Impact of Negative Interest Rate Policy on Emerging Asian markets: An Empirical Investigation

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Impact of Negative Interest Rate Policy on Emerging Asian markets: An Empirical Investigation

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Abstract

In last few years, several central banks have implemented negative interest rate policies (NIRP) to boost domestic economy. However, such policies may have some unintended consequences for the emerging Asian markets (EAMs). The objective of this paper is to provide an assessment of the domestic and global implications of negative interest rate policy. We also present how the implications differ from that of quantitative easing (QE). The analysis shows that the impact NIRP is heterogeneous; with differential impacts for big Asian economies (India and Indonesia) and small trade dependent economies (STDE) (Hong Kong, Philippines, South Korea, Singapore and Thailand). Nominal GDP and exports are adversely impacted in EMs in response to NIRP, especially in India and Indonesia. The inflation goes significantly high in EMs in response to plausible negative interest rates but the impact is much more severe for India and Indonesia than in STDEs. The local currencies also depreciate in all EAMs in response to negative interest rates. QE, on the other hand, has no significant impact on inflation but nominal GDP growth declines in EAMs. The currency appreciates and exports decline. The impact is much more severe in big emerging economies like India and Indonesia

Key words: Negative interest rate policy, Quantitative easing, emerging economies
JEL codes: E52, E58.

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1. Introduction

Post the global financial crisis of 2008, the way the monetary policies were conducted in advanced economies changed dramatically. These policies have generally been termed as "unconventional" monetary policy (UMP) as opposed to "conventional" monetary policies where the central banks either cut or raise policy rates to influence short-term interest rates. However, the central banks of many of the advanced economies had to look beyond conventional monetary policies after it reached the zero lower bound in order to help their economies come out of deflationary pressures.

The experience so far suggests that the central banks have resorted to two different ways of conducting UMP- quantitative easing (QE) and negative interest rate policy (NIRP). The QE was aimed at suppressing the long term interest rates by large scale purchase by central banks of long –term government bonds and mortgage backed securities. The Federal Reserve (Fed), the Bank of England (BOE), the European Central Bank (ECB) and the Bank of Japan (BOJ) actively engaged in QE in various phases.

Since mid-2014, increasing number of central banks have implemented UMP by resorting to NIRP. Six central banks –Danmarks Nationalbank (DN), ECB, Sveriges Riksbank (SR), the Swiss National Bank (SNB), BOJ and most recently Hungarian National Bank (MNB)– decided to move their policy rates below zero, traditionally seen as the lower bound for nominal interest rates. Even the Fed had indicated that NIRP remains a possible tool at its disposal if required[2].

The UMP may have certain unintended consequences for EAMs given the global linkage of EAMs with rest of the world has increased in last decade. Specifically, EAMs worry that ultra-easy monetary policy in advanced economies have led to huge capital inflows and currency appreciation making them less competitive in the trade market. There exist abundance of literature analysing the spillover impact of QE on EM. Unfortunately, the same is not true for NIRP and literature availability is scant. Central banks of many EMs have raised concerns over adverse spillover effects of NIRP. Also, the way spillover effects of NIRP are transmitted to EAMs may be different from QE.

The aim of this paper is to fill this gap by attempting to quantify the possible spillover impact of NIRP on EAMs. Although six central banks have adopted NIRP so far but accept for Japan and eurozone, no other country is systematically important for emerging Asia. As far as Japan and Eurozone are concerned, there are two limitations- first, the available dataset is not sufficient to arrive at any conclusion and second the BOJ and ECB actively pursued together QE as well as NIRP making it difficult to disentangle the impact of NIRP.

To get rid of the data problem, we try to answer the following: What if the USA, globally the most important country for emerging Asia, adopted NIRP after reaching the zero lower bound in 2008 instead of QE? We analyse the possible spillover impact on EMs had the Fed cut the fund rate to negative territory after hitting the zero lower bound. We compare the possible domestic impact of NIRP and QE on the US economy. We also study and compare the spillover impact of both the policies on EAMs.

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[2] "Yellen Doesn't Rule Out Negative Rates in Letter to Congressman" - http://www.bloomberg.com/news/articles/2016-05-12/yellen-doesn-t-rule-out-negative-rates-in-letter-to-congressman

For our study we use macroeconomic data of the US and EAMsfrom1997 onwards and divide it into two sub-periods- pre-crisis (up to December 2008) and post-crisis (January 2009 onwards). Since the Fed exclusively used federal fund rate to support growth and control inflation in the pre-crisis period, we use this sample to study and quantify the domestic and spill over impact of NIRP. The post-crisis period sample is used to study the impact of QE. The Federal Fund target rate remained constant after reaching the ZLB and it was raised as late as in December 2015. Thus, separately studying the pre-crisis and post-crisis sample makes it easier to disentangle the impact of NIRP from QE. We use ten-year US government bond yield (g-sec) as a proxy for QE. Changes in the US 10-year sovereign bond yield is be a good indicator of QE, when the zero lower bound on nominal interest rates becomes binding, and when the major objective of Fed asset purchase programmes has been to reduce long-term bond yields (Chen, Filardo, He and Zhu 2011). Similarly, we use US three-month treasury bill (T-bill) as an indicator for NIRP. The inspiration for using T-bill for our analysis comes from the experience so far suggesting that modest negative policy rates are transmitted to money market rates and short-term maturity government bonds in very much the same way as positive rates are (Bech, Malkhozov et. al. 2016). Hence, an impulse response function for a negative shock in T-bill helps us identify the possible impact of negative rates on the economies of the US as well the EAMs.

We use data for Hong Kong, India, Indonesia, Philippines, South Korea, Singapore, and Thailand to study the spill over impact of NIRP on EAMs. However, we understand that the impact of NIRP on different EAMs may be heterogeneous. To check if different set of countries are impacted differently we study separately the spill over impact of NIRP and QE on big Asian economies (India and Indonesia) and STDE (Hong Kong, Philippines, South Korea, Singapore and Thailand). We present impulse response functions (IRF) of the US macroeconomic variables when a negative shock is given to g-sec and T-bill. Next, we use panel IR to study the spill over impact of QE and NIRP on EAMs, big Asian economies and STDE. We present IRF of key macroeconomic variables for the given set of countries when a negative shock is given to g-sec and T-bill.

The focus of the paper is on NIRP as enough literature already exist on QE. The paper is organised as follows. Section 2 looks at existing literature on QE and NIRP. Section 3.1 explains briefly NIRP and how they have been implemented in various countries. Section 3.2 explains the possible ways the QE and NIRP may influence the emerging countries. Section 4 explains the data and methodology used for our study. Section 5 presents the results of the model and section briefly explains the conclusion of our findings.

2. Literature Review

While the domestic and spill over impact of QE has been studied extensively, the analysis of the domestic as well as spill over effects of NIRP from advanced economies to emerging markets have not received much attention in the empirical literature. The reason for the limited literature is understandable given the rather limited experience central banks have with NIRP.

Much of the work to study domestic and international spill over impact of QE has resorted to event studies analysing the announcement or surprise effects of QE. Lately, many literatures have also employed regression analysis. Relying on event studies of US asset purchases on domestic and international financial markets, Nealy (2010) employed event studies method and found that US QE reduced treasury bond yields by 100 basis points and corporate bond yields by 80 basis points. He also found in his study that US QE led to lowering of bond rates in the other advanced economies by 20-80 basis points and the US dollar depreciated by 4-11 percentage points. Glick and Leduc (2011) showed that, despite the fall in long-term interest rates and the

depreciation of the dollar, commodity prices fell on average on days of QE announcements and the effects were more pronounced during the first round of QE. Vhen, Filardo, He and Zhu (2011) employed global VECM technique in their study and found that compared to its domestic impact, the US QE turned out to have far greater impact on most emerging economies. In the emerging Asia, inflation increase range from 0.5 in Singapore to almost 4 percentage points in Indonesia while US inflation rises at most by 0.6 percentage point. Bhattarai and Chatterji (2015) using Bayesian VAR technique found that an expansionary US QE shock leads to an exchange rate appreciation, a reduction in long-term bond yields, and a stock market boom for emerging market countries. Fratzscher et al. (2013) study the global spillovers of the Fed's UMP measures and find that it affected capital flows to emerging market economies in a pro-cyclical manner, have raised asset prices globally and weakened the US dollar. Lim et al. (2014) study the effects of US QE on gross financial inflows to developing countries and conclude that QE have been transmitted internationally through liquidity, portfolio rebalancing, and confidence channels.

As per as NIRP is considered, most recent work has focused on its domestic effects, analysing several channels of domestic transmission. There is very little research on the international spillovers of central bank balance sheet policies, especially the impact on emerging Asia. Data availability is a main obstacle as the period following the implementation NIRP remains very short and the effects are yet to be fully transmitted to other countries. The Financial Stability Report published by the Reserve Bank of India (RBI) concludes that the impact of NIRP on rising inflation/inflation expectations are more benign compared to asset price inflation and wealth effects. Roach (2016) contends that NIRP transmission through wealth effects from asset markets rather than through the borrowing costs is impacting the cost of credit. Arteta et. al (2016) argue that since the introduction of NIRP, both inflation projections and expectations have continued to decline. The downgrades in inflation projections reflected to a large extent the impact of sharply declining oil and other commodity prices since mid-2014. However, long term inflation expectations have also showed signs of a downward drift. They also use event study technique and conclude that currencies appreciated, bond spreads declined, and equity prices increased for EMs on the day of the announcement of NIRP. Genay and Podjasek (2014) find that a low interest rate environment is associated with decreased profitability for banks, but they estimate the effect to be economically small and outweighed by other macroeconomic factors. Lipton (2016) argues that NIRP is also likely to push capital either out of the economy leading to currency depreciation pushing exports and reducing imports, akin to competitive devaluations, or could inflate certain asset prices like housing necessitating the use of macro prudential measures. Coeuré (2014) raises concerns that banks may choose to borrow less from the central bank in order to lower excess reserves and avoid the negative deposit rate. This would put upward pressure on rates in the interbank and bond market, offsetting the stimulative impact of the NIRP. Hannoun (2015) is of the view that NIRP would reduce the incentive for fiscal consolidation and structural reform in cases where it is needed. Negative interest rates lower the debt service ratio, which would give a misleading picture of debt sustainability and hence, could reduce incentive for fiscal discipline.

This paper contributes to the existing NIRP literature by employing IR technique enabling us to extend the insights from the announcement effects literature. We also assess the cross-border impact of NIRP on broader macroeconomic and financial variables that policy, such as output and exchange rate, on emerging Asia. Finally, we do a comparative analysis of QE and NIRP with respect to their domestic as well as spillover impact on macroeconomic and financial variables.

