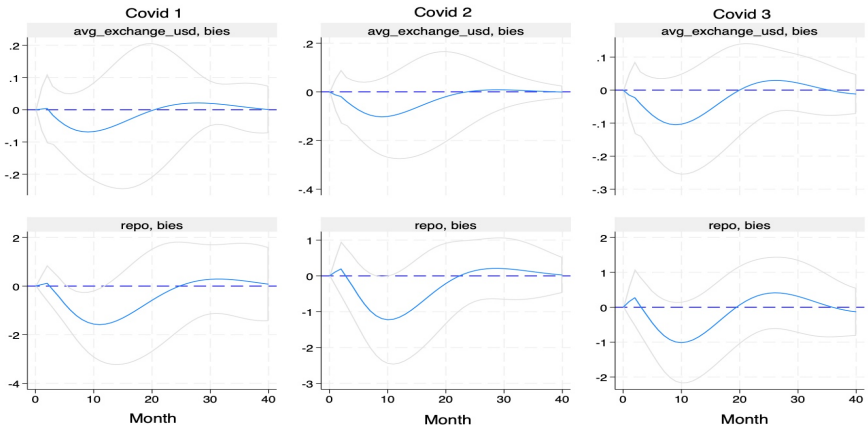
The repo rate is the policy interest rate that the central bank uses to control the money supply in the economy. An increase in the interest rate will lead to a decrease in the inflation rate. Managers will hence expect the inflation rate to go down if there is a decrease in the interest rate. Monetary policy instruments such as the policy repo rate respond to changes in the exchange rate (Taylor, 2001).Thus, the impact of the exchange rate on the repo rate is considered contemporaneous. We note that a shock to the repo causes a slight increase in BIES initially and then a decline. This could reflect the perception that a one per cent increase in the repo rate could signal higher inflation rates. Goyal and Parab, 2021 note a similar reaction of household expectations to the policy repo rate. However, the eventual decline of the shock on business inflation expectations is reflective of the credibility of the central bank in maintaining the targeted rate of inflation. The Reserve Bank of India adopted the inflation-targeting regime in 2016. The flexible inflation targeting regime targets inflation at 4 per cent with a bank of +/- 2 per cent. We do not see a considerable difference across Covid measures when the repo rate is the impulse.

Figure 14: SVAR Model



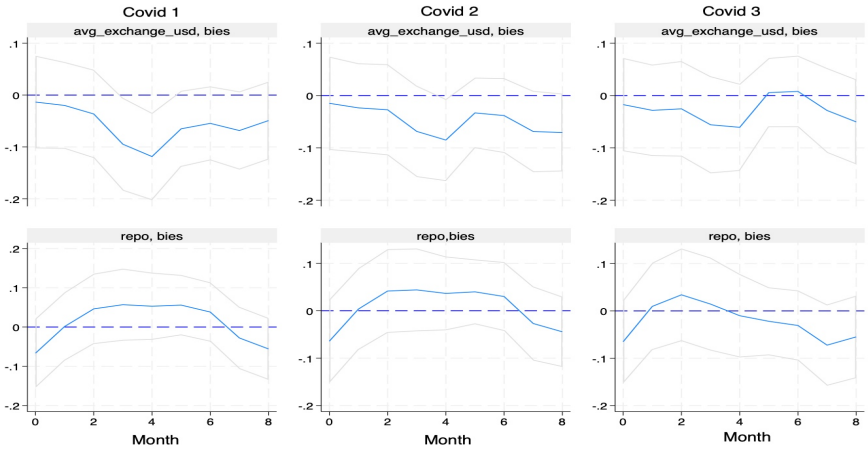
Notes: The variables in the SVAR specification are INR-USD Exchange Rate, Repo Rate, and BIES. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 3 for all the specifications of the model presented in this section. The IRFs are structural impulse response functions.

Figure 15: SVAR - 40 month horizon



Notes: The variables in the SVAR specification are INR-USD Exchange Rate, Repo Rate and BIES. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 3 for all the specifications of the model presented in this section.

