ERASMUS UNIVERSITY ROTTERDAM

Erasmus School of Economics

Master Thesis (Programme Economics and Business)

Title: The Spillover Effects Of Fed Quantitative Easing On Indian Economy: Lessons From The GFC And Covid-19 Pandemic

Name student: Niharika Agrawal

Student ID Number: 638642

Supervisor: Felix Ward

Second Assessor:

Date Final Version:

Abstract

Unconventional monetary policy has emerged as an additional means of stimulating the economy when traditional policies have reached their limits. A prominent tool in this regard is quantitative easing (QE), which gained importance after the Global Financial Crisis (GFC) when central bank interest rates had already hit their effective lower bounds. These QE measures had significant implications, both domestically and globally, particularly for emerging market economies (EMEs). This paper focuses on investigating the spillover effects of Federal Reserve (Fed) QE measures on Indian economy during the GFC and the more recent Covid-19 pandemic. By employing a VAR (Vector Autoregression) framework on monthly data of Indian financial and economic variables, the study examines the relationship between Fed QE actions and performance of Indian economy. The analysis reveals positive effects for financial variables while negative for economic variables; however, high statistical significance overall is not established during both crises. Additionally, assessing the difference in magnitude of impact of QE measures during the two crises revealed that the effectiveness is relatively higher in magnitude during the Covid-19 pandemic, notably for the financial variables. The impact on stock market returns, on average, is five times higher while that on bond yields is two times larger than the GFC period. Furthermore, robustness tests using exchange rates and combining two asset classes (stock market returns and bond yields) were conducted, confirming the reliability of the main findings.

Table of Contents

1. Introduction

For decades, the central bank policy rate has been the most valuable tool in performing countercyclical monetary policy around the world. During recessions, central banks slash their policy rate in an attempt to stimulate consumption, investment, and thus aggregate demand. However, during the eruption of the Great Financial Crisis (GFC) in 2008, the effective lower bound had been reached in many western countries, rendering conventional monetary policy ineffective. In order to propel growth, central banks namely in the US, UK and Euro Area implemented quantitative easing (QE), an unconventional monetary policy (UMP) tool which includes large scale purchases of assets in the open market by the central bank. The purpose of such tools is to put downward pressure on longer term interest rates to support borrowings of households and firms to spur real economic activity (Baumeister and Benati, 2013)

Till date, major central banks have resorted to QE during two main crises: the GFC 2008-09 and the Covid-19 pandemic. While the former was a financial mishap, the latter was an unprecedented health crisis which quickly turned into a financial and economic crisis. The effects of QE extended beyond domestic boundaries, impacting economies worldwide (Bhattarai et al., 2015). While current research has focused mainly on the global spillover effects of the QE during the GFC (see Chen et al. (2012), Fratzscher et al. (2014), Horvath & Voslarova (2017), Lavigne et al. (2014)), there exists a dearth of literature assessing the effect during the pandemic.

Emerging market economies (EMEs) were particularly affected by the QE programs. After the implementation of the QE during the GFC, emerging market economies (EME) were a major recipient of huge capital inflows leading to significant impact on their financial and macroeconomic variables (Bhattarai et al., 2015). The transmission mechanism of such a policy towards EME has been extensively studied in the literature and can be summarized in the following channels. (see Chen et al., (2012), Fratzscher et al., (2014), Lavigne et al. (2014), Neely (2010)).

Firstly, portfolio rebalancing channel comes from intersubstitutability of assets. Depressed yields in the US encourage asset holders to seek higher risk-adjusted returns in EMEs by adjusting their portfolio. This leads to a boom in asset prices and reduces long term interest rates in EMEs. The second channel involves a signaling channel which works through an integrated global financial markets. If advanced economies' central bank is committed to QE policy and keeping policy rate near zero levels in the foreseeable future, it would lead to persistence of an interest rate differential

between EMEs and advanced economies, prompting capital flows and trade into EMEs. Huge trade flows into EMEs lead to depreciation of exchange rate with respect to EMEs. This channel is known as the exchange rate channel. Long periods of QE could put persistent appreciation pressure on EME currencies which would help bolster their exports known as external demand and trade flow channel.

In this research paper, I aim to explore the spillover effects of Federal Reserve (Fed) QE during the GFC and the recent Covid-19 pandemic on the Indian economy. India is chosen as the primary focus due to its classification as one of the Fragile Five economies during the GFC. Additionally, I seek to understand the impact during the pandemic, considering it marked the largest Fed QE program in history.

This paper contributes to the academic literature in two ways. Firstly, it specifically examines the impact of US QE on the Indian economy. Secondly, it conducts a comparative analysis between the two significant monetary policy shocks, offering insights into the differential impact on the Indian economy. As far as my knowledge extends, this is the first paper that concentrates on the effects of US QE on the Indian economy and investigates the differential impacts during the GFC and the Covid-19 pandemic.

Using monthly data from 2008-2014 for the GFC period and 2020-2022 for the Covid-period, I employ a VAR framework to generate impulse response functions. Inflation, industrial production, stock market returns, bond yields are the main Indian financial and economic variables of interest. Note, stock market returns refer to the yearly change in equity prices (capital gains). The results suggest spillover effects of Fed QE measures prop up financial variables more than real variables. The impact of one standard deviation positive QE shock on stock returns is initially negative and significant and gradually turns positive but statistically insignificant during both periods. The impact on bond yields is similar to stock returns during the GFC period while remains insignificant throughout in the Covid period. The impact on Indian macroeconomic variables is negative and insignificant during both periods. In order to assess difference in magnitude of impact, variables are rescaled to gauge the effect of one-unit positive QE shock. The magnitude of impact is notably higher during the Covid period, particularly for financial variables. The impact on stock returns, on average, is five times higher while that on bond yields is two times larger. Furthermore,

robustness checks were done using USD/INR nominal exchange rate and the two asset classes together. The main findings of the paper were robust to different model checks.

This paper is further divided as follows. Section 2 outlines the theoretical framework presenting a brief history and literature review of QE. Section 3 presents the empirical framework describing the underlying hypotheses to answer the research question. Furthermore, it explains the data and methodology used. Section 4 presents the findings followed by robustness checks in Section 5. Section 6 provides concluding remarks.

2.Theoretical Framework

2.1 History of Quantitative Easing

In this section, the paper briefly outlines UMP instrument implemented by the US Federal Reserve. Quantitative easing (QE) serves as an alternative method to boost overall demand when the policy interest rate is constrained by the zero-lower bound. In such cases, central banks have the option to increase their balance sheet by purchasing assets from commercial banks and other financial institutions using central bank money. These assets usually include long term duration assets namely government bonds and securities. The main aim of QE is to inject liquidity into the system to lower interest rates, encourage borrowing and spending with the overall goal of stimulating economic activity.

While the general adoption of QE took place in the aftermath of the GFC of 2008-09, it was first implemented by the Bank of Japan (BoJ) in the early 2000s to combat deflation at a time when policy interest rate was at the zero-lower bound. Subsequently, during the GFC, the U.S. Federal Reserve, the European Central Bank, and the Bank of England, also implemented QE measures to combat turmoil in the market. This paper solely focuses on the Fed QE.

The Federal Reserve since 2008 till date has implemented 4 QE programs, three of which were implemented during the GFC while the last one was implemented during Covid-19 pandemic. Figure 1 shows the trajectory of the Fed QE programs. QE1 was implemented in November 2008 and went on till March 2010. It involved purchase of $1.25 trillion of mortgage-backed securities, $0.6 trillion of treasury debt and $0.3 trillion of agency debt. During the second tranche of QE between November 2010-June 2011, purchase of $0.6 trillion of treasury securities was announced. The last phase of QE in the aftermath of the GFC took place during September 2012 to October 2014 with monthly purchase of $0.04 trillion in mortgage backed securities and $0.045

trillion in treasury securities with no information on total purchase amount. In December 2013, tapering measures were announced following which QE3 program was gradually concluded in 2014.

Between 2014-2018, Fed asset purchases were rather muted as can be seen in Figure 1. In 2019, Fed implemented Quantitative Tightening (QT) for a brief period before the Covid-19 pandemic hit in January 2020 which caused massive financial uncertainty in markets all over the world. Fed's response to the pandemic was very swift. In March 2020, QE4 was announced. This was the largest ever open-ended QE program announced with asset purchases nearing $4.3 trillion between March 2020-March 2022.

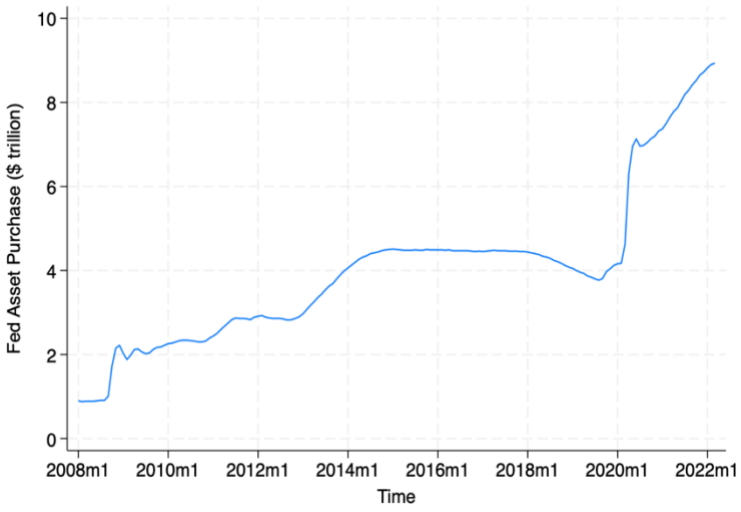

Figure 1: Federal Reserve Asset Purchase between 2008-2022

2.2 Effects of QE on domestic economy

Since the inception of QE in 2008, much academic literature has been published on the effectiveness of such a policy on the domestic economy. However, the literature still remains inconclusive. In this section, I explore the body of literature surrounding major economies that implemented large-scale QE programs during both the Global Financial Crisis (GFC) and the Covid-19 pandemic.

2.2.1. Euro Area

Using daily data between May 2007 to September 2012, Fratzscher et al. (2014) investigate the effectiveness of European Central Bank's (ECB) QE policy on asset prices, exchange rate, capital flows and changes in yield in the Euro Area as well as globally. They find positive and significant results of the policies on the equity market as well less fragmentation in the bond market.

Boeckx et al. (2017) also examine the effect of ECB unconventional policies on the euro area economy. Using a structural VAR framework, they find positive impact on bank lending, output growth, inflation and overall economic activity. Moreover, conducting a post-QE analysis revealed the impact on output and prices would have been 1 percentage point lower without the 3-year QE programs.

Haitsma et al. (2016) study the response of stock markets to the ECB policies during 1999-2015. They find that both conventional and unconventional policies affect the EURO STOXX 50 index with the latter having a much more notable effect on the index.

2.2.2 United Kingdom (UK)

Chortareas et al. (2018) assess the response of UK equity prices and implied volatility during 2009-2017 towards Bank of England's (BOE) QE announcements. They find significant impact on the returns and volatility following the announcements.

Joyce et al. (2010) study the effect of BOE's QE measures, particularly gilt purchases on UK asset prices. They find medium to long term gilt yields to be 100 bps lower than they would have been in the absence of QE programs. A substantial part of the depressed yields came from the portfolio balance effect into other assets, namely equity prices and corporate bonds. Interestingly, the impact on equity prices was rather difficult to conclude, however, a strong positive reaction was noted during 2009.

Balatti et al. (2016) examine the impact of UK QE particularly on stock prices, output and prices. Using a six-variable VAR model, they find significant positive results on stock market returns. On the other hand, impact on output and prices remained insignificant outlining the limitations of central bank policies to provide economic stimulus. They argue QE inflates asset price growth rather than boost consumption.

2.2.3 United States of America (USA)

Rahman & Apostolos Serletis (2023) use a VAR framework on weekly data on change of Fed balance sheet between 2008-2020 to investigate the effect of Fed unconventional monetary policy on stock market returns. They find that a one standard deviation policy shock leads to 0.3% increase in stock prices in first four weeks after policy shock.

Villanueva (2015) finds significant positive effects of Fed QE on S&P 500 index, DJIA and Nasdaq using data between 1990-2014 in a VAR framework. However, QE was not the sole reason for the stock market boom but changes in exchange rates, conventional policy, yield spreads supplemented it.

Rosa (2012) investigates the effect of large-scale asset purchases (LSAP) on US bonds, equity and spot exchange rate using intraday data. The paper finds statistically strong and significant impact on all asset prices after controlling for the surprise decisions on Fed's conventional monetary policy and forward guidance. Moreover, the study suggests the cumulative impact of LSAP is equivalent to an unanticipated cut in fed fund rate between 0-197 basis points.

Gambacorta et al. (2014) examine the effect of QE on US and seven other advanced economies between 2008-2011 using a structural VAR framework. They find statistically similar results for all countries. An expansionary policy shock leads to decline in stock market volatility which remains negative for a year after impact, implying robust increase in equity prices. The impact on output and prices is significant but temporary.

Fratzscher et al. (2013) study Fed QE measures on domestic as well as international economy. They find significant impact on boosting equity prices and depressing sovereign yield in the US at the onset on QE1. However, the magnitude of impact subsided during subsequent QE announcements.

Using a Bayesian VAR approach, Weale & Wieladek (2022) analyze the magnitude of financial effects of QE relative to conventional monetary policy on asset valuation, credit imbalances and financial market risk in the US, UK and Euro Area. The results indicate that while both policies impact the three variables, the effect of both is not statistically different.

In all, the literature suggests that while the effects of QE has positive impact on boosting equity valuations, its effect on the real economy has not been very pronounced.

2.3 Spillover effects of QE on emerging market economies

When the Federal reserve implemented QE policy in 2008, it led to significant capital flows into emerging markets economies (EME) which had significant financial and macroeconomic repercussions (Bhattarai et al., 2015).

Andreou et al. (2021) examine the effect of QE by the Fed, ECB and BoJ on net private equity inflows by global investment funds. The response of global investors in EMEs is particularly large for Fed QE and to a relatively lower extent towards ECB policy. BoJ's policies had no impact in influencing equity inflows in EMEs. The authors find statistically significant results on the spillovers of Fed QE towards EME equity inflows. The effect is particularly large in Asia.