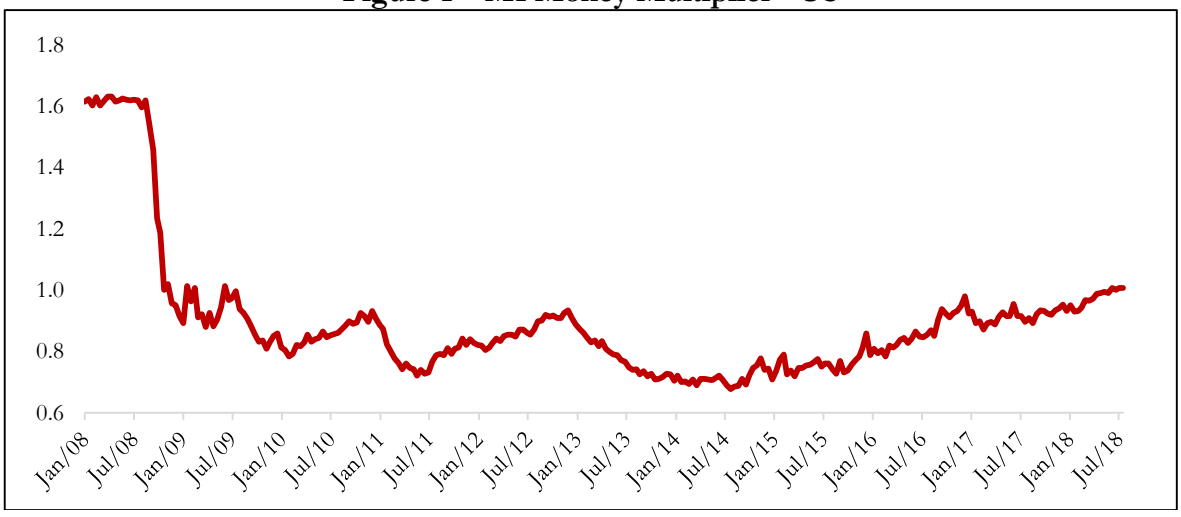
3. Implementation of NIRP

This section explains in detail the experience of NIRP so far since its implementation by five central banks. We are excluding Hungary National Bank from our analysis as its decision to implement NIRP is very recent and not enough data points are available to arrive at a meaningful conclusion. Section 3.1 describes in detail how central banks have implemented NIRP and its transmission in the economy. Section 3.2 looks at various routes through which NIRP may have been transmitted to emerging economies.

Section 3.1: An assessment of NIRP and its transmission

Many of the central banks in the advanced economies cut their policy rates close to zero in the aftermath of the financial crisis of 2008 to help reinvigorate the flagging economy. Once the policy rates hit the zero lower bound, further monetary easing was achieved through unconventional measures such as forward guidance and QE. Despite all these efforts, the economic recovery in advanced economies remained slow and uneven. Ultra easy credit policy failed to increase bank lending to the private sector. In US, banks in response to QE chose to keep the excess reserve money supply either as deposits with the Fed or invested in government securities. As a result, even in response to a quantum leap in reserve money, the money supply never really picked up in the US. In the US, for example, M1 money multiplier plummeted post September 2008 (figure 1). In fact, it fell below one implying that every dollar created by the Fed results in less than a dollar increase of the money supply (M1).

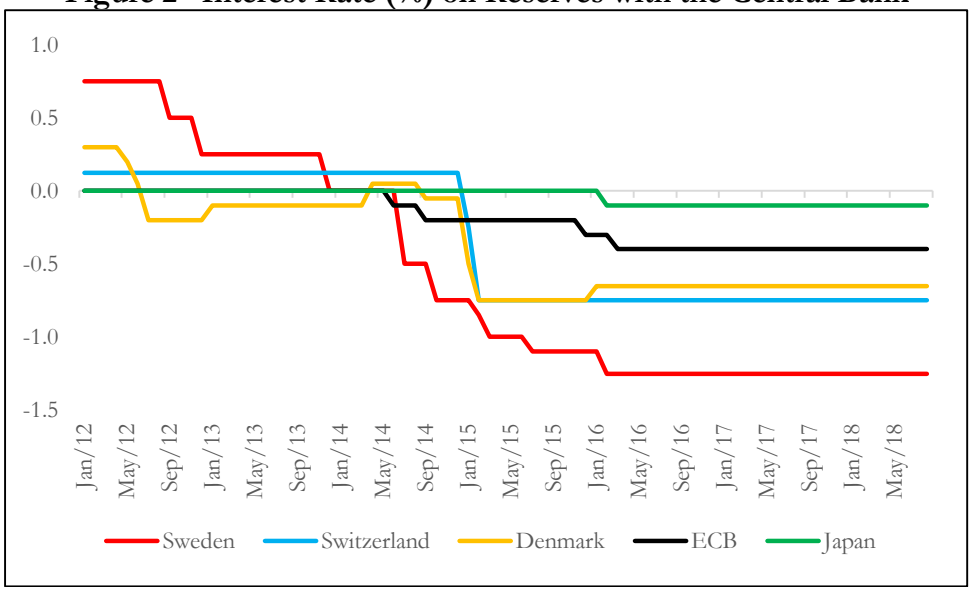
Figure 1 – M1 Money Multiplier - US



Source: Federal Reserve.

Against this background, it was considered necessary by some central banks to experiment with unchartered waters of NIRP. Six central banks- ECB, SNB, DN, Riksbank, BOJ and HNB – have pushed their key policy rates (mainly the deposit rates on excess reserves) in negative territory since mid – 2014 (figure 2).

Figure 2 –Interest Rate (%) on Reserves with the Central Bank



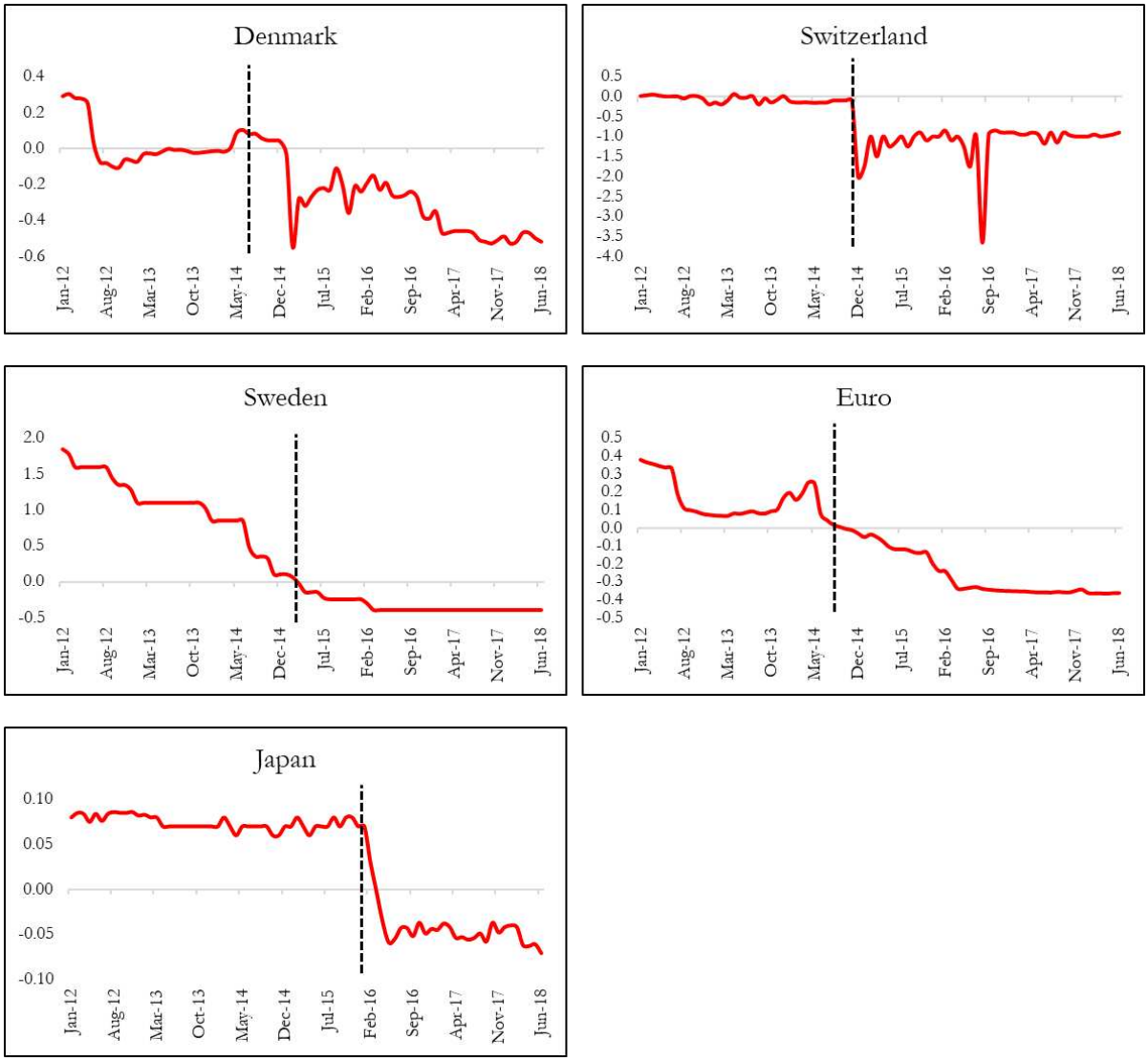
Source: Central Banks of respective countries.

The main motivation for these central banks for the adoption of NIRP vary. For ECB, BOJ, Riksbank and MNB, the main motivating factor was to counter sluggish growth and deflation. The ECB introduced a negative interest rate of 10 bps on its deposit facility in June 2014 to "underpin the firm anchoring of medium to long-term inflation expectation" (Draghi 2014). The Riksbank introduced a negative one week repo rate of 10 bps in February 2015 to "provide support for inflation so that it rises and stabilizes around 2 percent in 2017" (Riksbank 2016). The BOJ imposed a negative interest rate of 10 bps on in January 2016 "in order to achieve the price stability target of 2 percent at the earliest possible time"(BoJ 2016a). The MNB, latest entrant to the NIRP club, cut its overnight deposit rate to -0.05 percent in March 2016 keeping in view" persistently low cost-side inflationary pressure, the slowdown in global growth and the historically low level of inflation expectations" (MNB 2016).

For SNB and DN, countering currency appreciation due to capital inflows was the key factor to adopt NIRP. The SNB announced a negative interest rate on 25 bps on sight deposits account balance in December 2014 to discourage capital outflows and Swiss franc's appreciation. The DNB first set its deposit rate below zero in July 2012 but it returned to positive territory in April 2014. The rate was cut again to negative territory in September 2014 "in order to stem the capital inflow" (Rohde 2015).