Figure 16: Local Projections Model



Notes: The variables in the Local Projections model are INR-USD Exchange Rate, Repo Rate and BIES. Panel 1 presents the IRFs for Covid measure 1 wherein the we assign a dummy for the year 2020. For Covid measure 2, we assign a dummy from March 2020-August 2021. Covid measure 3 represents the covid stringency index. According to AIC lag selection criterion, the optimal number of lags is 3 for all the specifications of the model presented in this section.

6. Discussion

Our focus has been to understand how inflation expectations respond to macroeconomic shocks. In addition, we bring in Covid as the exogenous variable and incorporate three different measures to capture the effects. The results are similar for SVAR

and Local Projections and hence robust. We find that wholesale price inflation and crude oil inflation shocks have the most impact on firm inflation expectations. This could be because the two mentioned indicators are representative of cost pressures. The persistence of two indicators increases across the Covid measures. The exchange rate can be categorised in the second tier of measures that impact firm inflation expectations, along with output gap and Repo rate. The persistence of the average exchange rate also increases across Covid measures. Shocks to the Repo rate and Output gap do not seem to vary considerably across the Covid measures. The impact of a shock to food and beverages inflation reduces as we incorporate more months into the Covid measure. This could be in line with Arce-Alfaro and Blagov, 2023, who suggests that people pay more attention to macroeconomic indicators during a crisis. An indicator representative of personal experience may not be of significance to the formation of inflation expectations when the managers are able to assess parameters appropriate for cost expectations. It can be reasonable to conclude that managers assign importance to indicators that could considerably impact firm pricing decisions through a cost push. Shocks to these indicators have higher persistence with respect to their inflation expectations during increasing periods of uncertainty. Identifying key indicators that influence inflation expectations of firms can help the central bank create better forecasts and structure relevant policy actions. Our insights on dynamics during COVID-19 can be extended to policy planning during heightened periods of economic uncertainty. Inflation targeting requires that inflation expectations be well-anchored. A strong understanding of the formation of expectations is key to anchoring expectations.

7. Concluding Remarks

In this paper, we analyse the formation of inflation expectations of firms. Our contribution to the literature and policy sphere is novel since we focus on the propagation of macroeconomic shocks to business inflation expectations. Additionally, we introduce COVID-19 as the exogenous shock. The External sector indicators we analyse include crude oil inflation and the INR-USD exchange rate. The components of domestic inflation in our analysis are Wholesale price inflation and Food and Beverages inflation. We also incorporate the Repo rate (interest rate) and a measure for Output gap. Managers are more likely to form inflation expectations based on indicators that impact input costs of firms to form. This study has implications for the short run aggregate demand and supply changes. Effective implementation of the inflation targeting regime requires the anchoring of inflation expectations in the short and long horizons. Our analysis can be extended to generating forecasts and studying long run relationships between variables.

References

Aastveit, K. A., Bjørnland, H. C., & Cross, J. L. (2023). Inflation Expectations and the Pass-Through of Oil Prices. *The Review of Economics and Statistics*, *105*(3), 733–743.

Andrade, P., Coibion, O., Gautier, E., & Gorodnichenko, Y. (2022). No firm is an island? how industry conditions shape firms' expectations. *Journal of Monetary Economics*, *125*, 40–56.

Andrade, P., Gautier, E., & Mengus, E. (2023). What matters in households' inflation expectations? *Journal of Monetary Economics*.

Arce-Alfaro, G., & Blagov, B. (2023). Monetary policy uncertainty and inflation expectations. *Oxford Bulletin of Economics and Statistics*, *85*(1), 70–94.

Bachmann, R., Topa, G., & van der Klaauw, W. (Eds.). (2023). Chapter 5 - what do the data tell us about inflation expectations? In *Handbook of economic expectations* (pp. 133–161). Academic Press.

Baqaee, D., & Farhi, E. (2022). Supply and demand in disaggregated keynesian economies with an application to the covid-19 crisis. *American Economic Review*, *112*(5), 1397–1436.

Bernanke, B. (2007). Inflation expectations and inflation forecasting [Speech delivered at the Monetary Economics Workshop of the NBER Summer Institute, Cambridge, MA].