Anaya et al. (2017) find large scale asset purchases by the Fed increases capital flows into EMEs for almost 6 months after QE announcements. Furthermore, several economic and financial variables experience positive impact. Equity prices and output rises, real exchange rate appreciates.

Bhattarai et al. (2015) study the impact of Fed QE in the domestic economy as well as the international spillovers effect in select EME as well as particularly among the Fragile 5 economies. Using a Bayesian VAR on monthly data between 2008-2014, they find statistically significant impact on exchange rate, stock prices and long-term bond yields of EMEs. The effect is even more pronounced among Fragile Five Economies relative to other EMEs. This is related to ex-ante financial conditions of the Fragile Five. Overall, the spillover of QE policy was relatively much stronger for financial variables than real economic variables.

Lin et al. (2018) conduct a similar analysis using a panel data regression on seven EMEs during the GFC period. They find strong significant results on stock and foreign exchange markets. However, the first stage of the policy seemed have strong significant impact with the magnitude diminishing with every stage. The last stage showed no significant impact.

Fratzscher et al. (2013) find Fed QE policies significantly inflate asset prices of EMEs relative to capital flows. The effect was different during QE1 and QE2. QE1 led to a stock market boom in the US relative to other countries. However, QE2 boosted equity prices worldwide. The authors note the pro-cyclical nature of capital flows into EMEs during QE2 due to the portfolio rebalancing effect. Furthermore, they do not find evidence of policies pegged to protect EMEs (exchange rate and capital account controls) from spillovers of QE policy to have contained the effect.

Studying the effect of US QE1 and QE2 on emerging Asian economies' bond yields, liquidity and exchange rate, Morgan (2011) finds no significant impact on overall financial markets, inflation and economic activity. The paper suggests excess capital inflows were easily absorbed by policy interventions. This is in contrast to what Fratzscher et al. (2013) found. However, on a regional level, there was a significant impact on bond yield and exchange rate.

Chen et al. (2012) conduct an event study to examine effect of US QE on financial asset prices of a set of Latin American and East Asian EMEs. They find positive impact on equity prices and decrease in sovereign yields on days of QE announcements. In addition, they also assess long term impact of QE spillover onto EMEs using a VECM model. Results indicated significant positive results on asset prices with the heterogeneity in magnitude of impact depending on specific country fundamentals. Equity prices specifically experienced a boom during QE1 but had mixed results in QE2 (plausibly due to already priced in expectations of asset purchase programs by the market (Krishnamurthy & Vissing-Jorgensen, 2011)).

Similarly, Bowman et al. (2014) examine the effect of Fed QE on sovereign bond yield, exchange rate and stock prices of 17 EMEs during 2006-2013. They find that the spillover effect might not have outsized effects on EME. However, there is severe heterogeneity between countries. The magnitude of effect depends on the time-varying vulnerabilities of each country. Countries with deteriorating financial and economic fundamentals are more prone to outsized effects of shock to US monetary policy. Additionally, they find the effect of US QE to be significantly different from conventional monetary policy measures.

Examining the impact of US QE on 10-year Indian government bond yields, Paul and Reddy (2021) find that volatility in yields rose by 4 bps for a 10-percentage point rise in US QE. A counterfactual analysis revealed the volatility would have been much less in the absence of QE.

In summary, the literature finds spillover effects of Fed QE policies lead to a stock market boom and depressed sovereign yields in EMEs mainly through portfolio balancing effects. However, there is heterogeneity in the magnitude of impact depending on country characteristics. Moreover, effect on macroeconomic variables was less pronounced.

3. Empirical Framework

3.1 Hypotheses

This primary research question of the paper is *What is the spillover effects of the Fed quantitative easing on the Indian economy?* This can be addressed by analyzing the three hypotheses below:

H_{01}: US QE did not have significant impact on the Indian economy during GFC crisis.

H_{02}: US QE did not have significant impact on the Indian economy during Covid-19 pandemic.

As outlined in the theoretical framework, GFC experienced three episodes of QE while Covid-19 period experienced one but the largest episode in QE history. Hence, the first two hypotheses help us analyze the effect of the QE shock on the Indian economy indices during the two periods.

H_{03}: There is no differential impact of US quantitative easing on the Indian economy during GFC and Covid-19 Pandemic

Regarding the third hypothesis, the paper expects a differential impact during the two periods due to the different characteristic nature of the crises. While the GFC was a financial mishap, Covid-19 pandemic was an unprecedented global health and economic crisis. Uncertainty was relatively much higher during the Covid crisis and hence, the monetary policy response was very different. Within a small timeframe, there was a massive injection of liquidity in the market. As seen from Figure 1, the Fed balance sheet more than doubled from USD 4 trillion to USD 8.9 trillion between March 2020 to March 2022. On the other hand, asset purchases took nearly 5 years to double from USD 2 trillion to USD 4 trillion between November 2008 and December 2013. Hence, the magnitude of impact (effectiveness of QE measures) on the Indian economy during the Covid-19 period is expected to be higher.

3.2 Data

This paper estimates the effect of QE on the Indian economy during the GFC and during the Covid-19 pandemic. Hence, the timeline used is January 2008-December 2014 encompassing the GFC period between January 2008-December 2014 and January 2020-March 2022 for the Covid period. Table 1 presents an overview of the variables used with the symbolic representation, sources and frequency. The symbolic representations will hereon be used to represent the variables employed.

Most of the data has been retrieved from Fred St Louis Fed, RBI and OECD. With the exception of Federal Reserve assets, all other variables are Indian financial and economic variables.

Sensex is the benchmark stock market index of India. It comprises of 30 highly traded stocks and are the largest in terms of market capitalization. It is considered to be the barometer for the overall performance of the market. Nifty is another Indian stock market index which consists of 50 largest companies in India. Together, the two indices form the most important gauge of the Indian stock market performance. The two variables are expressed as yearly percentage change. Note, I mention change in stock market prices i.e. capital gains as stock market returns throughout the paper. This should not be confused with total equity returns which include dividend payments as well. Stock market returns is calculated as $(Index_t - Index_{t-1})/Index_{t-1}$where t refers to time period. Indian Government 10-year bond yield is another financial variable used to assess the impact of QE.

Asset purchases (in $ millions) by the Federal Reserve are used to capture the unconventional monetary policy instrument employed. This variable is expressed in logs. USD/INR nominal exchange rate is the spot exchange rate expressed in logs. An increase in the exchange rate implies INR depreciates against the Dollar.

Table 1: Variables and Sources

Variable	**Symbol**	**Frequency**	**Source**
Bombay stock exchange	Sensex	Monthly	Investing.com
National stock exchange	Nifty	Monthly	Investing.com
Federal Reserve Assets	QE	Monthly	Fred database St Louis Fred
Inflation	CPI	Monthly	RBI database
Industrial Production	IIP	Monthly	RBI database
10y Govt Bond Yield	10Y	Monthly	RBI database
Nominal US Dollar exchange rate	FX	Monthly	Fred database St Louis Fred

CPI and IIP are the main Indian economic variables employed. Both are expressed in yearly percentage changes. Coherent with monetary policy literature, IIP is used as a proxy for real GDP

due to unavailability of GDP numbers on monthly basis. To check the strength of the proxy, Pearson correlation test is employed. During 2000Q1 to 2023Q1, the correlation between Real GDP and IIP is strong at 0.86. In the time period of study 2008Q1- 2022Q1, the coefficient is 0.9. During the GFC period, the correlation is 0.85 and 0.95 for the Covid period respectively.

Figure 2 plots the variables of interest related to the study's timeframe. The Figure indicates a noticeable decline in stock market returns and yields at the onset of both periods, with the GFC period displaying a more substantial impact. However, after a lag, the intervention by the Federal Reserve (Fed) appears to have contributed to an upturn in the financial market and a depreciation of the exchange rate. It is important to note that these observed patterns do not necessarily establish a direct causal relationship with the Fed's policy. The objective of this paper is to employ econometric modeling techniques to isolate and examine this particular spillover effect of the Fed's policy.

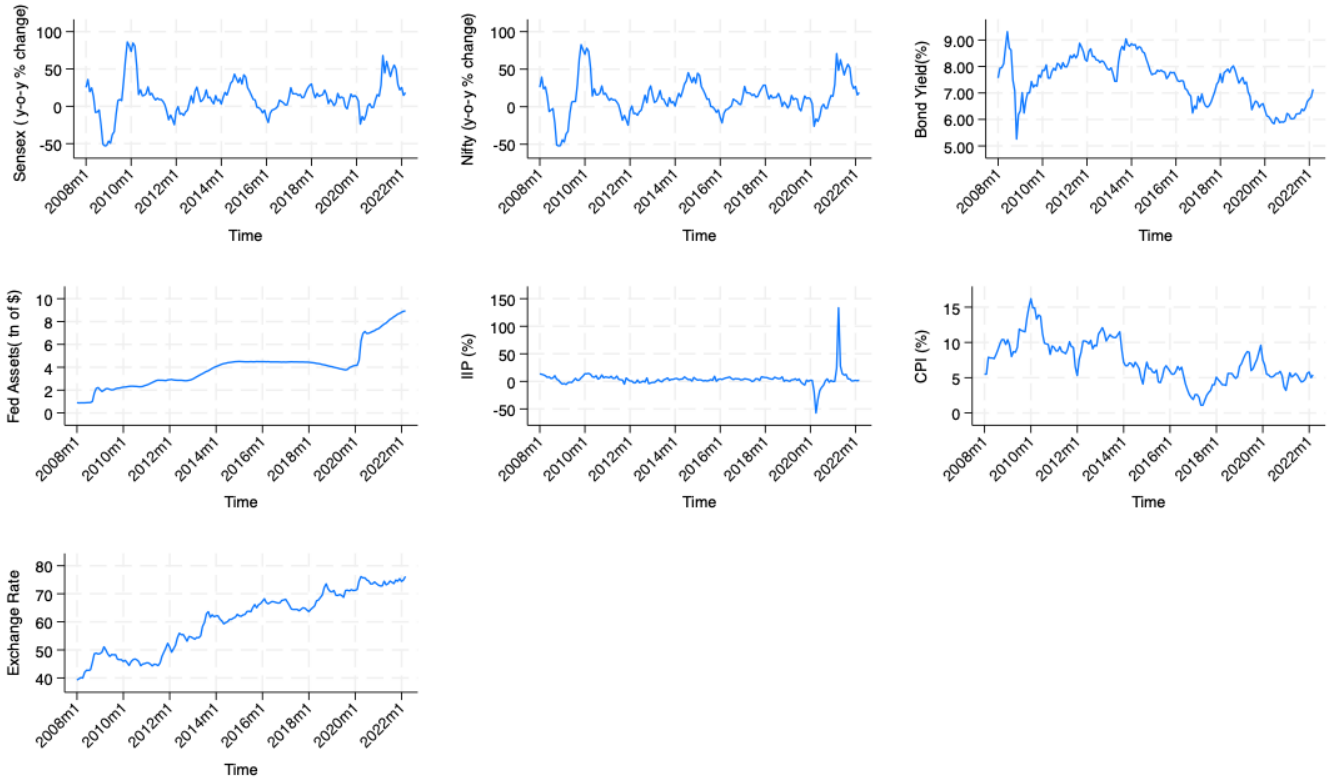

Figure 2: Selected Indian financial and economic variables. (Except Federal Reserve Assets).Note: y-o-y refers to year-on-year percentage change.

3.3 Methodology

This paper implements a recursive VAR model to study dynamic relationship between Fed QE and Indian economy.

The k-lag VAR model has the form:

$$y_{i,t} = G_0 + \sum_{j=1}^{k} G_j y_{i,t-j} + \epsilon_{i,t} \quad (1)$$

where $y_{i,t}$ is a vector of endogenous variables for each unit i at time t. G_0 is a constant term, G_j is parameter to be estimated and $\epsilon_{i,t}$ is error term. The VAR system of equation includes 4 variables: Sensex, IIP, CPI and QE. The specification mentioned above is similarly used to perform analysis on Nifty and 10Y bond yields as well.

In recent years, VARs have become an important tool to estimate the effects of monetary and fiscal policy shocks (Caldara & Kamps, 2008). There is an exhaustive source of literature that has used VAR frameworks to study macroeconomic effects of monetary policy on a particular country or a panel of countries (Paul & Reddy (2021), Bagliano & Favero (1998), Bhattarai et al. (2015), Rey (2015), Horvath and Voslarova (2017), Eichenbaum and Evans (1995)).

This paper broadly relies on the works of Bhattarai et al. (2015), Rey (2015) and Horvath and Voslarova (2017) for the main identification strategy. The Cholesky ordering of the variables is such that the first variable does not contemporaneously react to shock of other variables. It only responds with a lag. IIP and CPI are usually sticky and respond with a lag to other variables and are placed first and second respectively. QE takes the penultimate position while financial variables (stock market return, bond yields) are placed last. This assumption that QE does not contemporaneously react to financial variables is based on the grounds that volatility in such variables is more a response to shocks rather than the source.

The baseline results include tracing out the orthogonalized response of Indian financial and economic variables due to Fed UMP shock (QE). Furthermore, some robustness checks are performed in which i) nominal exchange rates is included in the model (ii) Stock indices as well as bond yield are both incorporated in the same VAR equation.

To assess the impact of unconventional monetary policy shock, the following are the models to be estimated:

Model 1: $X_{it} = [\, Y_{it}\ P_{it}\ M_{it}\ SM_{it}]$

Model 2: $X_{it} = [\, Y_{it}\ P_{it}\ M_{it}\ BY_{it}]$

Model 3: $X_{it} = [\, Y_{it}\ P_{it}\ M_{it}\ FX_{it}\ SM_{it}]$

Model 4: $X_{it} = [\, Y_{it}\ P_{it}\ M_{it}\ BY_{it}\ SM_{it}]$

where Y_{it} represents industrial production index, P_{it} denotes inflation, M_{it} is the unconventional monetary policy tool, SM_{it} stands for Sensex/Nifty, BY_{it} is the 10-year bond yield and FX_{it} reflects the nominal exchange rate.