The experience of NIRP suggests that the negative policy rates are transmitted to the money market in the same way as positive rates. In all the jurisdictions, the overnight call money rates have followed the policy rate below zero (figure 3). It appears that if there is a positive spread to encourage borrowing and lending, the absolute level of interest rates is not particularly important for intermediaries (Jackson 2015).

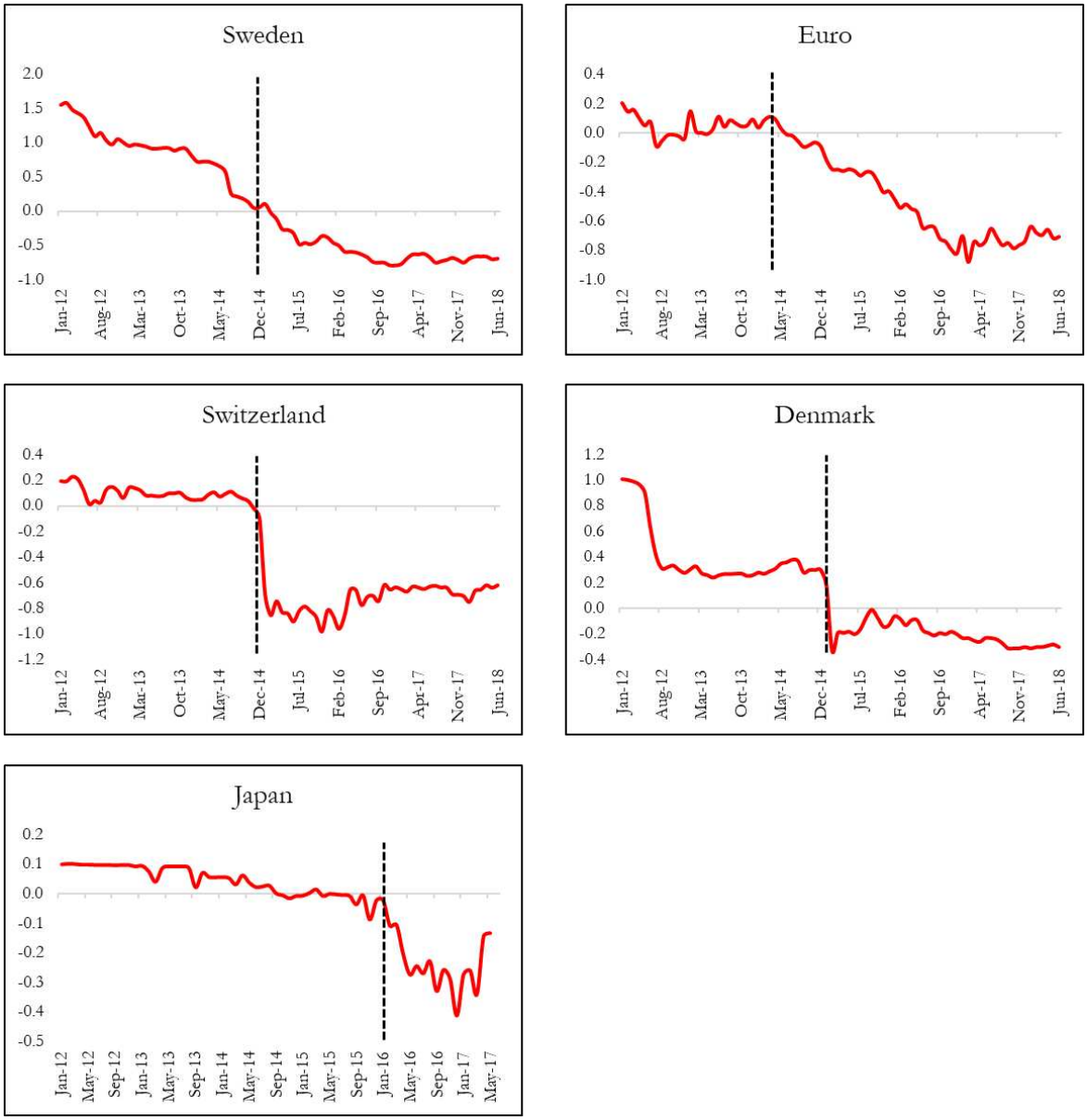
Figure 3: Transmission of NIRP to Money Market Overnight Call Money Rate (%)



Sources: ECB, Riksbank, DN, SNB, BOJ
Notes: The vertical line depicts the time of adoption of NIRP.

The transmission of NIRP beyond money markets presents a mixed picture. Yield on treasury bills and short maturity government bond yields have turned increasingly negative (Figure 4). However, in case of longer maturity bonds, there was a decline in the yields initially after the introduction of NIRP (Figure 5). However, this decline in yields cannot be attributed to NIRP solely as the central banks simultaneously pursued asset purchase programs. Also global forces, such as declining inflation and growth expectations, low investment and excess savings, as well as a diminishing pool of highly-rated low-risk fixed income assets, have put significant downward pressure on long maturities government bonds yield (Arteta et. al. 2016).

Figure 4: Transmission of NIRP to Short – Term Maturities Bond Market



Sources: ECB, Riksbank , SNB, DN, BOJ

Notes: 3 Months t-bill yield for Japan, Denmark and Sweden; 1-year security yield for Euro area and Switzerland

The vertical line depicts the time of adoption of NIRP.

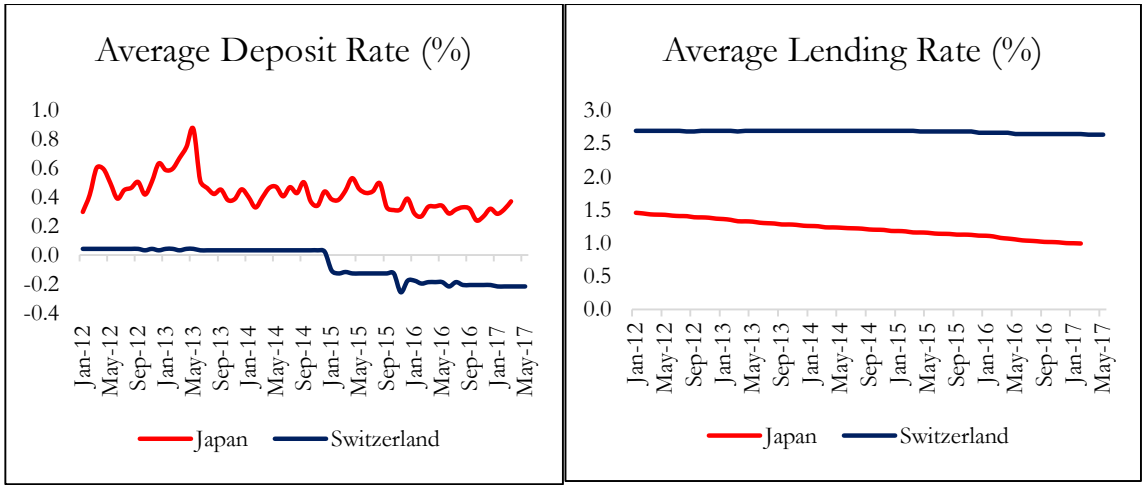
Figure 5: Transmission of NIRP to long – term Maturities Bond Market

Sources: ECB, Riksbank , SNB, BOJ, DN

Notes: Figures are for 10 year government bonds yield.
The vertical line depicts the time of adoption of NIRP.

The transmission of NIRP beyond money markets and short maturities bonds are affected mainly on account of reluctance of commercial banks to pass negative rates through to depositors, especially retail depositors (Figure 6). Banks worry that negative retail deposit rates may lead to mass deposit withdrawals affecting the profitability of banks. In the Sweden and Japan, deposit rates moved to about zero. Time deposits rates have moved in the negative territory in Switzerland. However, to maintain the net interest margin the banks have raised the investment and mortgage loan rates.

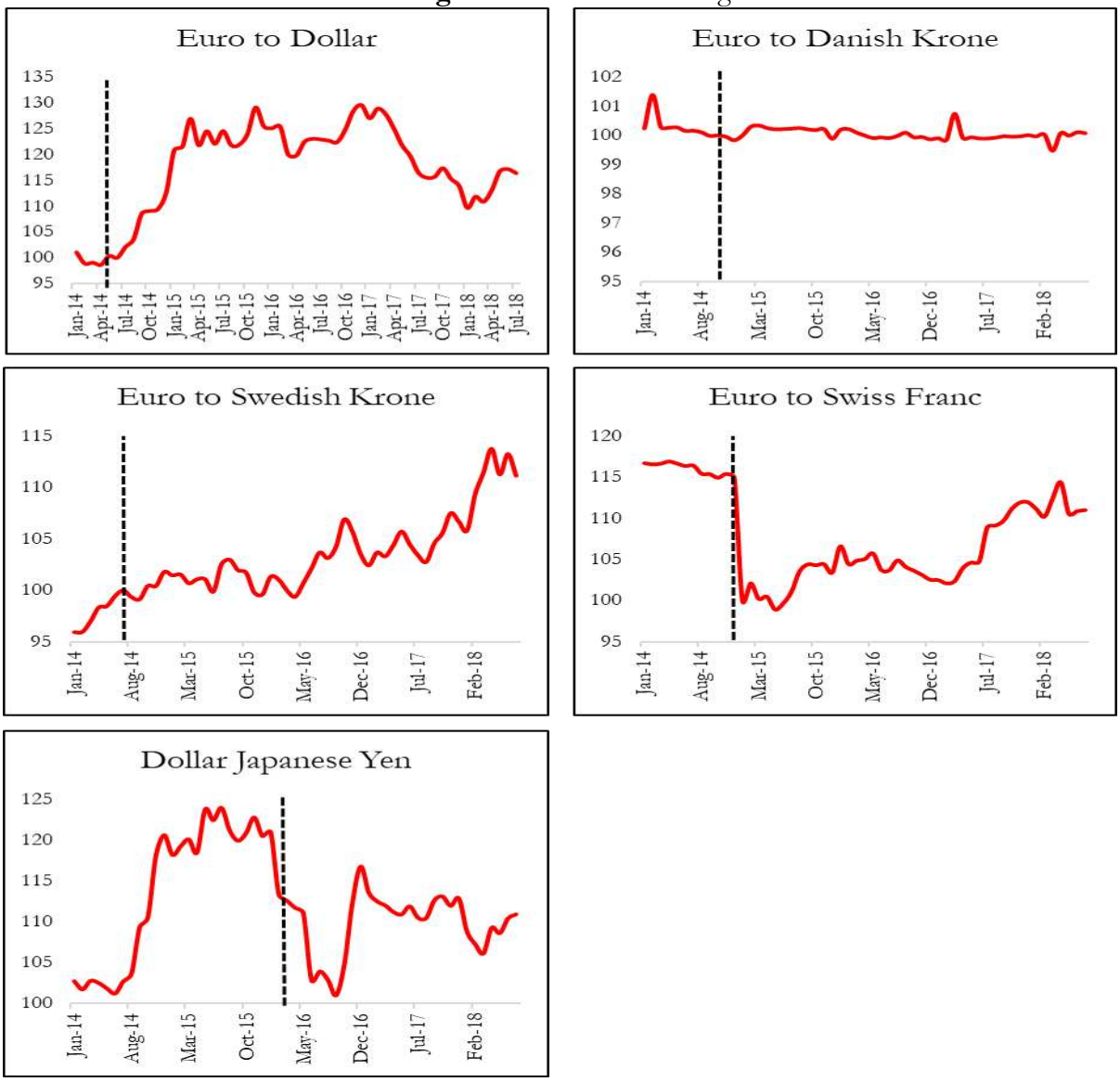
Figure 6: Deposit and Lending Rates



Sources: International Financial Statistics (IFS).