Bottone, M., & Rosolia, A. (2019). *Monetary policy, firms' inflation expectations and prices: causal evidence from firm-level data* (tech. rep.). Bank of Italy, Economic Research and International Relations Area.

Bryan, M. F., Meyer, B. H., & Parker, N. B. (2015). *The inflation expectations of firms: What do they look like, are they accurate, and do they matter?* (Working Paper 2014-27a). Federal Reserve Bank of Atlanta.

Candia, B., Coibion, O., & Gorodnichenko, Y. (2021). *The inflation expectations of u.s. firms: Evidence from a new survey* (Working Paper No. 28836). National Bureau of Economic Research.

Carroll, C. D. (2003). Macroeconomic expectations of households and professional forecasters. *The Quarterly Journal of Economics*, *118*(1), 269–298.

Cavallo, A., Cruces, G., & Perez-Truglia, R. (2017). Inflation expectations, learning, and supermarket prices: Evidence from survey experiments. *American Economic Journal: Macroeconomics*, *9*(3).

Clarida, R., Gali, J., & Gertler, M. (1999). The science of monetary policy: A new keynesian perspective. *Journal of Economic Literature*, *37*(4), 1661–1707.

Coibion, O., Gorodnichenko, Y., & Kumar, S. (2018). How do firms form their expectations? new survey evidence. *American Economic Review*, *108*(9), 2671–2713.

Coibion, O., Gorodnichenko, Y., Kumar, S., & Pedemonte, M. (2020). Inflation expectations as a policy tool? *Journal of International Economics*, *124*, 103297.

Conflitti, C., & Zizza, R. (2021). What's behind firms' inflation forecasts? *Empirical Economics*, *61*(5), 2449–2475.

D'Acunto, F., Malmendier, U., Ospina, J., & Weber, M. (2021). Exposure to grocery prices and inflation expectations. *Journal of Political Economy*, *129*(5), 1615–1639.

Falck, E., Hoffmann, M., & Hürtgen, P. (2021). Disagreement about inflation expectations and monetary policy transmission. *Journal of Monetary Economics*, *118*, 15–31.

Galati, G., Poelhekke, S., & Zhou, C. (2011). Did the Crisis Affect Inflation Expectations? *International Journal of Central Banking*, *7*(1), 167–207.

Galí, J. (2015). *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework and Its Applications Second edition*. Princeton University Press.

Ghosh, S., & Tomar, S. (2019). *The impact of crude price shock on india's current account deficit, inflation and fiscal deficit* (Working Paper No. 17). Reserve Bank of India.

Goyal, A., & Parab, P. (2021). What influences aggregate inflation expectations of households in india? *Journal of Asian Economics*, *72*, 101260.

Guerrieri, V., Lorenzoni, G., Straub, L., & Werning, I. (2022). Macroeconomic implications of covid-19: Can negative supply shocks cause demand shortages? *American Economic Review*, *112*(5), 1437–74.

Istiak, K., & Alam, M. R. (2019). Oil prices, policy uncertainty and asymmetries in inflation expectations. *Journal of Economic Studies*, *46*(2), 324–334.

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review*, *95*(1), 161–182.

Kilian, L. (2008). The economic effects of energy price shocks. *Journal of Economic Literature*, *46*(4), 871–909.

Kilian, L., & Zhou, X. (2021). *The Impact of Rising Oil Prices on U.S. Inflation and Inflation Expectations in 2020-23* (CEPR Discussion Papers No. 16776). C.E.P.R. Discussion Papers.

Kumar, S., Afrouzi, H., Coibion, O., & Gorodnichenko, Y. (2015). *Inflation targeting does not anchor inflation expectations: Evidence from firms in new zealand* (Working Paper No. 21814). National Bureau of Economic Research.

Leduc, S., Sill, K., & Stark, T. (2007). Self-fulfilling expectations and the inflation of the 1970s: Evidence from the livingston survey. *Journal of Monetary Economics*, *54*, 433–459.