Each of the models are estimated in VAR in levels unless specified elsewhere. Stock market return, inflation, industrial production and bond yields are expressed in levels while exchange rate and QE are expressed in logs. Variables are tested for stationarity using Augmented- Dickey-Fuller test and Phillips-Perron test. All variables are I (1) stationary. Given the small-time framework of the study, this paper does not analyze long term behavior of variables. Then, lag selection criteria tests namely Akaike information criterion (AIC) and Schwartz Bayesian information criterion (SBIC) are used to determine lag order. The criterion favored 1 lag for the GFC period while 2 lags for the Covid period under the baseline as well robustness check models. Some diagnostic checks are also performed. VAR autocorrelation tests indicated no evidence of autocorrelation at lag 1. Stability tests indicated eigen values lie within unit circle except for the bond yield model during the Covid-period (see Figure 3a,3b,3c). Taking first differences of the variables for that model specifically yields stability. Then, normality tests were performed. The tests indicated evidence of non-normal distribution of residuals. This was expected due to the short timeframe of the data especially during the Covid- period where the data includes only 23 observations. The non-normality is mainly driven by QE (see Table 2a, 2b). Economic shocks like these are unusual and hence could lead to larger than usual residuals which might make it difficult for the model to capture it. However, all the other variables are normally distributed. Finally, impulse response functions (IRF) are generated for the models outlined above with a 90% confidence interval.

4. Results

In this chapter, the main findings of the paper are presented as per the identification strategy and methodology outlined in the previous section. This section is divided into 2 parts based on two

main financial variables used in the analysis: this paper first presents the impact of US QE shock on stock returns and the second for the bond yield during the GFC and Covid-19 pandemic. The results are log-level interpretations unless specified.

4.1 Effect of positive QE shock on Stock returns

4.1.1 GFC

Figure 4 presents the impulse responses of positive one standard deviation Fed QE shock on Indian stock market returns, IIP and inflation during the GFC. A one-standard deviation shock amounts to an increase of 40 billion dollars on average in Fed assets during the GFC. IRFs indicate that Sensex returns are negative on impact and turn positive after 6 months. After 6 months, a one standard deviation shock amounts to nearly 150 bps increase in Sensex for up to 20 months. However, it reaches a peak around the 15th month and flattens after. The results for Nifty are similar to Sensex (Figure 4a). This is perhaps strikingly different from the literature which finds significant results for EMEs. Although Bowman et al. (2014) did find that spillover effects on Fed QE may not have outsized effects on EMEs depending on country characteristics. Moreover, Morgan (2011) finds no statistically significant impact of financial variables, inflation and overall economic activity on emerging Asian economies.

The responses of price and output also indicate QE policy is ineffective in driving the macroeconomy. Output falls up to 11 months post which it peaks at about 12 bps around the 19th month. Inflation, on the other hand, remains negative throughout with the magnitude reducing post the 5th month. A one standard deviation shock leads inflation to fall by nearly 20 bps on impact post which it gradually alleviates to a fall by 12 bps after 10 months. Both output and inflation remain significant up to 10 months. The weaker effect on prices compared to output in line with findings from Gambacorta et al. (2014). They find the effect of QE on output to be three times larger than on prices. Moreover, the overall weak effect on output and prices could be because the QE shock is estimated during a recessionary period where aggregate demand was subdued.

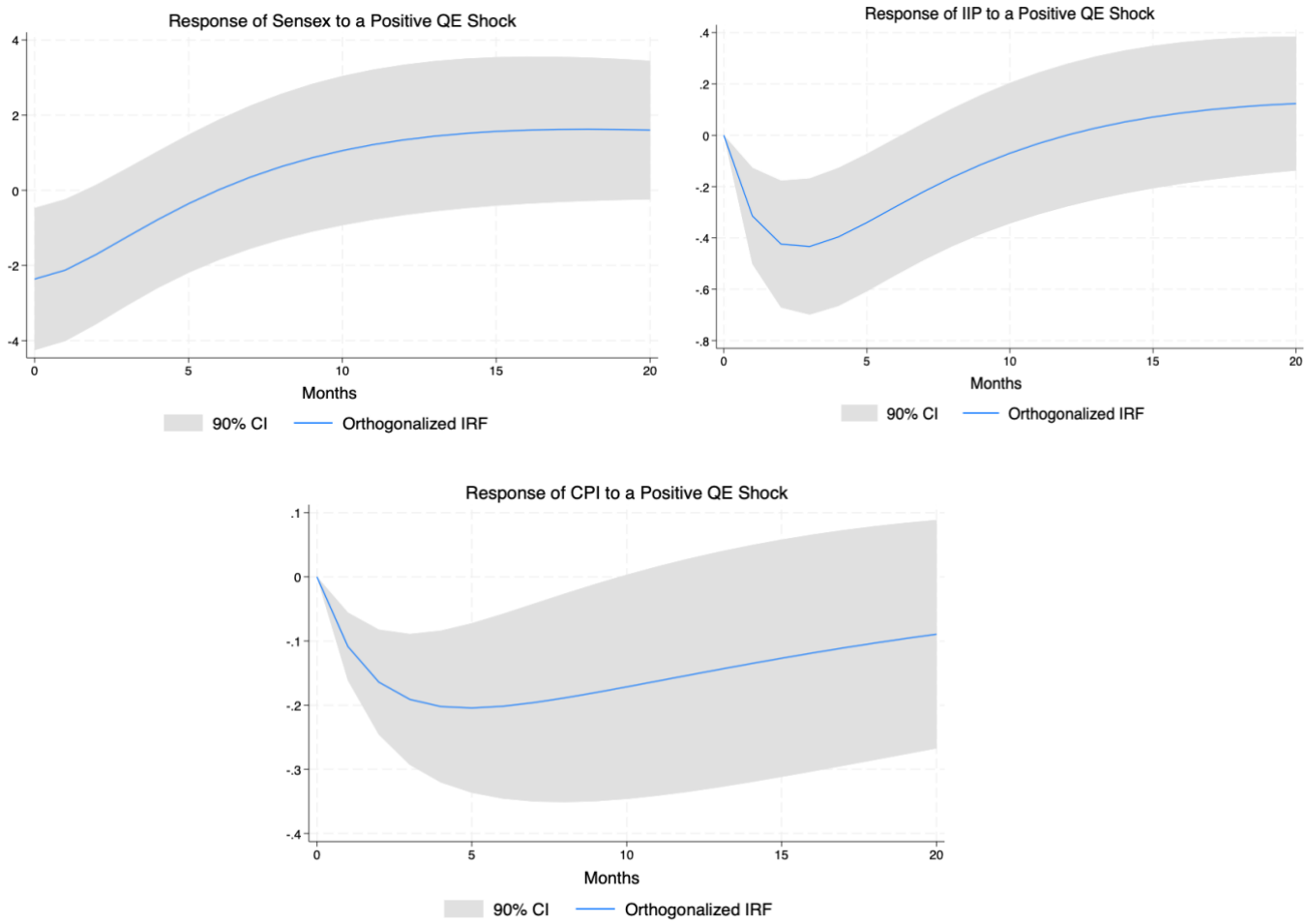

Figure 4: Impulse response functions of positive shock to QE during the GFC. Note: the values on y-axis are basis points.

4.1.2 Covid-19 Pandemic

The impulse responses in Figure 5 indicate that 1 standard deviation QE shock leads to nearly 320 bps increase in Sensex returns which peaks out in the 3rd month and gradually converges to baseline by the 10th month. A one standard deviation shock amounts to an increase of 90 billion dollars on average during Covid-19 period. The positive effect is weakly significant until 5 months. As seen during the GFC, the impact of Nifty returns is similar to Sensex. (Figure 5a). The responses of output and prices remain broadly insignificant. The response of output is subject to many fluctuations until the 10th month after which it converges to 0. Moreover, due to the nature of the crisis, there were major supply side disruptions which may have limited the impact of QE on output. This argument holds valid for inflation as well. Apart from supply side disruptions, high

unemployment levels and subdued animal spirits due to several restrictions may have contributed to low inflation levels.

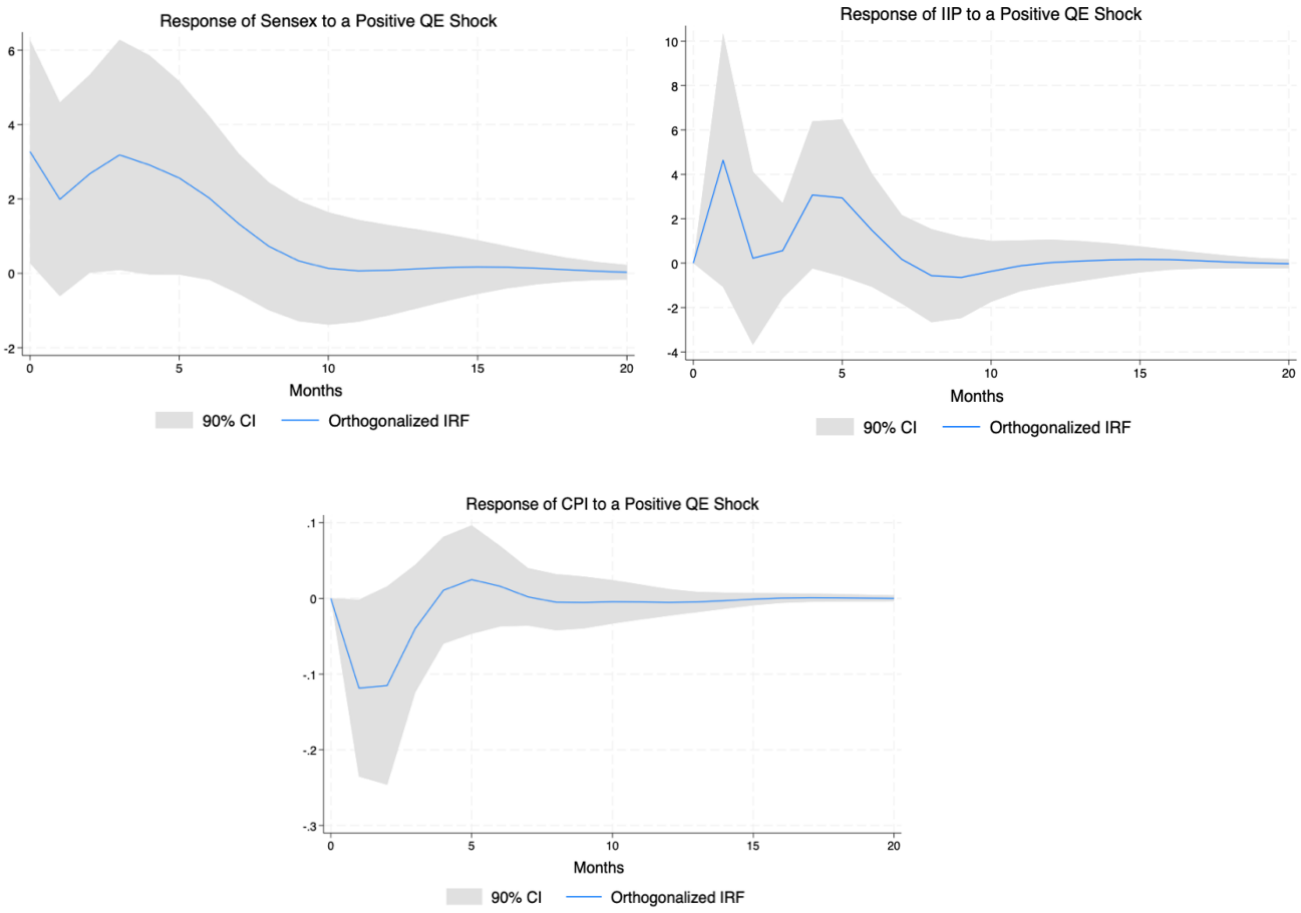

Figure 5: Impulse response functions of positive shock to QE during the Covid-19. Note: the values on y-axis are basis points.

In all, QE4 implemented during the pandemic helped prop up financial markets while the effect on real economic variables remained insignificant. This is in line with findings from Bhattarai et al. (2015) who find stronger spillover effects of Fed QE to EMEs on financial variables than real variables. Moreover, Balatti et al. (2016)) find QE policies inflate asset growth rather than consumption.

4.2 Effect of positive QE shock on Bond Yield

This paper also looks at bond yields, another important financial variable. Empirical literature investigating the spillover effects of QE on EMEs frequently incorporates bond yields as a pivotal asset class in addition to equity prices. By considering bond yields alongside equity prices,

researchers are able to comprehensively analyze the transmission mechanisms and impact of QE on EMEs, recognizing the significance of both asset classes in shaping the overall financial landscape (see Fratzscher et al. (2013), Chen et al. (2012), Bowman et al. (2014)).