The impact of NIRP on exchange rate presents a mixed picture. Euro depreciated against dollar after NIRP was adopted but it was short-lived and the direction has reversed in the recent past. Swedish krone has generally shown a depreciating trend against the euro. The Swiss franc appreciated after the interest rate moved in the negative territory in December 2014. This could be attributed to the SNB's decision to abandon its exchange rate ceiling vis-à-vis the euro. Danish krone and Yen has remained stable. Exchange rate is expected to depreciate in response to negative interest rate shock to equalize risk-adjusted real returns on various debt instruments. However, the NIRP was introduced when the general global risk environment undergoing substantial swings leading to muted impact of NIRP on exchange rate. However, the Japanese yen and Swiss franc do not confirm to this trend. In Japan, the yen appreciated post NIRP adoption mostly driven by capital inflows due to flight to safety considerations.

Figure 7: Bilateral Exchange Rate



Source: IFS

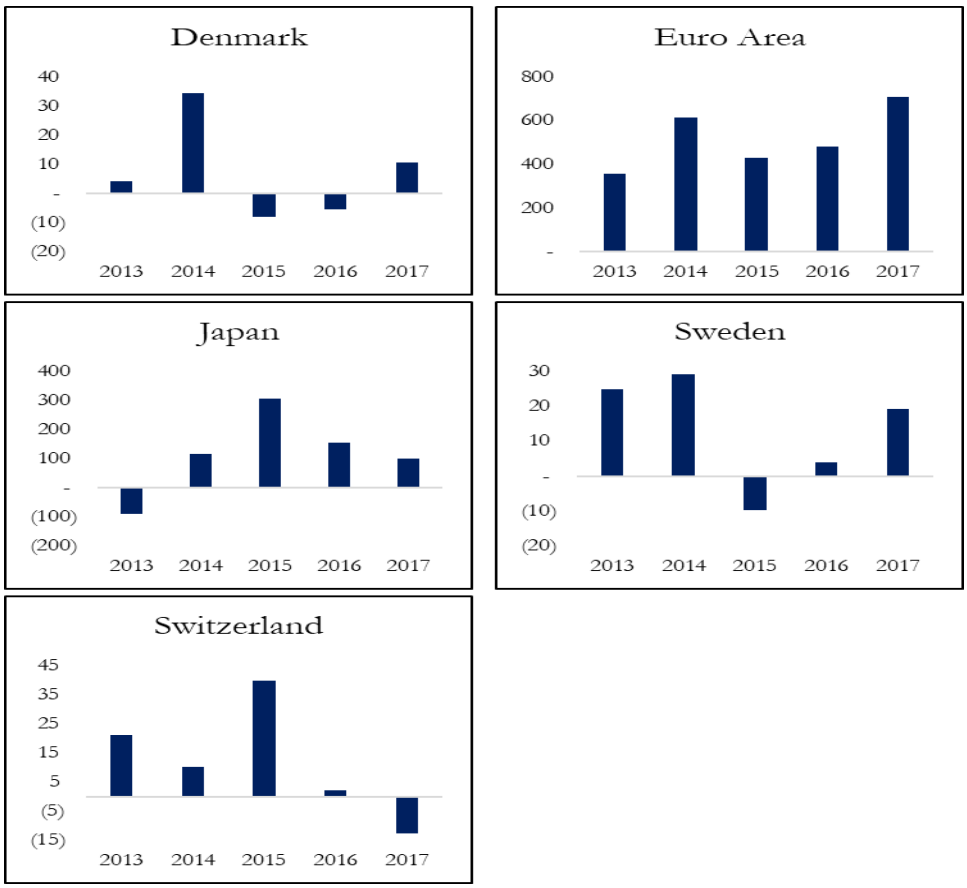
Notes: Exchange rates normalised to zero beginning January 2014
The vertical line depicts the time of adoption of NIRP.

One of the key reasons for the adoption of NIRP was to discourage capital inflows in these jurisdictions. Except for euro zone, portfolio inflows have remained subdued in other regions post NIRP adoption. Portfolio inflows in euro zone can be attributed to other factors such as accommodative global liquidity and flight for safety (figure 8).

In terms of macroeconomic variables, the performance continue to remain below par post NIRP introduction (Figure 9). NIRP countries are still struggling to achieve the desired inflation level of 2 percent. In fact, Switzerland—where the penalty imposed on excess reserves is the maximum—witnessed disinflation for more than a year post NIRP. Not only has inflation failed to reach the desired level in these countries, bank lending has also failed to pick up. In response to the financial meltdown of 2008, average bank lending growth plummeted and even remained negative for many quarters in Denmark and the Euro area. Bank credit growth to private non – financial corporation continues to remain sluggish even after adoption of NIRP. Banks continue

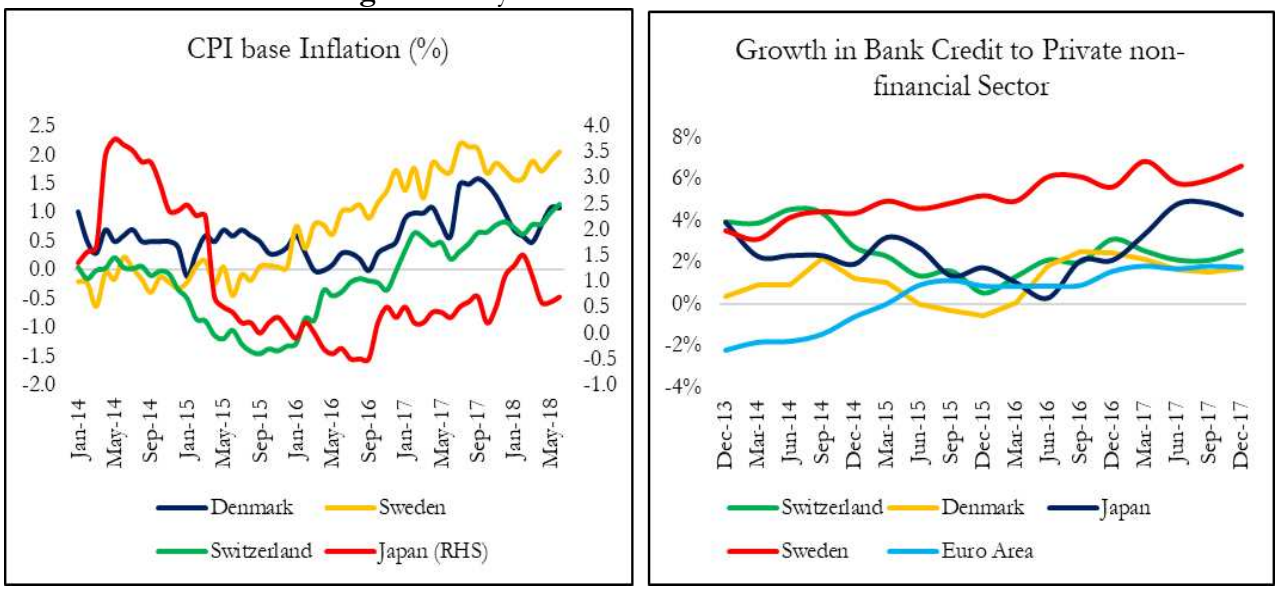
to hold enormous amount of excess reserves with their central banks even though they have to pay penalty for the same. Banks in Japan were holding of excess reserve was 3000 times the required reserve as of June 2015. Banks in Euro area were also holding excess reserves to the tune of 500 times the required reserve in July 2016. Banks' unwillingness to lend more is reflective of the persistent macroeconomic and financial uncertainty.

Figure 8: Portfolio Inflows (USD Billion)



Sources: IFS.

Figure 9: Key Macroeconomic Variables and NIRP



Sources: Bank of International Settlements, BOJ, ECB, IFS

However, it will not be fair to dismiss NIRP as they have not led to desired outcome One of the difficulties in evaluating UMP is that we don't know the counter-factual. In particular, Europe was hit by the eurozone crisis, and perhaps things would have been much worse if the ECB hadn't adopted the NIRP.

Section 3.2: Emerging economies and spill over effect of NIRP

Many of the central banks in the EAMs have flagged the concerns regarding adverse effects of NIRP being pursued in advanced economies. Former RBI governor Raghuram Rajan, had asked global central banks to adopt a system for assessing the adverse impact of NIRP on emerging economies. Bank Negara Malaysia governor Zeti Akhtar Aziz highlighted the need for greater policy coordination among emerging countries to prevent over-reliance on monetary policy. In this section we discuss the possible channels through which NIRP may have adverse impact on emerging economies.

Portfolio rebalancing channel: NIRP has led to fall in the yields of short – term as well as long – term maturities bonds. In such scenario, investors may turn to emerging market assets of similar maturities for higher risk-adjusted returns in search of higher yield. Such capital inflows may boost asset prices rates in the emerging economies and put upward pressure on their currencies. Easing of liquidity conditions may also put inflationary pressure.

Trade route Channel: NIRP may lead to depreciation of currencies where it is adopted. If it happens, it may put adverse impact on trade balances of emerging economies who export a major share of their goods and services to these economies.

Monetary Policy Divergence: NIRP has led increasing monetary policy divergence across major advanced economies which has contributed to appreciation of US dollar. This pressure has contributed to a higher cost of debt servicing and rising credit risks for emerging economies. (Hofmann, Shim, and Shin 2016).

4. Empirical Methodology

We proceed in two steps in our empirical study. A VECM for the US economy is estimated first. We run this model for two periods – (a) June 1997 to November 2008 (pre-crisis), and (b) December 2008 to March 2017 (post-crisis). Pre-crisis sample is used to assess the impact on domestic US real and financial variables had the Fed adopted NIRP after hitting zero lower bound. The reasons for using USA data for analyzing the spillover impact of the NIRP is explained in the introduction section.