McClure, E. M. L., Coibion, O., & Gorodnichenko, Y. (2022). *The macroeconomic expectations of u.s. managers* (Working Paper No. 29986). National Bureau of Economic Research.

Mian, A. R., Sufi, A., & Verner, E. (2015). *Household debt and business cycles worldwide* (Working Paper No. 21581). National Bureau of Economic Research.

Moessner, R. (2022). Determinants of Inflation Expectations in the Euro Area. *Intereconomics: Review of European Economic Policy*, *57*(2), 99–102.

Savignac, F., Gautier, E., Gorodnichenko, Y., & Coibion, O. (2021). *Firms' inflation expectations: New evidence from france* (Working Paper No. 29376). National Bureau of Economic Research.

Taylor, J. B. (2001). The role of the exchange rate in monetary-policy rules. *The American Economic Review*, *91*(2), 263–267.

Weber, M., D'Acunto, F., Gorodnichenko, Y., & Coibion, O. (2022). The subjective inflation expectations of households and firms: Measurement, determinants, and implications. *Journal of Economic Perspectives*, *36*(3), 157–184.

Wong, B. (2015). Do inflation expectations propagate the inflationary impact of real oil price shocks?: Evidence from the michigan survey. *Journal of Money, Credit and Banking*, *47*(8), 1673–1689.

Appendix A. Stationarity Test Results

The table presents the results for the Augmented Dicky Fuller Test. The lags are chosen based on the AIC criterion. The table presents results for Null hypotheses of Random walk without drift and with drift

Variable	Lags	Test Statistic	P value (without Drift)	P value (Drift)
Business Inflation Expectations	1	-1.848	0.357	0.035**
Crude oil inflation	2	-2.328	0.163	0.012**
CPI Food and Beverages inflation	2	-2.072	0.256	0.021**
CPI Headline inflation	2	-2.054	0.263	0.022**
Exchange Rate INR-USD	1	-1.192	0.677	0.119
Output Gap	1	-2.783	0.061*	0.004***
Repo Rate	4	-1.472	0.548	0.073*
WPI Inflation	3	-1.440	0.563	0.078*

Appendix B. Forecast Error Variance Decomposition for Baseline Results

Appendix B.1. FEVD for Model 1

Model 1: Crude Inflation, WPI Inflation, BIES. From the FEVD table, we notice that the respective contributions of crude oil inflation and wholesale price inflation increase across the Covid measures

	Covid 1		Covid 2		Covid Stringency	
Step	crude inflation	wpi inflation	crude inflation	wpi inflation	crude inflation	wpi inflation
0	0.000	0.000	0.000	0.000	0.000	0.000
1	0.065	0.007	0.031	0.008	0.077	0.012
2	0.112	0.009	0.074	0.024	0.143	0.026
3	0.141	0.023	0.097	0.084	0.178	0.073
4	0.161	0.046	0.125	0.159	0.209	0.129
5	0.171	0.068	0.160	0.209	0.237	0.164
6	0.173	0.083	0.186	0.235	0.252	0.180
7	0.170	0.092	0.197	0.250	0.256	0.191
8	0.166	0.097	0.198	0.262	0.255	0.201

Appendix B.2. FEVD for Model 2

Model 2: INR-USD Exchange Rate, WPI Inflation, BIES. In this model, shocks to wholesale price inflation considerably explain shocks to business inflation expectations

	Covid 1		Covid 2		Covid Stringency	
Step	exchange usd	wpi inflation	exchange usd	wpi inflation	exchange usd	wpi inflation
0	0.000	0.000	0.000	0.000	0.000	0.000
1	0.021	0.040	0.011	0.043	0.008	0.073
2	0.025	0.052	0.011	0.057	0.012	0.098
3	0.024	0.081	0.013	0.115	0.022	0.165
4	0.022	0.122	0.018	0.218	0.040	0.266
5	0.020	0.163	0.029	0.315	0.058	0.348
6	0.018	0.193	0.040	0.372	0.072	0.390
7	0.016	0.210	0.050	0.399	0.082	0.409
8	0.015	0.218	0.057	0.411	0.091	0.419