4.2.1 GFC

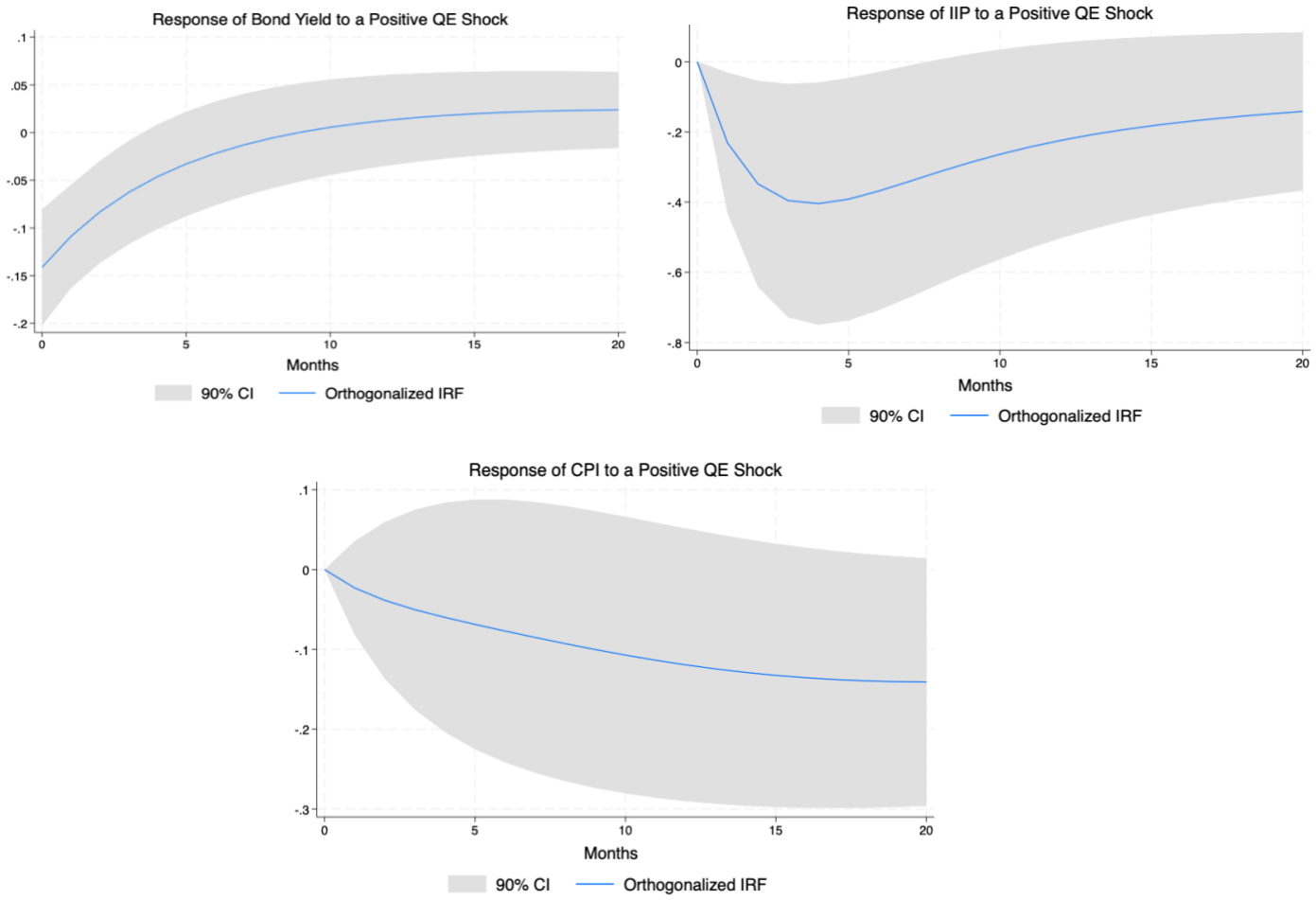

Figure 6: Impulse response functions of positive shock to QE during the GFC. Note: the values on y-axis are basis points.

Figure 6 presents impulse responses of 1 standard deviation QE shock to 10-year Indian government bond yields during the GFC. Bond yields fall around 14 bps on impact and eventually peak out at about a positive 2 bps after 11 months. This is similar to results found by Paul and Reddy (2021) who find a 4 bps increase in 10-year yields in response to Fed QE. The statistical significance of the results fades out after 5 months. The impact on output and prices remains negative and insignificant as well. The magnitude of impact on the macroeconomic variables under

this model is relatively larger than the stock return model. A one standard deviation shock leads to around 40 bps fall in output around the 4th month after which the fall progresses to an average 15 bps fall by the 15th month. Inflation sees a persistent downward negative decline ranging from a modest reduction of 2 bps to a more pronounced decrease of 20 bps.

4.2.2 Covid-19 Pandemic

Response of bond yield during the pandemic remains statistically insignificant after lag of three months. On impact, yields exhibit statistical significance and fall by 5 bps following which it peaks at 0.6 bps and converges to baseline after 10 months. Similarly, output and prices exhibit various fluctuations until the 10th month and return to baseline after. These results also remain insignificant. The argument for macroeconomic variables is similar to the one made for the stock market return model.

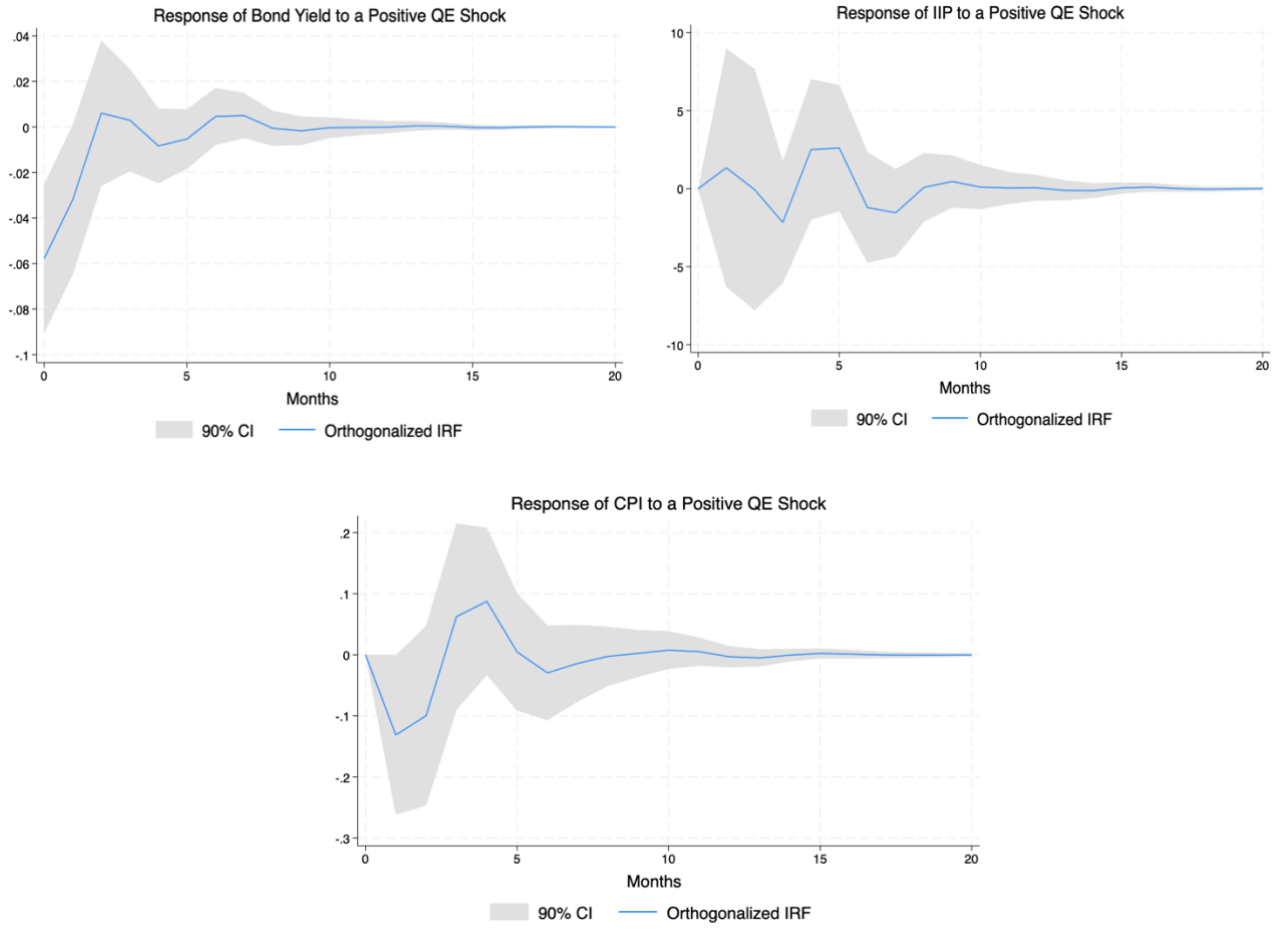

Figure 7: Impulse response functions of positive shock to QE during the Covid-19. Note: the values on y-axis are basis points.

Overall, the paper finds positive impact of Fed QE on Indian financial market performance. However, the significance of the results differs with the effect on financial variables being significant on impact during both periods which turns insignificant with further lags. The effect on macroeconomic variables remained insignificant and negative during both crises.

In order to compare the difference in the effectiveness of the shock during the two periods, the IRFs are rescaled to assess one-unit QE shock to variables. The scaling factor is the standard deviation (SD) of Fed QE for the two periods: 0.43 during the GFC period and 0.21 during the Covid-19 period. The variables are divided by respective SD during the two periods. When comparing the magnitude of difference in impact between the two crises, the effect was on average five times as big during the Covid-19 period for stock market performance. The difference in impact is twice as big for bond yields during the Covid period. There could be two reasons for the high magnitude, one being QE4 was the largest program implemented in the history of QE. Second, the shorter timeframe of the data may have created a discrepancy. During the pandemic, QE took off immediately and financial markets followed in line. The impact on macroeconomic variables was also much higher during Covid period. In all, I find the effectiveness of spillovers of Fed QE measures on Indian economy was much larger in magnitude, especially on financial variables, during the Covid-19 pandemic.

4.3 Variance Decomposition of Forecast Error

Next, I present the importance of Fed QE shock in explaining the forecast error variance of the variables at different horizons. Table 3 presents the variance decomposition results. The Fed QE plays a non-predominant role in explaining stock market variance during the GFC with the maximum of 6-7% at the 20^{th} month. However, the shock explains nearly 15% of the variation during the Covid period. One reason for such a difference in explaining the variance in the returns could be the different characteristics of the two crises as explained in section 2. Covid-19 was a health crisis with high uncertainty which compelled central banks to take swift actions. Moreover, QE4 was the largest ever QE program implemented which contributed to much greater increase in stock market returns as seen in the results.

The amount of variation explained by QE shock in bond yields is in sharp contrast to the stock market returns. It plays a much more important role during the GFC to the tune of 16% while only explains up to 7% of the variation during the Covid-period.

The role of QE shock in explaining output and prices as well remains relatively muted between the range of 3-7% during both the crises. (see appendix table 3a)

Table 3: Variance Forecast Error Decomposition

	GFC			**Covid-19**		
	Sensex	Nifty	Bond Yield	Sensex	Nifty	Bond Yield
Impact	0.05	0.07	0.16	0.12	0.11	0.04
5 months	0.03	0.05	0.13	0.13	0.12	0.05
10 months	0.03	0.04	0.12	0.15	0.14	0.06
15 months	0.04	0.05	0.12	0.15	0.14	0.07
20 months	0.06	0.07	0.12	0.15	0.14	0.07

Note: Forecast error variance for IIP and CPI presented in Appendix.

5. Robustness

Two extended models are studied as part of the robustness analysis. Given the baseline model is parsimonious with only 4 variables, I run robustness checks to make sure the model is not mis specified. In the first model, I incorporate USD/INR nominal exchange rate as an additional variable in the stock return model to study the exchange rate transmission channel of Fed QE. The second model includes stock returns and bond yields together. Moreover, the two models studied broadly follow current literature which explore the spillover effects of QE using these variables together. (see Fratzscher et al. (2013), Neely (2010), Bowman et al. (2014), Bhattarai et al. (2015))

5.1 USD/INR Nominal exchange rate

Figure 8a and 8b presents the impulse response of exchange rate, stock market returns and macroeconomic variables to a 1 standard deviation shock on Fed QE during the GFC and Covid-19 period. The results broadly remain statistically insignificant during both periods. Exchange rate appreciates 0.003% against the US dollar during the GFC. The insignificance of the results is in direct contrast with current literature who find high statistical significance of exchange rate appreciation of EMEs (Bhattarai et al. (2015), Morgan (2011)). The effect on stock market returns is relatively smaller in magnitude compared to baseline results.

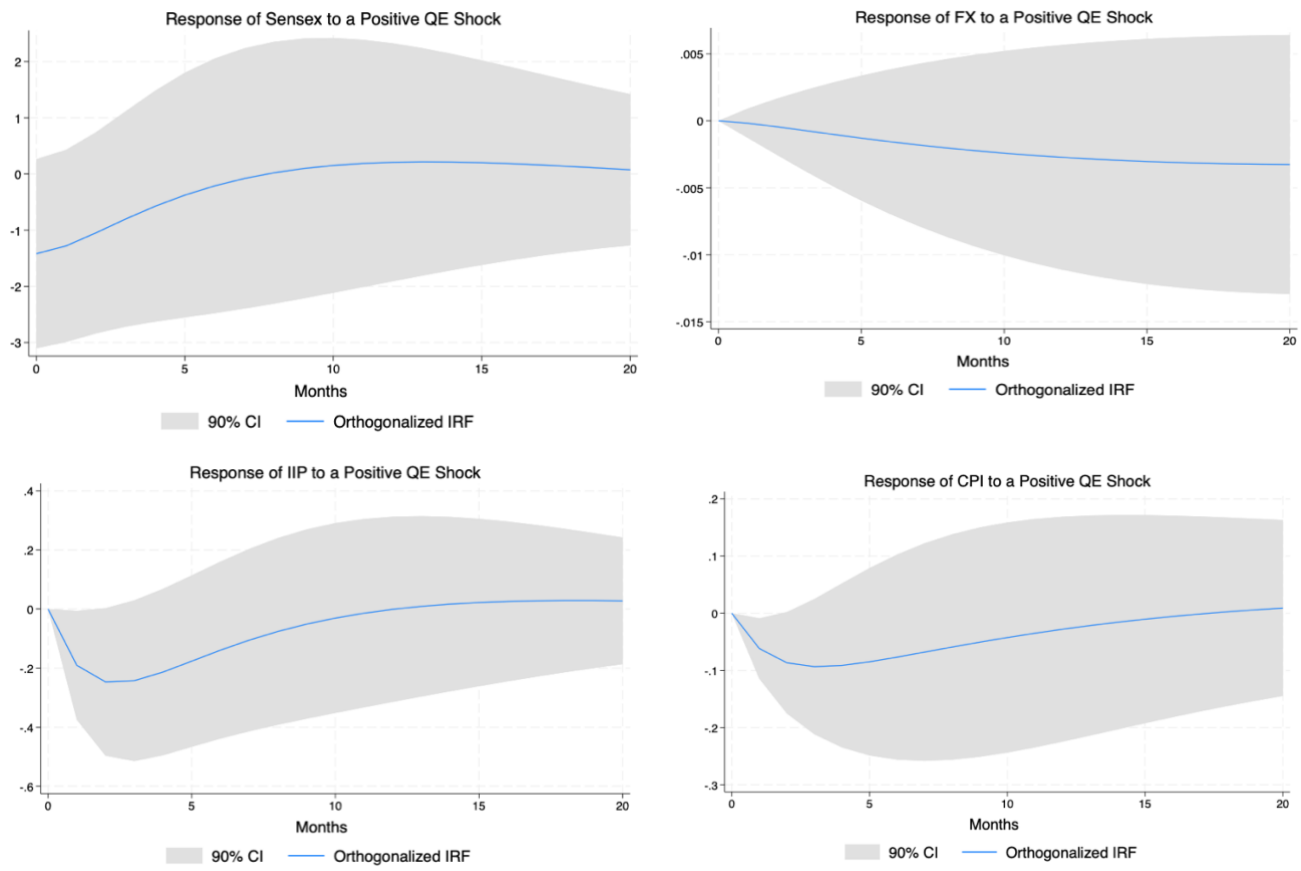

Figure 8a: Impulse response functions of positive shock to QE during the GFC. Note: the values on y-axis are basis points for Sensex and percentages for FX.