In pre-crisis the Fed exclusively relied on federal fund target rates as the key monetary policy tool. As we discussed earlier, negative policy rates are transmitted to money market rates and short-term bond yields in very much the same way as positive rates are. Hence we t-bill rates as a proxy for negative interest rates and we look at impulse response to examine the effects of a negative shock in t-bill on real and financial variables of the USA. Similarly, in post-crisis sample we use same set of real and financial variables. However, instead of t-bill rates we use g-sec yield as a proxy for QE. Again, we use impulse response to examine the effects of a negative shock in the g-sec yield on real and financial variables of the USA.

In the second step, a panel VECM for the EAMs is estimated to assess the international spillover effects of a negative t-bill and g-sec shock. We include Indian, Indonesia, Hong Kong, South Korea, Philippines, Singapore and Thailand in our sample. Again, using pre-crisis and post-crisis samples separately for EM, we compute IR to assess their macroeconomic variables. Please refer to annex for more details

5. Impulse Response Analysis:

5.1. Domestic effect of NIRP on US economy

We present in Figure 10 the impulse responses US macroeconomic variables to a negative shock of 20 basis points to 3 months US t-bill (one standard deviation of the shock) over 36 months based on the pre-crisis sample.

Impact on real variables: The impact of the negative shock in three months US T-bill rate on real GDP is insignificant. The shock leads to a decline in inflation rate by more than 10 bps in the first quarter. Peak effect comes in the third quarter when the inflation rate drops by 19 bps. This result is interesting as many countries have cut the rates in the negative territory to boost inflation. However, our result shows that the Fed cutting moving in the negative territory may aggravate the deflationary pressures.

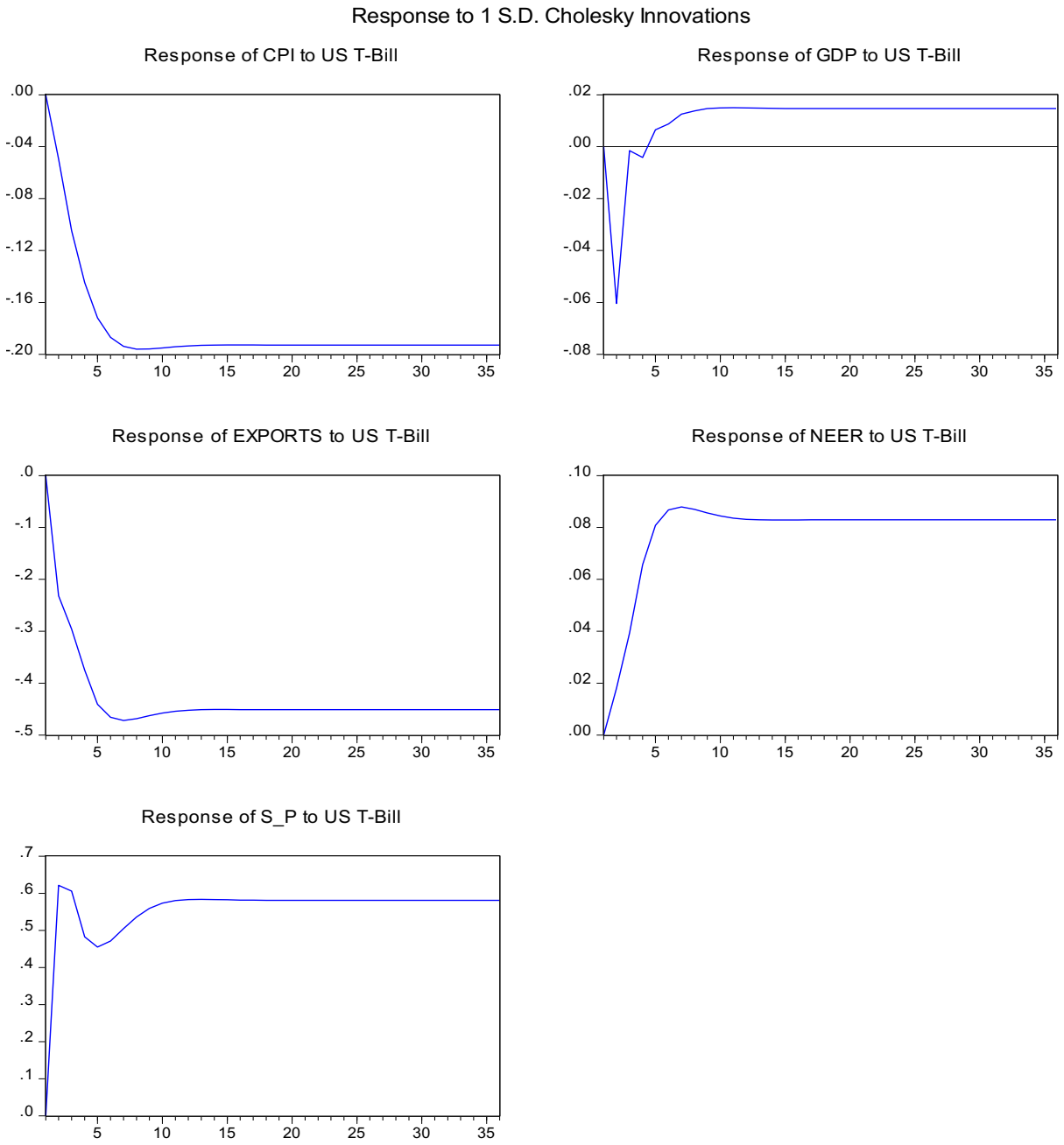
The immediate impact of these US gross exports to the rest of the world however is significant. Exports growth contracts by nearly 30 bps in the first quarter. Peak effect comes in the third quarter when gross exports growth fall by almost 47 bps.

Impact on financial variables: Magnitude of the impact of the shock on NEER index is insignificant but the direction of this impact is interesting. The NEER index appreciates immediately in response to the shock. Peak effect comes in the third quarter when the index appreciates by 8 bps. S&P index also goes up immediately in response to the shock. Peak effect comes in the first month itself when the S&P index goes up by 62 bps.

This exchange rate puzzle that we find supports the findings of Glick and Leduc (2013) who found in their study that the dollar appreciates on average in response to rate cuts of less than

50 bps. Hnatkovska, Lahiri and Vegh (2016) find in their paper that in response to a monetary tightening, the nominal exchange tends to appreciate in developed countries but depreciate in developing countries. They show in their paper that lower interest rates typically have three effects - lesser demand for domestic currency denominated assets (liquidity demand effect); lower cost of credit (output effect); and decline in debt service (fiscal effect). Liquidity demand effect causes currency to depreciate whereas output and fiscal effects appreciate currency. Net effect depends on relative strengths of these offsetting forces. It is possible that in response to Fed cutting the policy rate, the fiscal and output effects outweigh the liquidity demand effect leading to currency appreciation.

Figure 10: Impact of Fed Rate Cut on US Economy



5.2. Domestic effect of QE on US economy

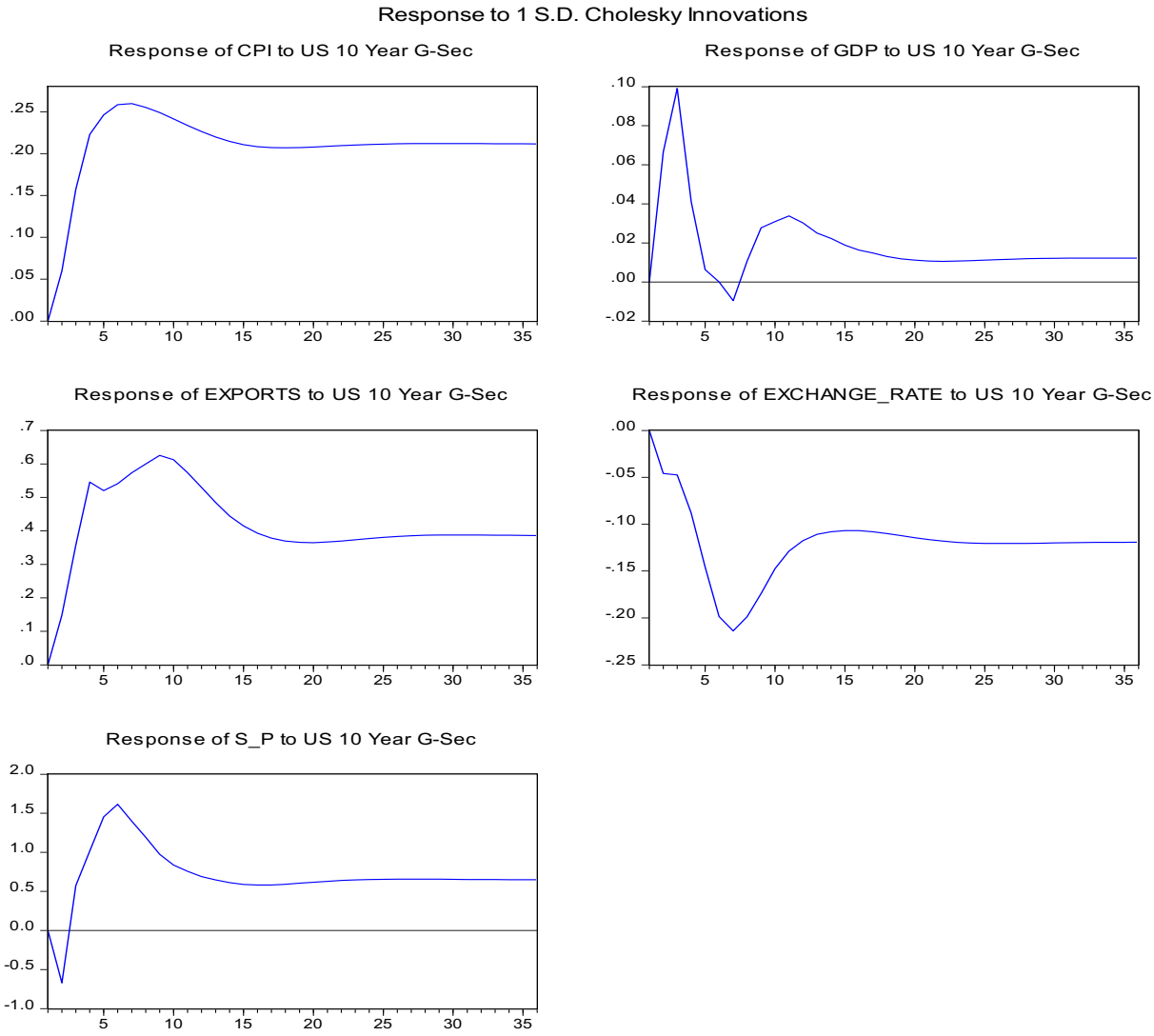
We present in Figure 11 the impulse responses of US macroeconomic variables to a negative shock of 18 basis points in US 10 year g-sec yield (one SD of the shock) over 36 months. The estimates are based on the post-crisis sample.

Impact on real variables: An 18 bps negative shock on US 10 year g-sec leads to an immediate increase in inflation by 6 bps in the first month. Peak effect is observed in the 3rd quarter when inflation rate increases by 25 bps. The impact of the shock on real GDP is positive in the first quarter and it goes up by 10 bps. Gross exports growth too increases by 55 bps in the 2nd quarter in response to the shock.

Impact on financial variables: NEER index depreciates significantly in response to the shock. Peak effect comes in the second quarter when it depreciates by 20 bps. S&P index too falls immediately by 67 bps in response to the shock. However, it starts to increase third month onwards and goes up by 160 bps in the second quarter.

Thus, a negative shock to US ten year g-sec yields leads to an increase in real GDP growth and inflation in the short run. The S&P index falls immediately, perhaps owing to capital outflows. The dollar depreciates in response giving a boost to exports growth in the short run. A negative shock in US three months T-bill, on the contrary, is not effective in containing capital inflow leading to an increase in S&P index. The dollar appreciates as well and so does gross exports growth. Impact on inflation is adverse as well. Inflation rate falls in response to the shock. Impact on real GDP, though positive, but is insignificant. Based on these results we may conclude that QE may work better relative to NIRP.

Figure 11: Impact of QE on US Economy



5.3. Spillover effect of NIRP on emerging Asia:

Figure 12 presents the IRF of a negative 1 SD shock (around 20 bps) to US t-bill on macroeconomic variables of emerging Asia based on pre-crisis sample of Hong Kong, India, Indonesia, South Korea, Philippines, Singapore and Thailand. The impact is significant and appears to be widespread. The US t-bill shock affects all variables – nominal GDP, inflation, exports, and exchange rate. This indicates several different transmission channels could have been at play.

A 20 bps negative shock to US t-bill leads to inflation rising by 10 bps by the end of the 1st quarter. Peak effect is observed in the 4th quarter when inflation goes up by almost30 bps. Nominal GDP is adversely affected and the growth declines by 25 bps in the first year. Peak effect is observed at the end of the 2nd year when growth rate declines by 31 bps. Bilateral exchange rate vis-à-vis dollar immediately depreciates by 37 bps in response to the shock. The depreciation is more than 90 bps in the 2nd quarter. However, the depreciation of the local currency fails to boost the gross exports to the US and it declines by 85 bps in the 2nd quarter.

Next, we consider two sub groups of EMs in an extension of our panel VECM analysis: big economies– Indian and Indonesia and small trade dependent economies (STDE) – Hong Kong, South Korea, Philippines, Singapore, Thailand. IRF are presented in Figure 13 and 14. The results show that the response of these two sub-groups in response to the shock are different. India and Indonesia witness significant inflation increase (peak effect of nearly 36 bps in 3rd quarter) compared to the STDE countries (peak effect of 8 bps in 2nd quarter) in response to negative shock to US t-bill rates. The impact on GDP remains muted in the first year in case of India and Indonesia. The STDE countries are adversely affected in the first year itself. Growth declines by just 10 bps by the end of the 1st year in BE countries. However, 2nd year onwards the decline in growth is steeper. Peak effect is observed in the 3rd year when the growth declines by 34 bps. STDE countries on the other hand witness a decline in growth of almost 40 bps in the first year itself.

Bilateral exchanges rate against dollar first depreciate in India and Indonesia but start to appreciate second year onwards. The immediate response is that of depreciation by almost 100 bps. Second year onwards however the currency starts to appreciate and the peak effect is observed towards the end of the second year with the currency appreciating by almost 145 bps. In STDE countries, on the other hand, the currencies depreciate by only 15 bps in immediate response. Peak effect is observed in the 2nd quarter when the currency depreciates by 40 bps.

The impact on gross exports to the US is more severe for STDE countries. In India and Indonesia exports growth to the USA decline by almost 95 bps in immediate response to the shock but it starts to improve thereafter and the exports decline is only 5 bps at the end of the second year. For STDE countries, exports to the US decline by 27 bps in immediate response to the shock and the decline is almost 70 bps in the 4th quarter.