During Covid-19, shock to QE led to a trivial exchange rate appreciation of 0.002% against the US dollar in the initial 5 months following which it gradually converged to zero. The impact of stock returns remains broadly similar to main response functions of the paper with a positive statistically significant result up to 6 months after which the effect peaks out and reaches zero. Macroeconomic variables remain negative and statistically insignificant during the GFC period and experience several fluctuations during the Covid-period during the first 5-10 months after which it converges to zero.

In all, I find that including exchange rate reduces the magnitude of impact on stock returns during the GFC period while remains in coherence with main results during Covid-19 period. The effect on macroeconomic variables is similar to main results during both crises. Overall, the significance of results remains broadly aligned with the main response functions.

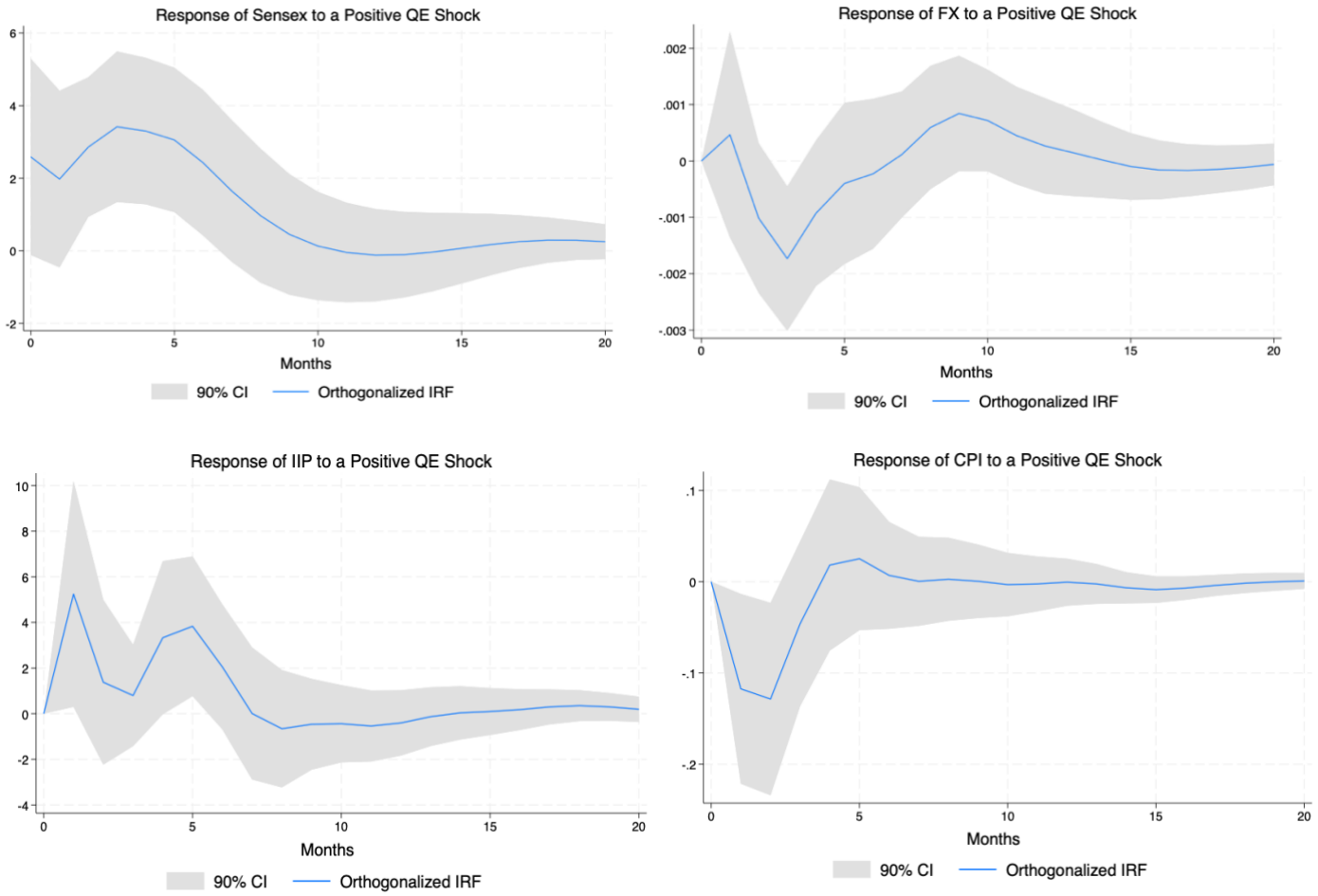

Figure 8b: Impulse response functions of positive shock to QE during the Covid-19 pandemic. Note: the values on y-axis are basis points for Sensex and percentages for FX.

5.2 Bond Yield and Stock returns

The impulse responses in Figure 9a indicate that a one standard deviation shock in Fed QE during the GFC leads to an initial significant negative impact of about 230 bps and 13 bps on stock returns and bond yields respectively. After a lag of seven months, there is a greater than 200 bps increase in stock market returns. The impact eventually peaks out around the 17th month. Bond yields peak around 4 bps after 16 months and then flatten out. These estimates align with the main results of the paper although the magnitude of impact for stock returns is much higher in this model. The impact on both asset classes is weakly significant up to 5 months. Industrial production falls 40 bps on impact and is significant up to 5 months. It gradually recovers and peaks at 19 bps after 15 months. Inflation is weakly significant on impact and remains negative throughout. The models

for Covid-19 (Fig 9b) are implemented using first differences to satisfy stability requirements (bond yields lead to instability). The response of market returns is subject to more fluctuations than the main results. The stock return model in the main results was implemented in levels instead of differences which could explain the contrast in the response functions. Bond yields fall by 5 bps on impact. It remains negative and statistically insignificant up to 5 months after which it converges to zero.

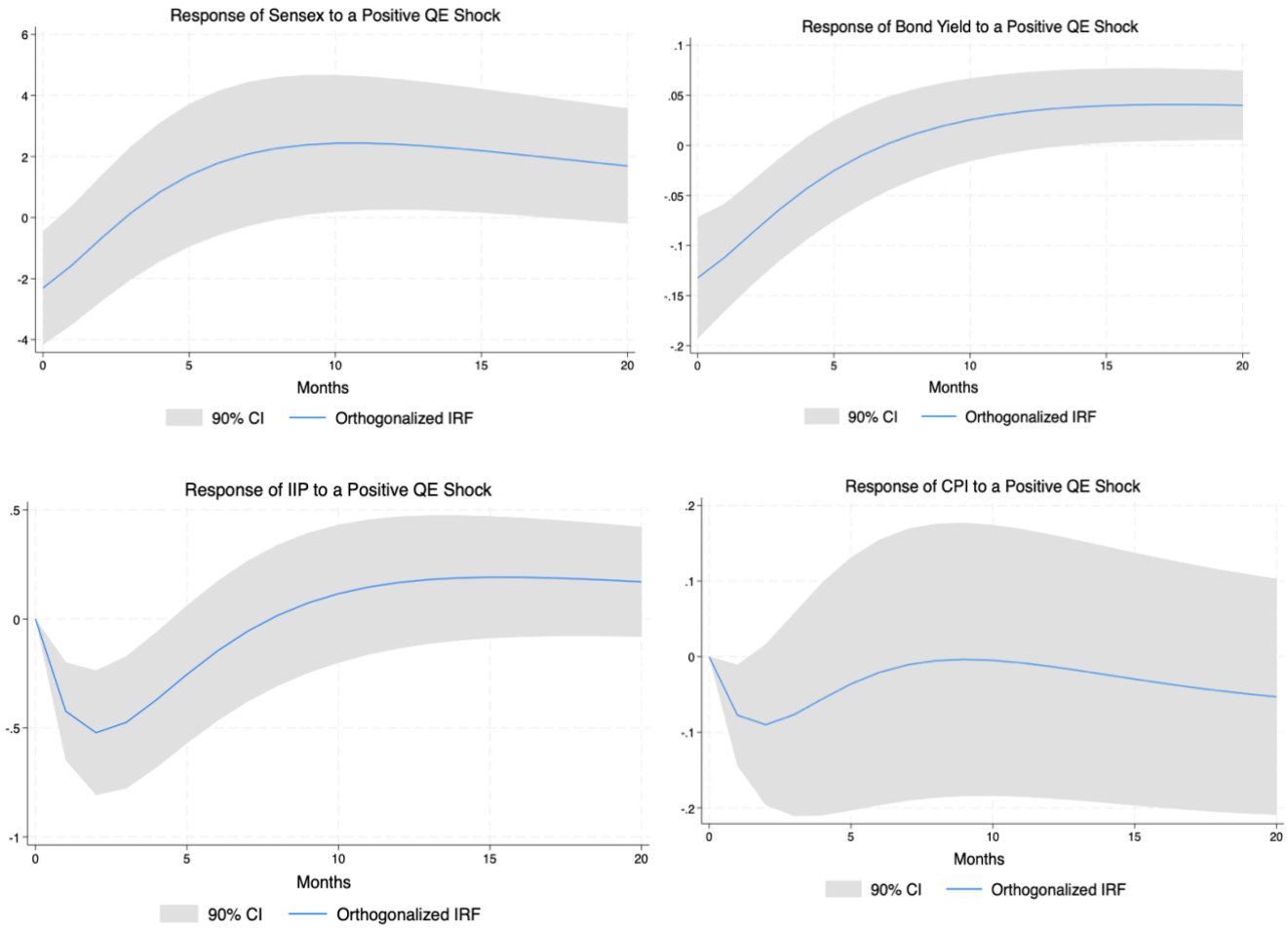

Figure 9a: Impulse response functions of positive shock to QE during the GFC. Note: the values on y-axis are basis points.

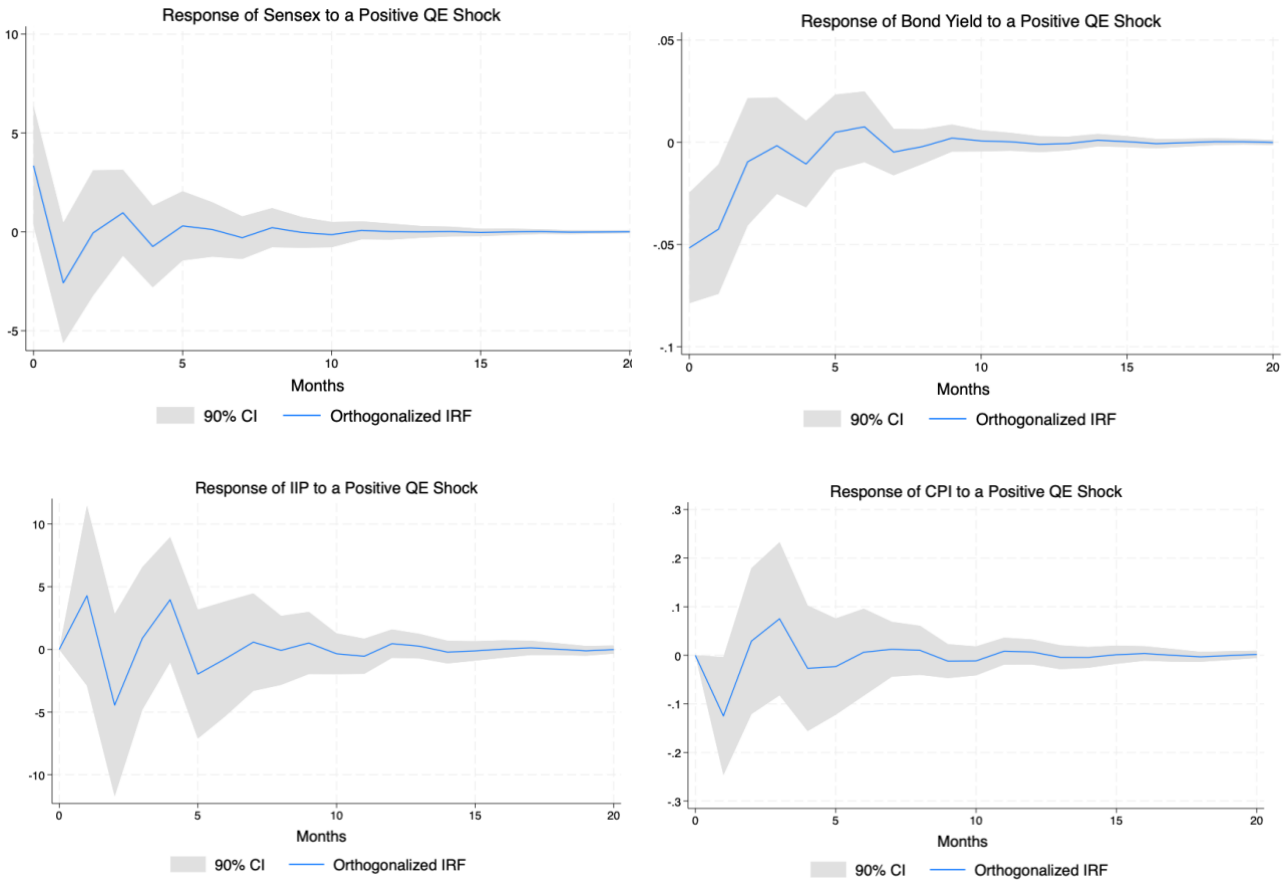

Figure 9b: Impulse response functions of positive shock to QE during the Covid-19 pandemic. Note: the values on y-axis are basis points.

In summary, the results for the GFC period follow the results in existing literature where EMEs see an increase in equity returns as well as yields while muted response on macroeconomic variables (see Bhattarai et al. (2015), Bowman et al. (2014)). However, for the Covid period, there exists a dearth of literature surrounding spillover effects.

6. Conclusions

Unconventional monetary policy (UMP) instruments have become a supplementary mode of stimulating the economy by central banks when the conventional policies have run out of steam. The usage of UMP, particularly QE has become more pronounced since the onset of the GFC where major central banks, particularly the Fed, ECB and BOE implemented massive QE programs that spanned over 4 years. These QE measures had reverberating financial and economic effects around the world, particularly in the EMEs. Till date, 4 QE programs have been implemented: 3 during the GFC and 1 during the Covid-19 pandemic.

In this paper, I attempt to study the international spillover effects of Fed QE on the Indian economy, one of the Fragile Five economies during the GFC. Using a VAR framework, I study the effect on financial and economic variables during the two crises and compare the magnitude of impact between the two. The results show that a one standard deviation Fed QE shock led to a 150 bps rise in Indian stock market returns after a lag of 5 months during the GFC while a 320 bps rise on impact during the Covid-19 pandemic. The significance of the results faded after 5 months. Bond yields rose by 2 bps and 0.6 bps after a lag of 10 months during the GFC and Covid-19 pandemic respectively. The impact on macroeconomic variables remained negative and insignificant during both crises suggesting that spillover effects of Fed QE measures have positive effects on financial markets rather than real economy.

Additionally, I compared the difference in magnitude of impact by rescaling variables to compute the effect of one-unit QE shock during the both crises. Results suggested the magnitude was much higher during Covid period, notably for financial variables. The impact on stock returns was on average five times higher while that on bond yields was two times larger.

Furthermore, two robustness model checks were done using USD/INR nominal exchange rate and two asset classes together. The main results are robust to various model evaluations. Overall, the models remain insignificant although the magnitude of impact differs.

There is a lot of contrasting evidence in the literature surrounding the significance of QE international spillover effects on EMEs. Most current literature is of the view that QE has significant effects on EME (Bhattarai et al. (2015), Lavigne et al. (2014), Lin et al. (2018), Fratzscher et al. (2014), Chen et al. (2012)). On the other hand, there are studies that find the effect of QE might not have huge effects on EMEs depending on country characteristics or have any statistical significance on financial and economic variables (Bowman et al. (2014), Morgan (2011))). The results of this paper side with the latter's view.

Existing literature has only been focused on the effects of QE during the GFC. There is a dearth of literature of its effect during the Covid-19 pandemic. Moving forward, academics can now focus more on the spillover effects during the pandemic given the QE4 program was the biggest one implemented in the history of QE. This paper has attempted to study individual and comparative effects of QE during the 2 crises. While this paper is limited to India, more research can be done using a panel of EMEs. While the VAR-model in this paper was parsimonious, using a different

methodological approach which allows more variables may be a better fit. I leave this to future research.

7. References

Anaya, P., Hachula, M., & Offermanns, C. (2017). Spillovers of U.S. unconventional monetary policy to emerging markets: The role of capital flows. *Journal of International Money and Finance*, *73*(PB), 275–295. https://econpapers.repec.org/article/eeejimfin/v_3a73_3ay_3a2017_3ai_3apb_3ap_3a275-295.htm

Andreou, C. K., Dimic, N., Piljak, V., & Savvides, A. (2021). Unconventional monetary policy and international equity capital flows to emerging markets. *European Financial Management*. https://doi.org/10.1111/eufm.12312

Bagliano, F. C., & Favero, C. A. (1998). Measuring monetary policy with VAR models: An evaluation. *European Economic Review*, *42*(6), 1069–1112. https://doi.org/10.1016/s0014-2921(98)00005-1

Balatti, M., Brooks, C., Clements, M. P., & Kappou, K. (2016). Did Quantitative Easing Only Inflate Stock Prices? Macroeconomic Evidence from the US and UK. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2838128

Baumeister, C., & Benati, L. (2013). Unconventional Monetary Policy and the Great Recession: Estimating the Macroeconomic Effects of a Spread Compression at the Zero Lower Bound. *International Journal of Central Banking*, *9*(2), 165–212.

Bhattarai, S., Chatterjee, A., & Park, W. Y. (2015). Effects of US quantitative easing on emerging market economies. *Globalization Institute Working Papers*. https://ideas.repec.org/p/fip/feddgw/255.html

Boeckx, J., Dossche, M., & Peersman, G. (2017). Effectiveness and Transmission of the ECB's Balance Sheet Policies. *International Journal of Central Banking*, *13*(1), 297–333. https://ideas.repec.org/a/ijc/ijcjou/y2017q0a8.html

Bowman, D., Londono, J. M., & Sapriza, H. (2014). *U.S. Unconventional Monetary Policy and Transmission to Emerging Market Economies*. RePEc - Econpapers. https://econpapers.repec.org/paper/fipfedgif/1109.htm

Caldara, D., & Kamps, C. (2008, March 1). *What are the effects of fiscal policy shocks? A VAR-based comparative analysis*. RePEc - Econpapers. https://econpapers.repec.org/paper/ecbecbwps/2008877.htm

Chen, Q., Filardo, A., He, D., & Zhu, F. (2012). International spillovers of central bank balance sheet policies. *BIS Papers Chapters*, *66*, 220–264. https://ideas.repec.org/h/bis/bisbpc/66-16.html

Chortareas, G., Karanasos, M., & Noikokyris, E. (2018). Quantitative Easing And The Uk Stock Market: Does The Bank Of England Information Dissemination Strategy Matter? *Economic Inquiry*, *57*(1), 569–583. https://doi.org/10.1111/ecin.12690

Eichenbaum, M., & Evans, C. L. (1995). Some Empirical Evidence on the Effects of Shocks to Monetary Policy on Exchange Rates. *The Quarterly Journal of Economics*, *110*(4), 975–1009. https://doi.org/10.2307/2946646

Fratzscher, M., Lo Duca, M., & Straub, R. (2013). *On the International Spillovers of US Quantitative Easing*. Papers.ssrn.com. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2276855

Fratzscher, M., Lo, M., European, D., Bank, C., Straub, R., & Central Bank, E. (2014). *ECB Unconventional Monetary Policy Actions: Market Impact, international Spillovers and*

Transmission Channels . https://www.imf.org/external/np/res/seminars/2014/arc/pdf/fratzscher_loluca_straub.pdf

Gambacorta, L., Hofmann, B., & Peersman, G. (2014). The Effectiveness of Unconventional Monetary Policy at the Zero Lower Bound: A Cross-Country Analysis. *Journal of Money, Credit and Banking*, *46*(4), 615–642.

Haitsma, R., Ünalmış, D., & de Haan, J. (2016). The impact of the ECB's conventional and unconventional monetary policies on stock markets. *Journal of Macroeconomics*, *48*(C), 101–116. https://econpapers.repec.org/article/eeejmacro/v_3a48_3ay_3a2016_3ai_3ac_3ap_3a101-116.htm

Horvath, R., & Voslarova, K. (2017). International spillovers of ECB's unconventional monetary policy: the effect on Central Europe. *Applied Economics*, *49*(24), 2352–2364. https://ideas.repec.org/a/taf/applec/v49y2017i24p2352-2364.html

Joyce, M., Lasaosa, A., Stevens, I., & Tong, M. (2010). The Financial Market Impact of Quantitative Easing. *SSRN Electronic Journal*, *7*(3). https://doi.org/10.2139/ssrn.1638986

Krishnamurthy, A., & Vissing-Jorgensen, A. (2011). The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy. *Brookings Papers on Economic Activity*, *42*(2 (Fall)), 215–287. https://ideas.repec.org/a/bin/bpeajo/v42y2011i2011-02p215-287.html

Lavigne, R., Sarker, S., & Vasishtha, G. (2014). *Spillover Effects of Quantitative Easing on Emerging-Market Economies*. https://www.bankofcanada.ca/wp-content/uploads/2014/11/boc-review-autumn14-lavigne.pdf

Lim, J., Mohapatra, S., & Stocker, M. (2014, March 1). *Tinker, taper, QE, bye ? the effect of quantitative easing on financial flows to developing countries*. RePEc - Econpapers. https://econpapers.repec.org/paper/wbkwbrwps/6820.htm

Lin, J. Y., Batmunkh, M. U. J., Moslehpour, M., Lin, C. Y., & Lei, K. M. (2018). Impact analysis of US quantitative easing policy on emerging markets. International Journal of Emerging Markets. https://doi.org/10.1108/IJoEM-03-2016-0082

Morgan, P. (2011). *ADBI Working Paper Series Impact of US Quantitative Easing Policy on Emerging Asia Asian Development Bank Institute*. https://www.adb.org/sites/default/files/publication/156176/adbi-wp321.pdf

Neely, C. J. (2010). The large scale asset purchases had large international effects. *Working Papers*. https://ideas.repec.org/p/fip/fedlwp/2010-018.html

Paul, M., & Reddy, K. S. (2021). US QE and the Indian Bond Market. *Journal of Quantitative Economics, 20*. https://doi.org/10.1007/s40953-021-00257-9

Peersman, G., & Smets, F. (2001). The Monetary Transmission Mechanism in the Euro Area: More Evidence from VAR Analysis (Mtn Conference Paper). *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.356269

Piotr, B. (2018). The Impact of Quantitative Easing on Emerging Markets – Literature Review. *Financial Internet Quarterly (Formerly E-Finanse), 14*(4), 67–76.

Rahman, S., & Apostolos Serletis. (2023). Unconventional monetary policy and the stock market. *Journal of Economics and Finance*. https://doi.org/10.1007/s12197-023-09624-z

Rey, H. (2015, May 14). *Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence*. National Bureau of Economic Research Working Paper Series. https://www.nber.org/papers/w21162

Rosa, C. (2012, May 1). *How "Unconventional" are Large-Scale Asset Purchases? The Impact of Monetary Policy on Asset Prices*. Papers.ssrn.com. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2053640

Villanueva, M. (2015). Quantitative Easing and US Stock Prices. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2656329

Weale, M., & Wieladek, T. (2022). Financial Effects of QE and Conventional Monetary Policy Compared. *Journal of International Money and Finance*, 102673. https://doi.org/10.1016/j.jimonfin.2022.102673

8. Appendix

8.1 Tables

Table 2a: Jarque-Bera Normality tests (Using Sensex)

	GFC period		Covid period	
Variable	Chi^2	P value	Chi^2	P value
IIP	1.4	0.497	2.96	0.228
CPI	1.96	0.3753	5.17	0.075
QE	3552.64	0.000	12.63	0.001
Sensex	4.53	0.103	3.15	0.206

Note: H_0 : Residuals are normally distributed

Table 2b: Jarque-Bera Normality tests (Using Nifty)

	GFC period		Covid period	
Variable	Chi^2	P value	Chi^2	P value
IIP	1.25	0.534	2.5	0.286
CPI	1.75	0.417	4.7	0.092
QE	3667.63	0.000	14.94	0.000
Nifty	6.87	0.032	2.76	0.251

Note: H_0 : Residuals are normally distributed

Table 3a: Variance Forecast Error Decomposition(Using Sensex)

	GFC		Covid-19 Pandemic	
	IIP	CPI	IIP	CPI
Impact	0	0	0	0
5 months	0.04	0.03	0.05	0.07
10 months	0.05	0.06	0.06	0.07
15 months	0.05	0.07	0.06	0.08
20 months	0.05	0.09	0.06	0.08

Table 3b: Variance Forecast Error Decomposition(Using Nifty)

	GFC		Covid-19 Pandemic	
	IIP	CPI	IIP	CPI
Impact	0	0	0	0
5 months	0.05	0.04	0.05	0.07
10 months	0.06	0.07	0.06	0.07
15 months	0.05	0.09	0.06	0.07
20 months	0.06	0.09	0.06	0.07

Table 3c: Variance Forecast Error Decomposition (Using Bond Yields)

	GFC		Covid-19 Pandemic	
	IIP	CPI	IIP	CPI
Impact	0	0	0	0
5 months	0.03	0.01	0.01	0.05
10 months	0.05	0.01	0.02	0.04
15 months	0.06	0.03	0.02	0.05
20 months	0.06	0.05	0.02	0.06

8.2 Figures

8.2.1 Stability tests

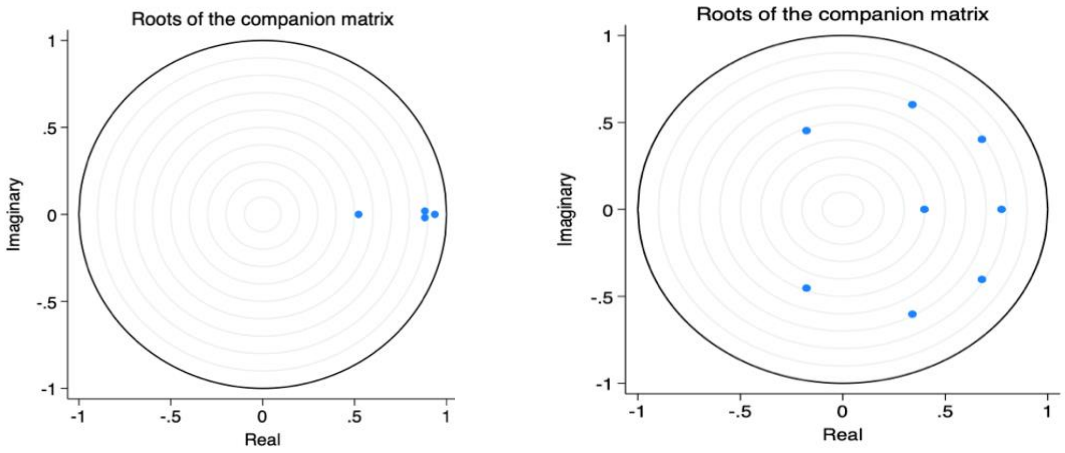

Figure 3a: Stability tests for Sensexx during GFC and Covid-19 Pandemic respectively. Note: All eigen values lie within unit circle indicate stability