Figure 12: Impact of US Rate Cut on Emerging Asia

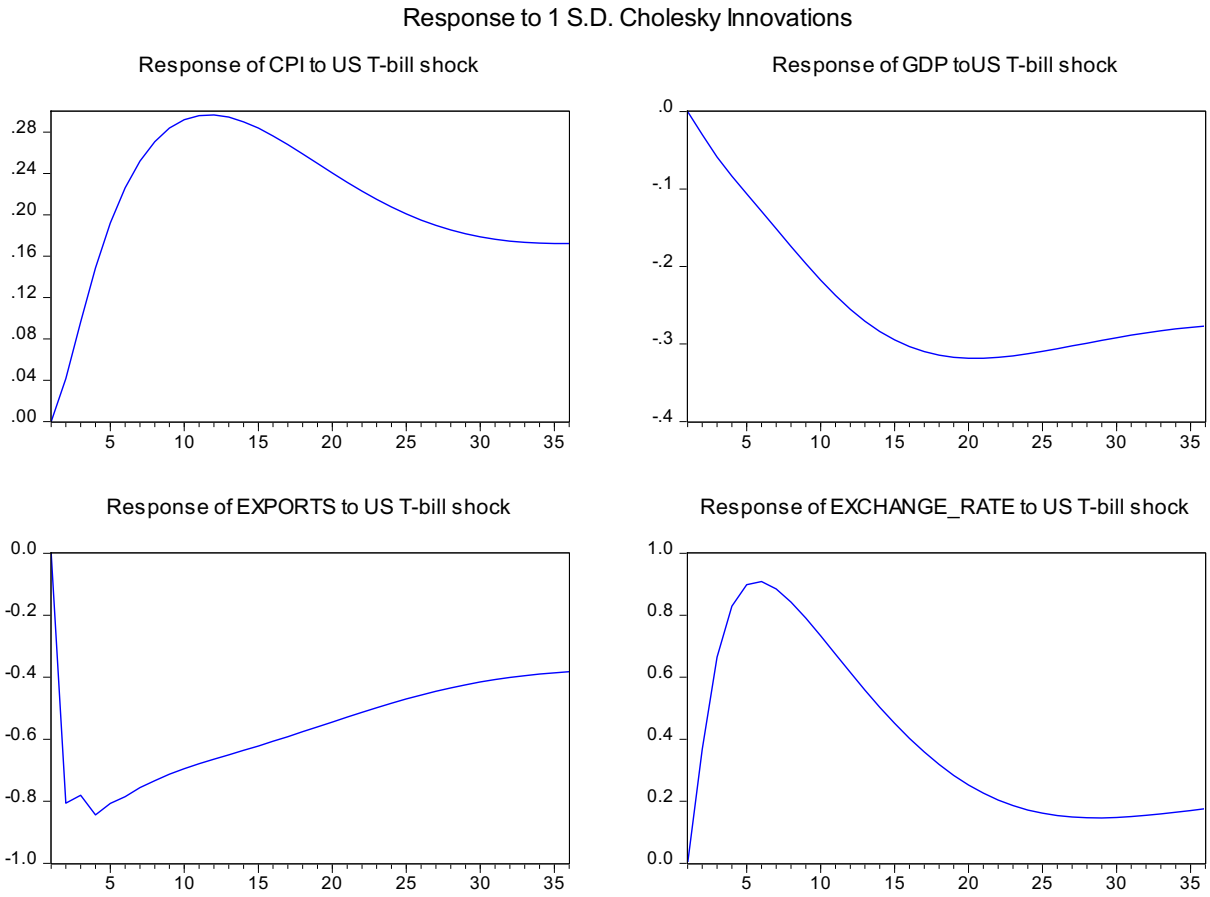


Figure 13: Impact of Fed Rate Cut on Big Emerging Asian Nations

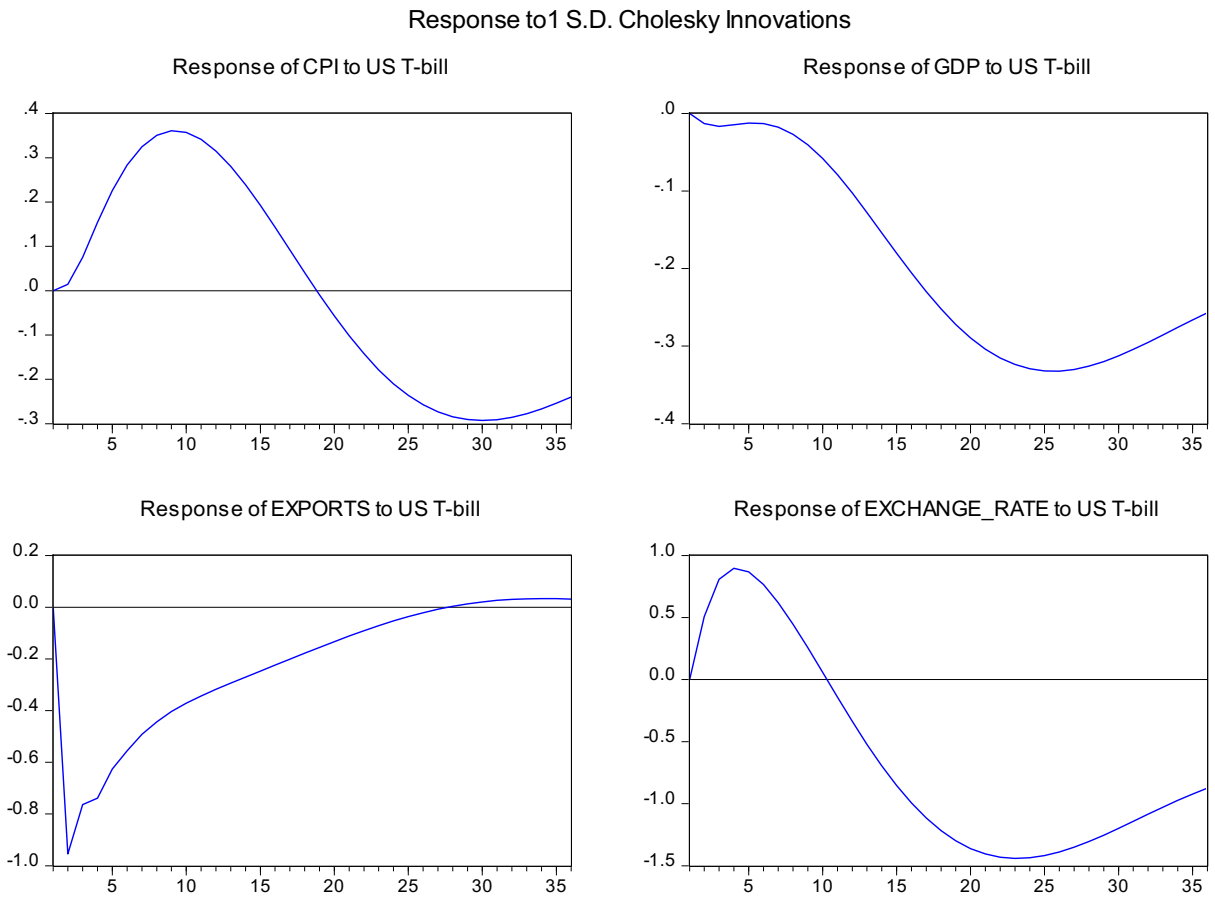
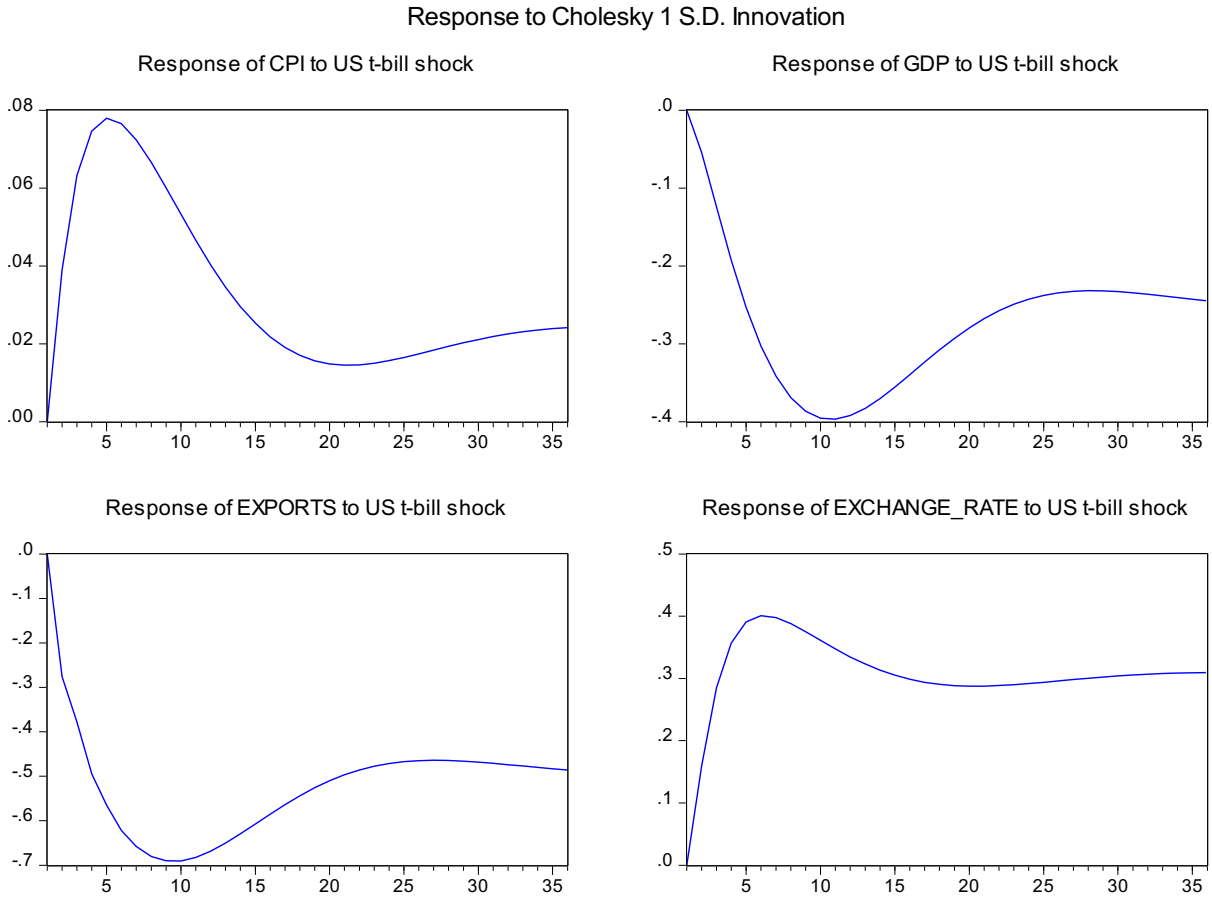


Figure 14: Impact of Fed Rate Cut on Trade Dependent Emerging Asia



5.3. Spill over effect of QE on emerging Asia:

Figure 15 represents the impact of a negative 1 SD shock (-18 bps) on US 10 Year g-sec yield on macroeconomic variables of EMs. The international transmission of a shock to g-sec yield is quite different from that of shock to t-bill. The impact on inflation of a negative shock to g-sec yield is insignificant. Nominal GDP growth, on the other hand, is more severely impacted declining by 34 bps in the 1st year. Bilateral exchange rate against dollar appreciates immediately by 18 bps in response to the shock. Peak effect comes in the second quarter when the currency appreciates by 36 bps. Growth in exports to the US also declines by 51 bps in the first year.

Next we analyse the impact of this shock in g-sec yield for India & Indonesia and STDE countries. The IRF are presented in Figures 16 & 17. There is no significant impact on inflation in STDE countries. In India and Indonesia inflation rate declines by 13 bps in the 1st year. Nominal GDP growth declines by 40 bps in BE countries and by 32 bps in STDE countries in the first year. Currency appreciates in both set of countries in response to the shock however the appreciation is stronger in India and Indonesia. Peak effect is observed in second quarter when currency appreciates by 53 bps. In STDE countries currency appreciates by 27 bps in the first year. Exports growth too declines in both set of countries but the impact is much severe in India and Indonesia. In response to the appreciation, exports growth to the US declines by 110 bps in the first year in

India and Indonesia. In STDE countries also exports growth to the US declines by 31 bps in the first year.