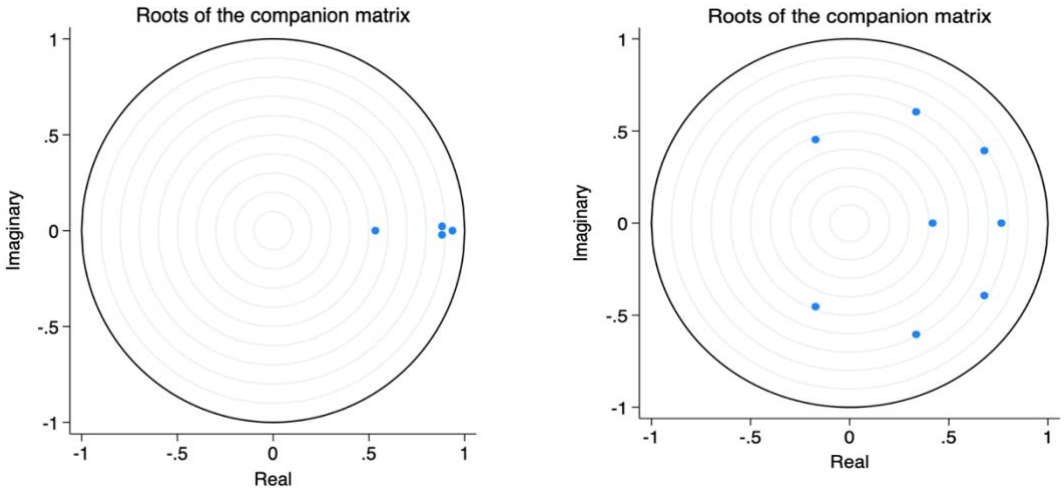

Figure 3b: Stability tests Nifty during GFC and Covid-19 Pandemic respectively. Note: All eigen values lie within unit circle indicate stability

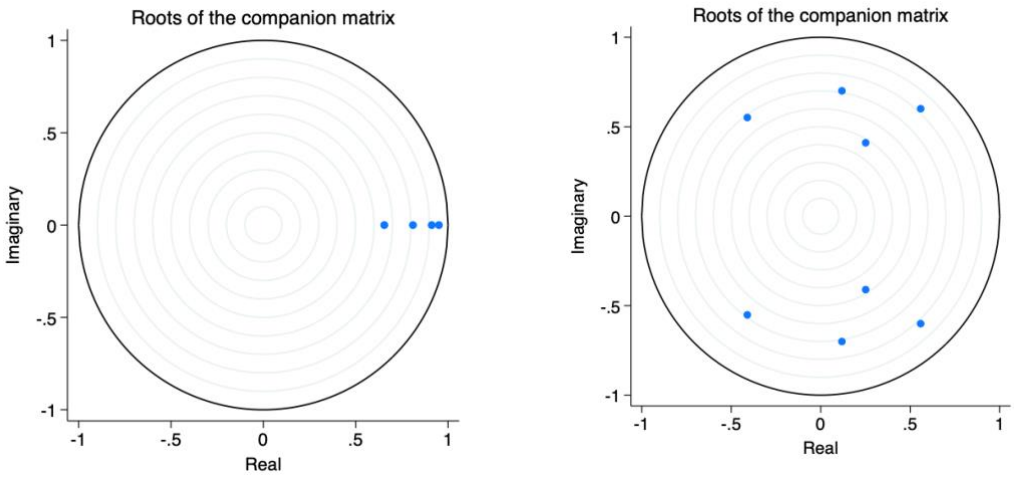

Figure 3b: Stability tests for bond yields during GFC and Covid-19 Pandemic respectively. Note: All eigen values lie within unit circle indicate stability

8.2.2Main Results

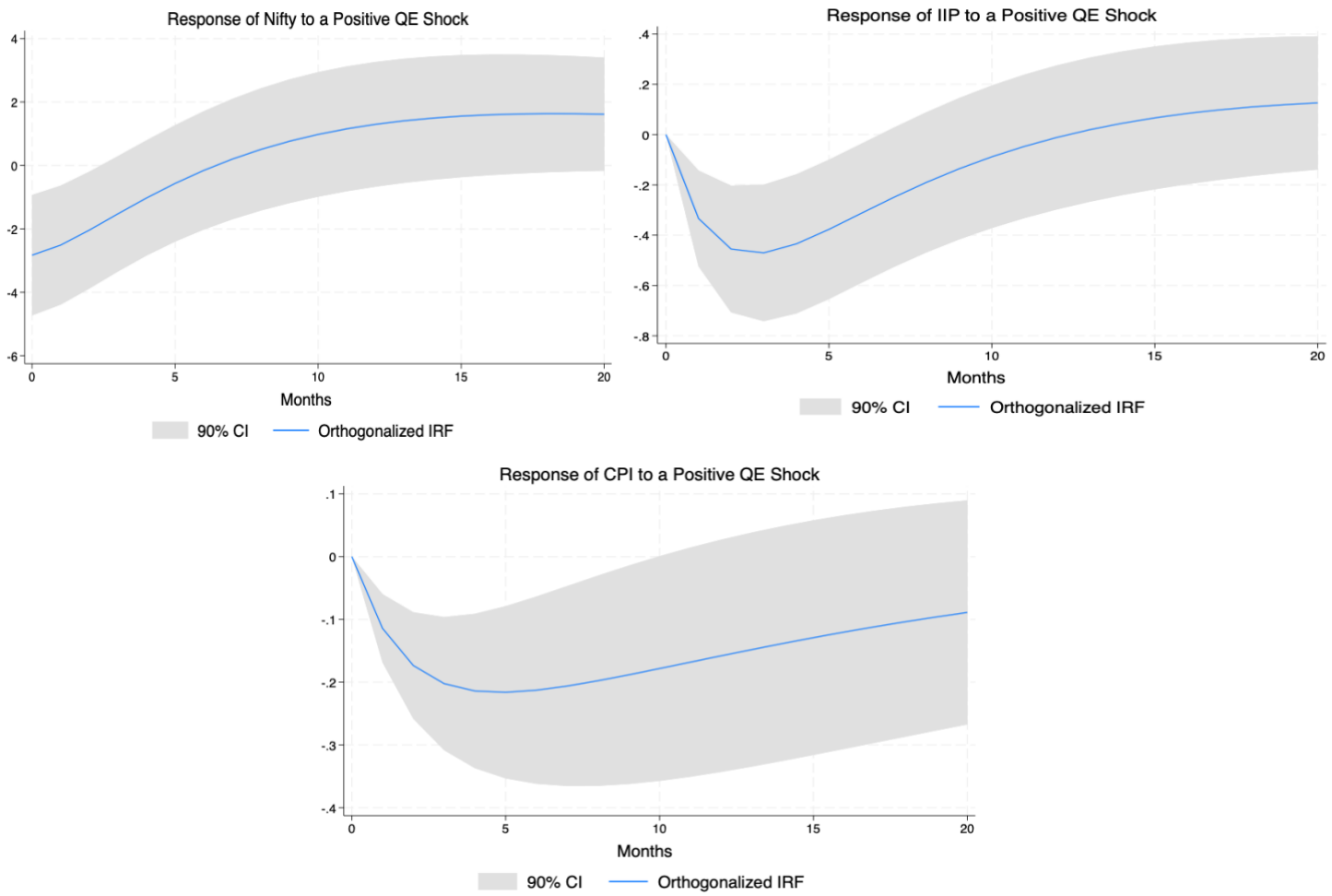

Figure 4a : Impulse response functions of positive shock to QE during the GFC on Nifty, IIP and CPI. Note: the values on y-axis are basis points.

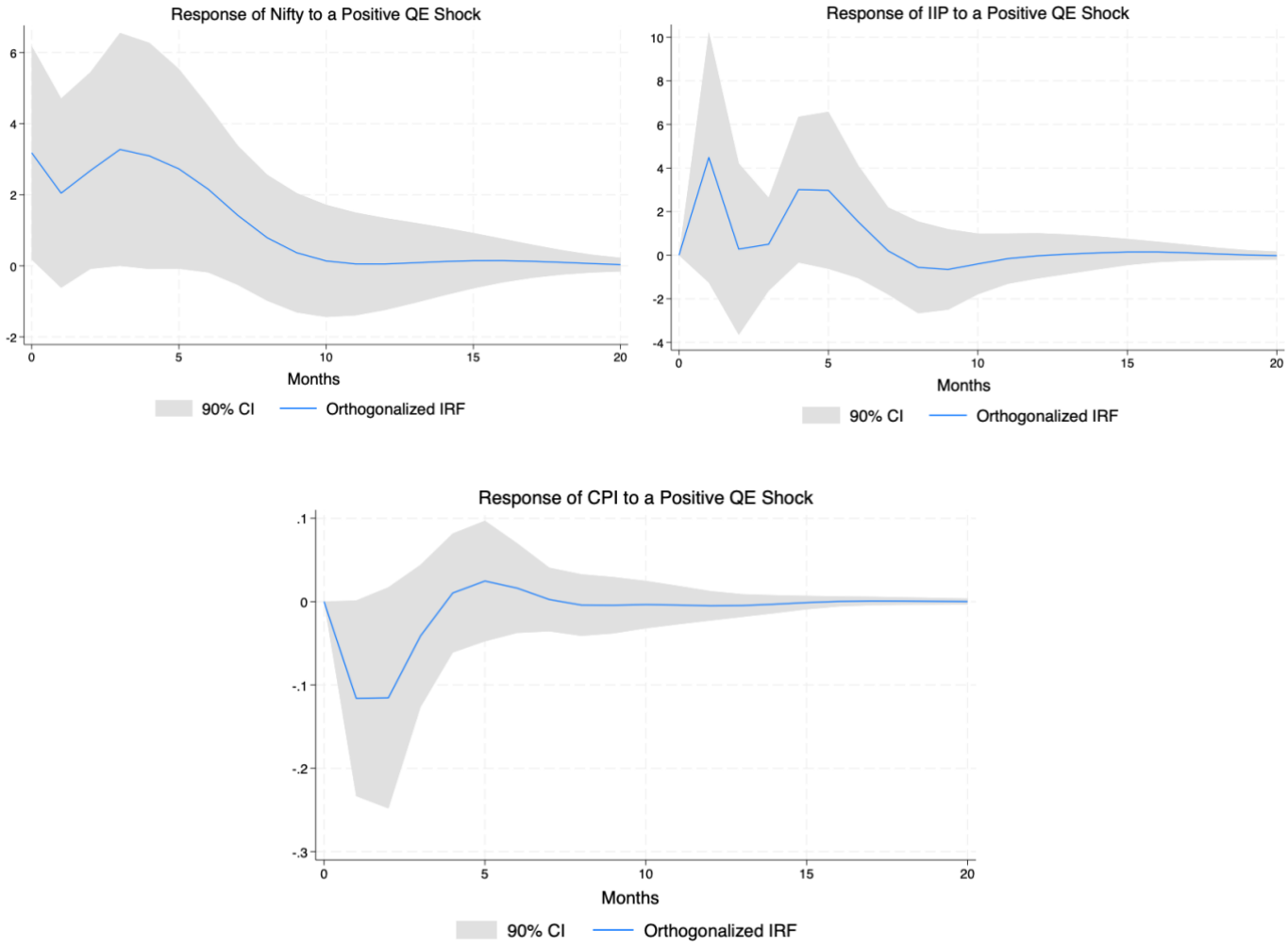

Figure 5a: Impulse response functions of positive shock to QE during Covid-19 pandemic on Nifty, IIP and CPI. Note: the values on y-axis are basis points.

8.2.4 Robustness Checks

8.2.4.1Nominal Exchange Rate

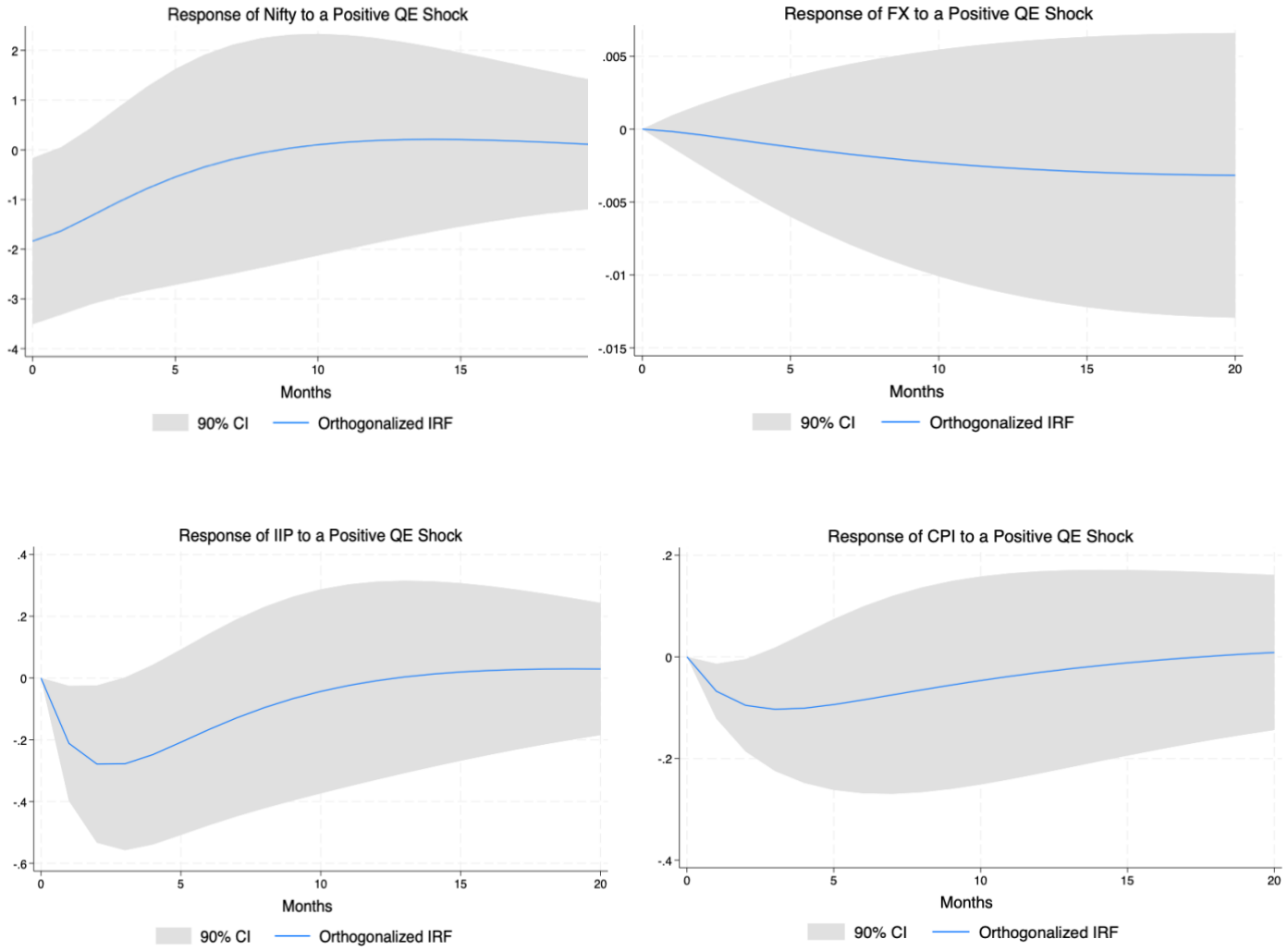

Figure 8a: Impulse response functions of positive shock to QE during the GFC on Nifty, FX, IIP and CPI. Note: the values on y-axis are basis points for Nifty, CPI, IIP and percentages for FX.

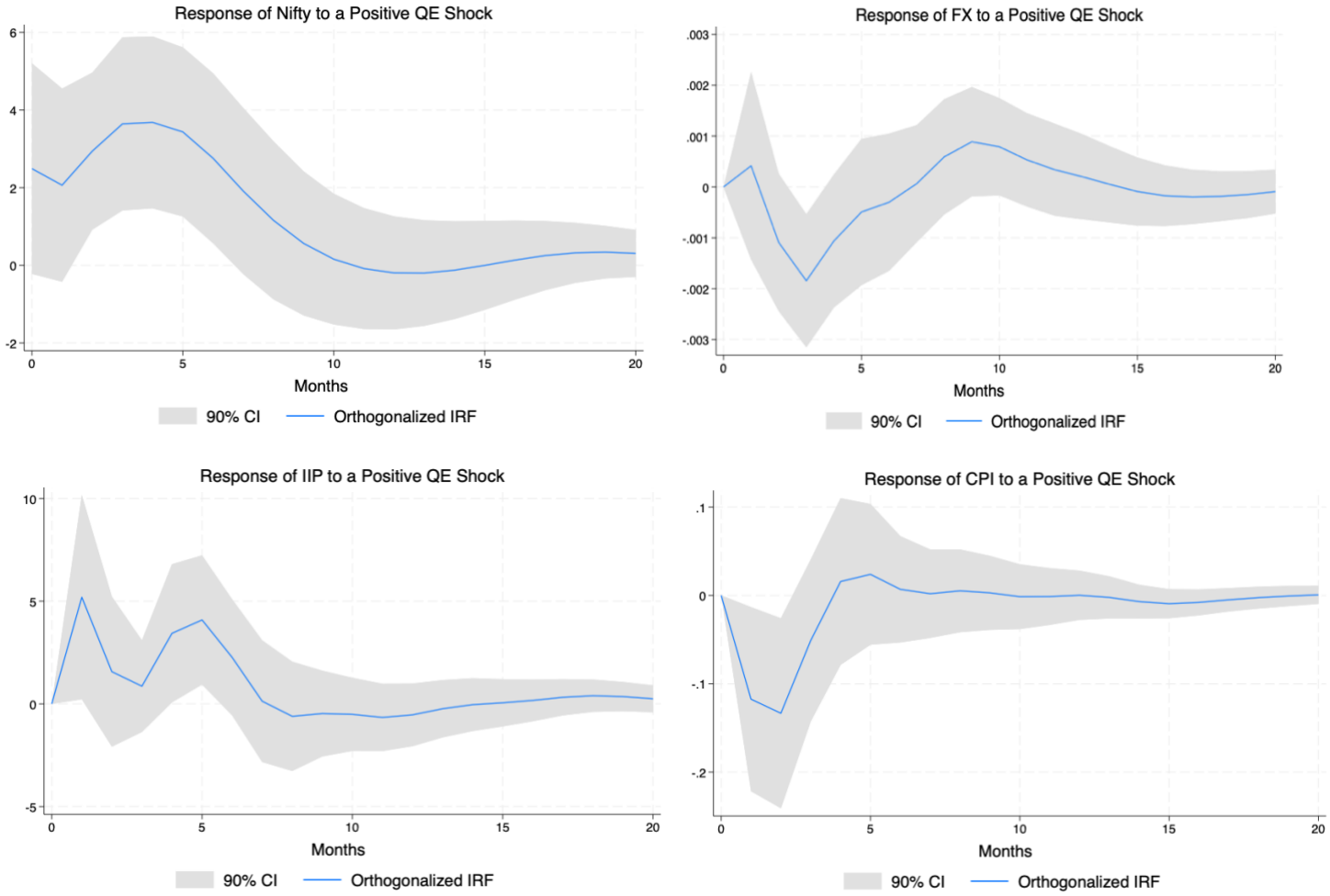

Figure 8b: Impulse response functions of positive shock to QE during the Covid-19 pandemic on Nifty, FX, IIP and CPI. Note: the values on y-axis are basis points.

8.2.4.2 Bond Yields and Stock market returns

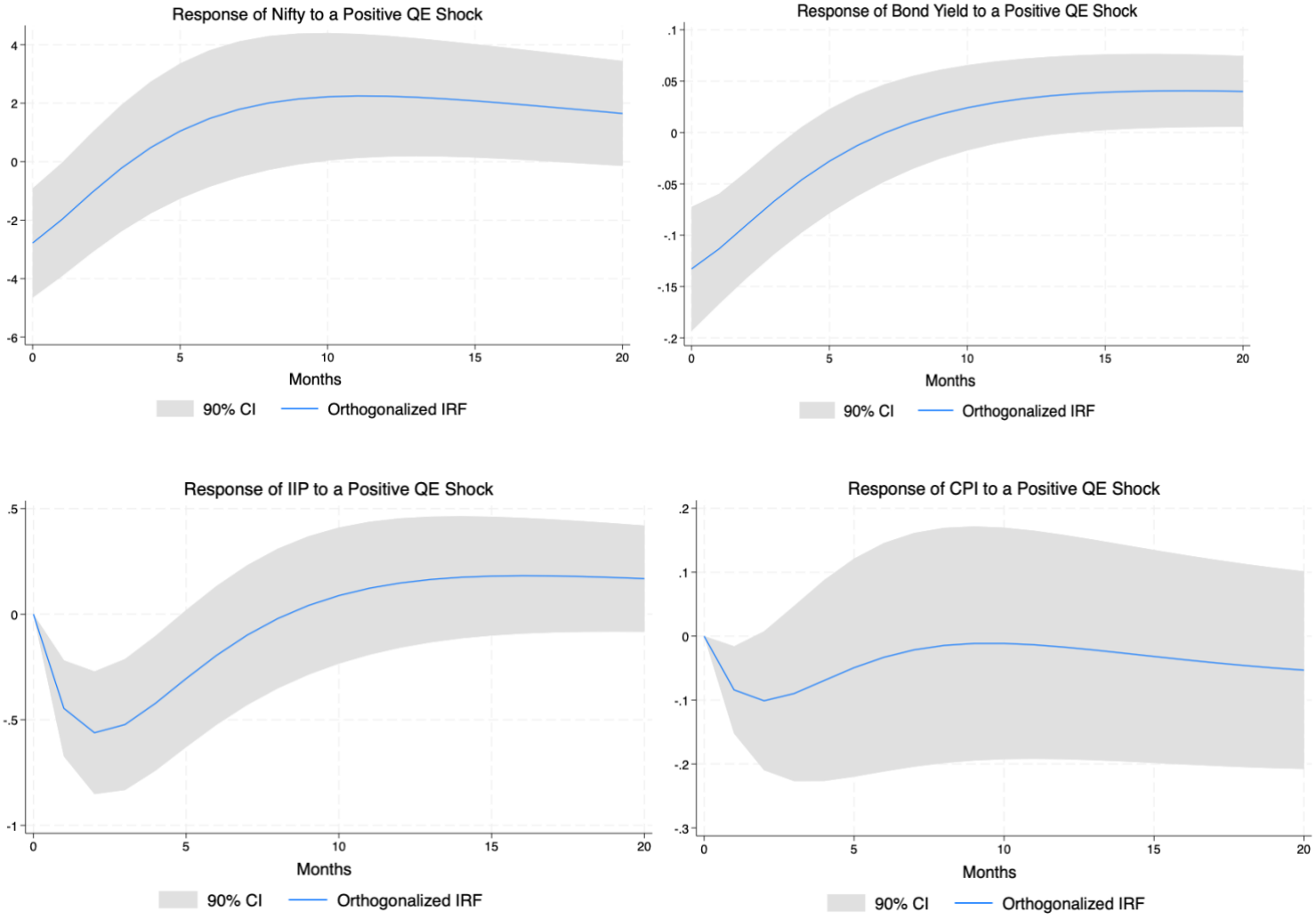

Figure 9a: Impulse response functions of positive shock to QE during the GFC on Nifty, Bond Yields, IIP and CPI. Note: the values on y-axis are basis points.

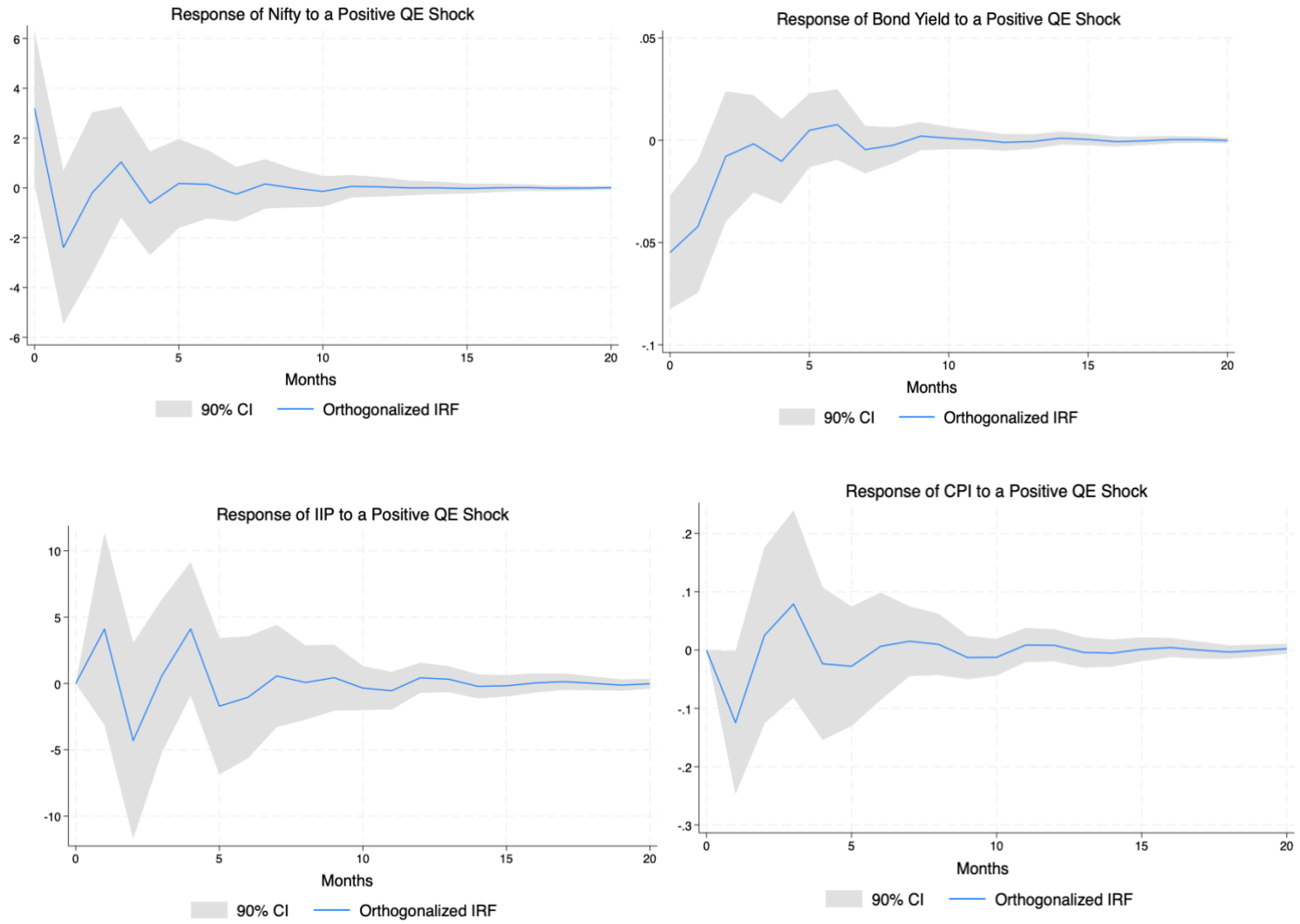

Figure 9b: Impulse response functions of positive shock to QE during the Covid-19 pandemic on Nifty, Bond Yields, IIP and CPI. Note: the values on y-axis are basis points.