Figure 15: Impact of US QE on Emerging Asia

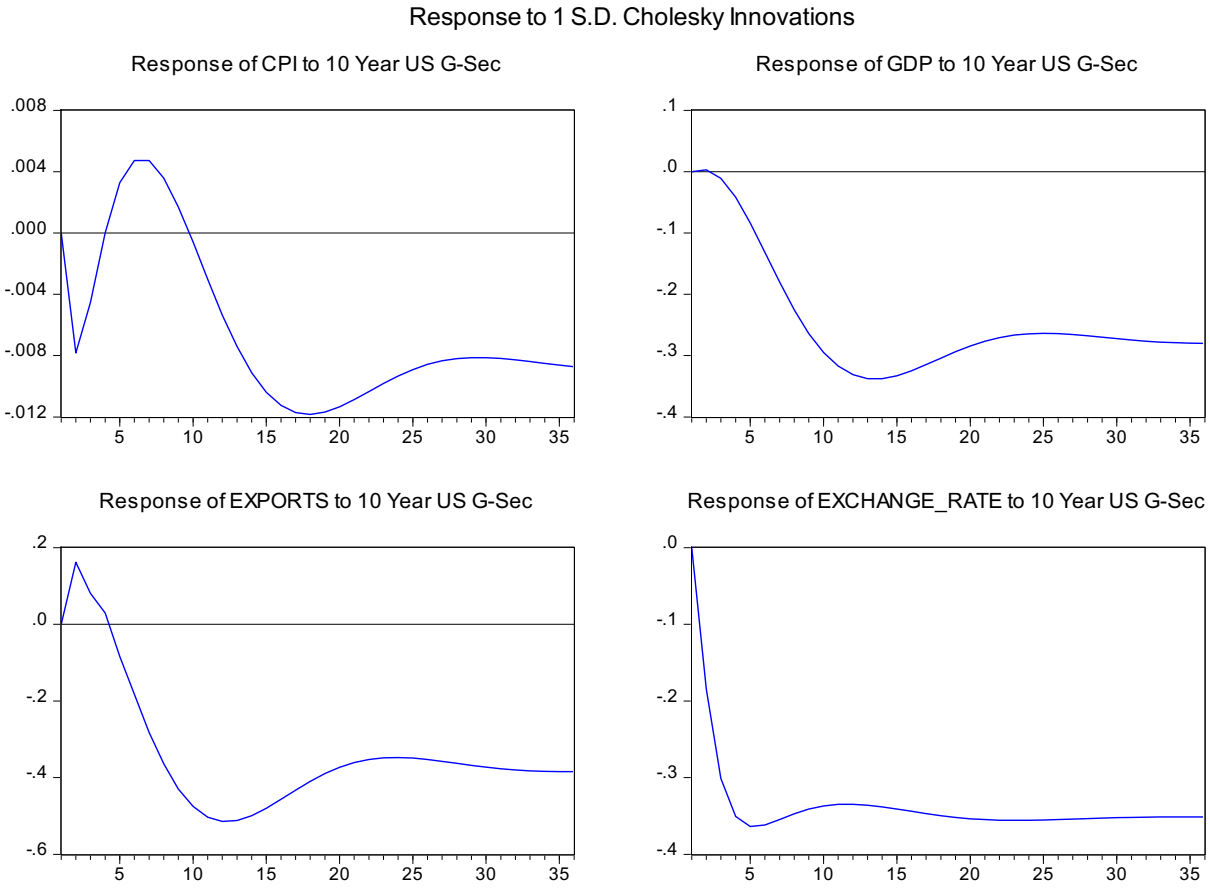


Figure 16: Impact of US QE on Big Emerging Asian Economy

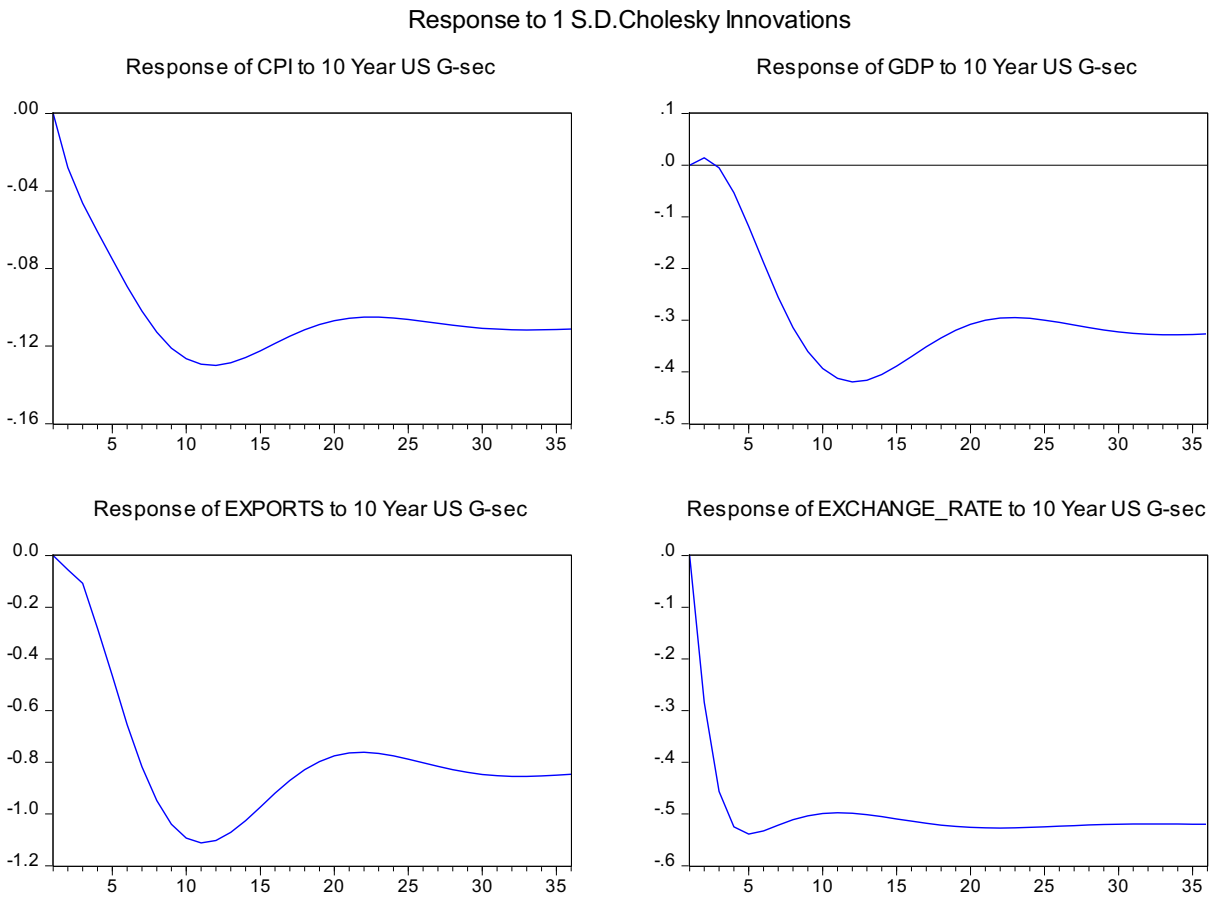
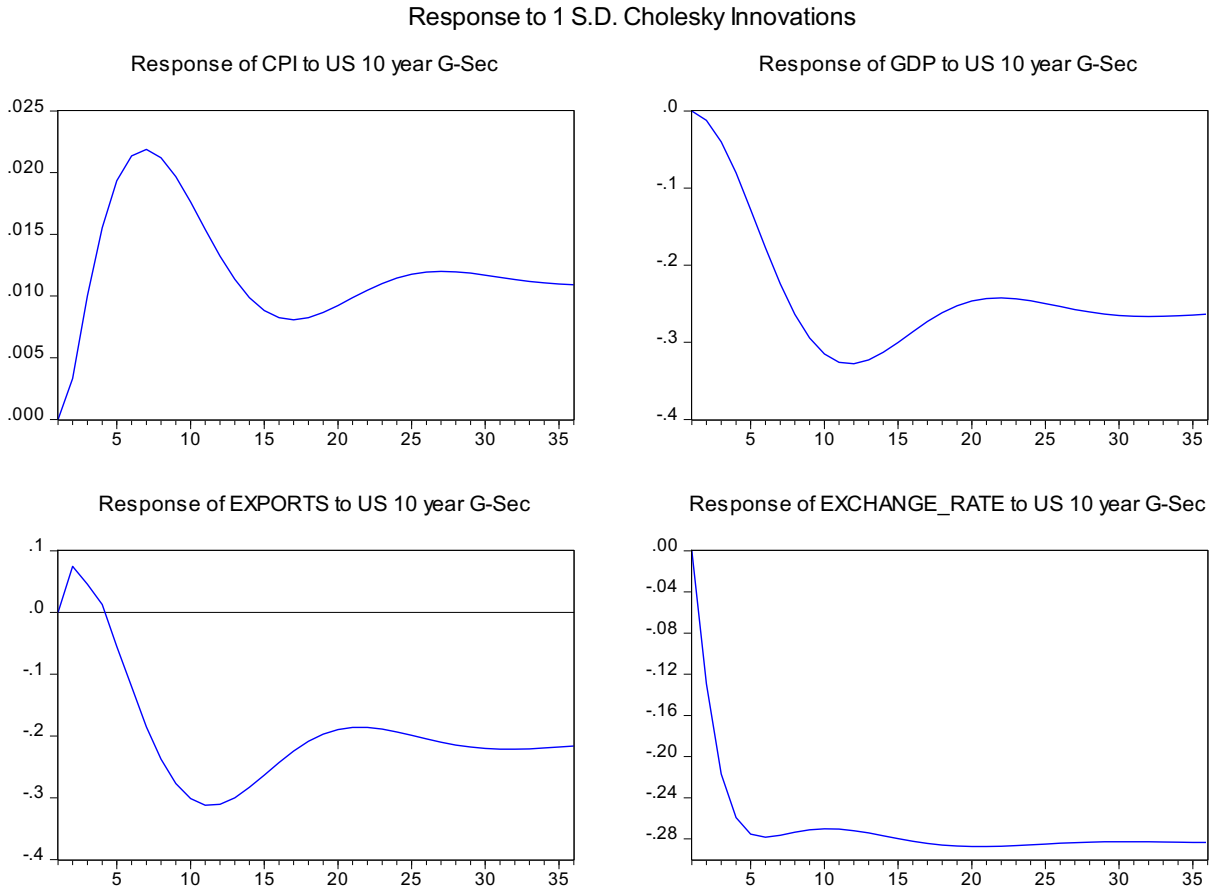


Figure 17: Impact of US QE on Trade Dependent Emerging Asian Economy



6. Conclusion

The econometric results show that inflation in the US decline in response to a negative shock to t-bill. The impact on real GDP is insignificant and exports growth decline. Interestingly dollar appreciates and S&P index go up in response. A negative shock to g-sec yields leads to an increase in real GDP growth and inflation in the short run. The S& P index falls immediately. The dollar depreciates in response giving a boost to exports growth in the short run. Based on these results we may conclude that the Fed's decision to use QE instead of NIRP has been successful. The nominal GDP growth as well as exports growth to the US on an average is adversely impacted in EMs in response to a negative t-bill shock. STDE countries are more severely impacted. Inflation goes significantly but the impact is much more severe for India and Indonesia. Local currencies also depreciate in both set of countries. A negative g-sec shock on the other hand has no significant impact on inflation but nominal GDP growth declines in EMs. Currency appreciates and exports to the US decline but the impact is much more severe in India and Indonesia.

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Annex:
Unit Root Tests

ADF Unit Root Test for the US based on pre-crisis sample				
Variable	Level	1st Difference	Critical Values	
	ADF	ADF	1% Level	5 % Level
Real GDP	-0.6	-17.41	-3.48	-2.88
Inflation	-2.55	-4.02	-3.48	-2.88
Exports	-2.5	-5.48	-3.48	-2.88
S&P Index	-1.06	-10.35	-3.48	-2.88
NEER Index	-2.44	-7.85	-3.48	-2.88
T-Bill	-1.17	-3.09	-3.48	-2.88

ADF Unit Root Test for the US based on post-crisis sample				
Variable	Level	1st Difference	Critical Values	
	ADF		1% Level	5 % Level
Real GDP	-3.03	-9.23	-3.51	-2.89
Inflation	-0.63	-3.22	-3.51	-2.89
Exports	-1.16	-5.14	-3.52	-2.9
S&P Index	-2.44	-8.31	-3.51	-2.89
NEER Index	-0.73	-3.76	-3.51	-2.89
g-sec	-2.65	-7.05	-3.51	-2.89

Panel Unit Root Test for the EAM based on pre-crisis sample				
Variable	Level		1st Difference	
	Breitung t-stat	p-value	Breitung t-stat	p-value
Nominal GDP	2.39	0.99	-2.37	0.00
Inflation	-0.87	0.19	-3.86	0.00
Exports	-1.39	0.08	-9.91	0.00
Exchange Rate	2.63	0.99	-4.55	0.00

Panel Unit Root Test for the EAM based on post-crisis sample				
Variable	Level		1st Difference	
	Breitung t-stat	p-value	Breitung t-stat	p-value
Nominal GDP	-1.57	0.06	-2.78	0.00
Inflation	0.27	0.6	-2.13	0.01
Exports	-0.45	0.32	-3.77	0.00
Exchange Rate	-1.28	0.1	-5.99	0.00

Cointegration Test:

Johansen Cointegration test for US variables based on pre-crisis data

Sample (adjusted): 1998M08 2008M11
Trend assumption: Linear deterministic trend
Series: EXPORTS INFLATION NEER REAL_GDP S_P_INDEX T_BILL
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.254265	105.2262	95.75366	0.0095
At most 1	0.187272	68.84659	69.81889	0.0596
At most 2	0.142501	43.13406	47.85613	0.1293
At most 3	0.123514	24.07094	29.79707	0.1975
At most 4	0.057738	7.723401	15.49471	0.4954
At most 5	0.002809	0.348849	3.841466	0.5548

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Johansen Cointegration test for US variables based on post-crisis data

Sample (adjusted): 2009M02 2017M03
Trend assumption: Linear deterministic trend
Series: EXPORTS G_SEC INFLATION NEER REAL_GDP S_P_INDEX
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.512480	138.5088	95.75366	0.0000
At most 1 *	0.265911	76.72442	69.81889	0.0127
At most 2 *	0.252263	50.13967	47.85613	0.0300
At most 3	0.155181	25.13907	29.79707	0.1565
At most 4	0.093085	10.63669	15.49471	0.2348
At most 5	0.025641	2.233903	3.841466	0.1350

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Johansen Fischer Panel Cointegration Test for EMs based on pre-crisis sample

Johansen Fisher Panel Cointegration
Test Series: CPI EXCHANGE_RATE EXPORTS GDP US_T_BILL
Sample: 1998M01 2008M11
Trend assumption: Linear deterministic trend
Lags interval (in first differences): 1 1

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	168.1	0.0000	130.9	0.0000
At most 1	65.32	0.0000	41.72	0.0001
At most 2	34.24	0.0019	27.34	0.0174
At most 3	17.08	0.2522	16.89	0.2618
At most 4	14.07	0.4448	14.07	0.4448

* Probabilities are computed using asymptotic Chi-square distribution.

Johansen Fischer Panel Cointegration Test for EMs based on post-crisis sample

Johansen Fisher Panel Cointegration
Test Series: CPI EXCHANGE_RATE EXPORTS GDP US_10YR_G_SEC
Sample: 2008M12 2017M03
Trend assumption: Linear deterministic trend
Lags interval (in first differences): 1 1

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	182.7	0.0000	130.6	0.0000
At most 1	79.30	0.0000	58.90	0.0000
At most 2	33.56	0.0024	21.50	0.0895
At most 3	23.51	0.0525	14.34	0.4244
At most 4	36.48	0.0009	36.48	0.0009

* Probabilities are computed using asymptotic Chi-square distribution.

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