The Effects of Asset Purchases and Normalization of US Monetary Policy

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Motivation 1

1. Federal Reserve (Fed) lowered federal funds (FF) rate effectively to zero and introduced the Large Scale Asset Purchases (LSAPs) in Dec 2008
2. Previous studies provide mixed evidence for the effects of LSAPs
   i. Weale and Wieladek (2016) (WW): LSAPs led to a significant rise in real GDP and CPI
   ii. Hesse et al. (2018) (HHW): Early LSAPs had significant positive macroeconomic effects
   iii. Greenlaw et al. (2018): Effects of LSAPs tended not to persist
3. Instructive to examine whether the LSAPs have been effective to boost economy

Motivation 2

1. Impacts of LSAP might have been changed
2. LSAPs were modified several times
   i. LSAP1: Dec 5, 2008 to Mar 31, 2010
   ii. LSAP2: Nov 12, 2010 to Jun 30, 2011
   iii. OT: Oct 3, 2011 to Dec 30, 2012
   iv. LSAP3: Sep 14, 2012 to Oct 31, 2014
3. WW: Including LSAP1 or not does not change the effectiveness of LSAPs
4. HHW: Effects of the late LSAPs were weaker
5. Interesting to consider a possible regime change

Motivation 3

1. Fed had started monetary policy (MP) normalization
   i. Dec 2012: First discussion at FOMC
   ii. Jan 2013: Ihrig et al. (2015)
   iii. May 2013: Bernanke shock (BS)
   iv. Jan 2014: Begin tapering the LSAP
   v. Sep 2014: Federal Open Market Committee (2014)
   vi. Dec 2015: Begin raising the FF rate

2. Important to accommodate another possible regime change associated with normalization

Contribution and Results

1. Empirically assess the macroeconomic effects of LSAPs and normalization of US monetary policy
2. Detect possible regime changes using a Markov switching model and a shadow rate (SR) as a measure of USMP stance
3. Provide empirical evidence of changes in the impacts of USMP over the last decade
4. Clear evidence of a structural change around BS
5. LSAPs had significant and positive effects on real economy and inflation before BS
6. Another structural change is detected around the beginning of 2011

Contribution and Results

7. LSAP1 had a solid monetary policy effects on real economy and inflation

8. The late LSAP had smaller and less persistent impacts

9. USMP seems to be less influential after BS

10. SR suggests monetary policy stance after BS has been mostly contractionary

11. US monetary policy normalization had marginal effects on real economy and inflation

12. Two policy instruments have been used during the normalization regime

Contribution and Results

13. Examine in more details using two policy measures: Fed's total asset to GDP and FF 12 month futures

14. Fed's balance sheet shocks seem to have some impacts even after BS

15. Expectations of FF rate hike had few contractionary effects on real economy and inflation

16. Use components of GDP as alternative indicators of real economic activity to discuss possible factors that generate different policy effects

17. FF rate shocks have positive impacts on durables, offsetting negative impacts on non-durables and service

Weale and Wieladek (2016)

1. Examine the impacts of LSAP on real GDP and CPI in UK and US

2. SVAR model consisting of real GDP, CPI, asset purchase announcement, long-term government bond yields, real stock prices

3. Use four identifications to identify a MP shock

4. Asset purchase announcement of 1% of GDP leads to a statistically significant rise of 0.58% and 0.62% rise in real GDP and CPI for the US

Weale and Wieladek (2016)
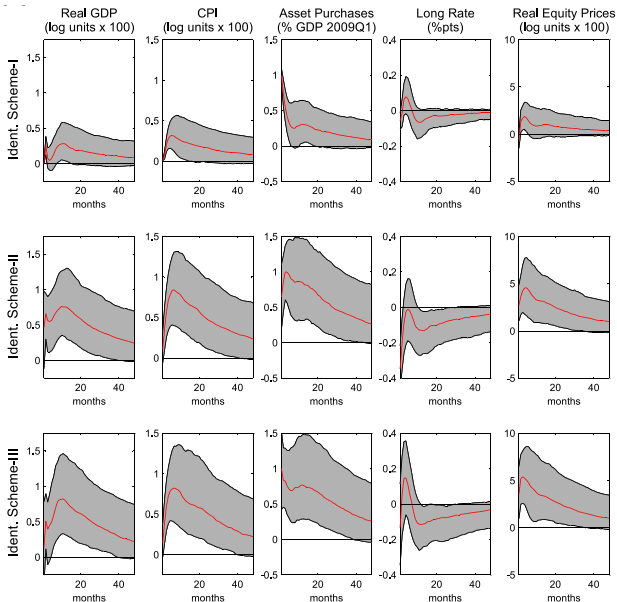
Weale and Wieladek (2016)

4. Including LSAP1 or not does not change the effectiveness of LSAPs

5. MP shocks have more effects on term spreads than short-term interest rate futures

6. Portfolio rebalancing channel plays a more important role than signaling channel

7. LSAPs reduce the financial market and household uncertainty, possibly affecting on expectations

8. Response of corporate bond spreads is negative but insignificant for two identification schemes

9. Some evidence of risk-taking channel

Weale and Wieladek (2016)
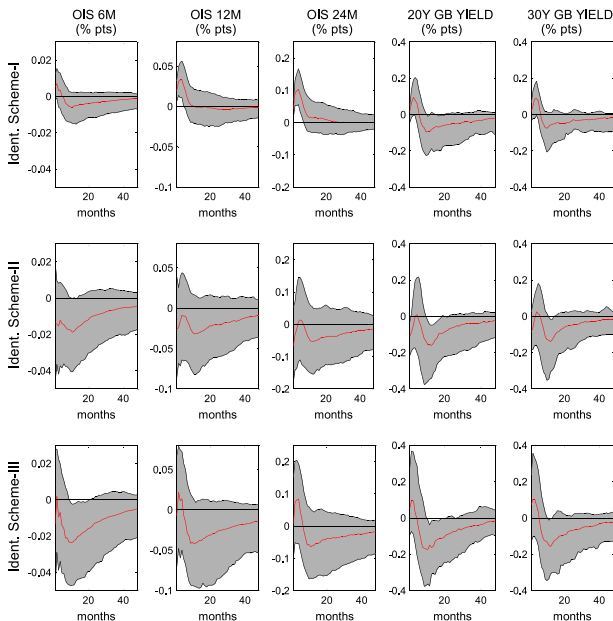
Weale and Wieladek (2016)
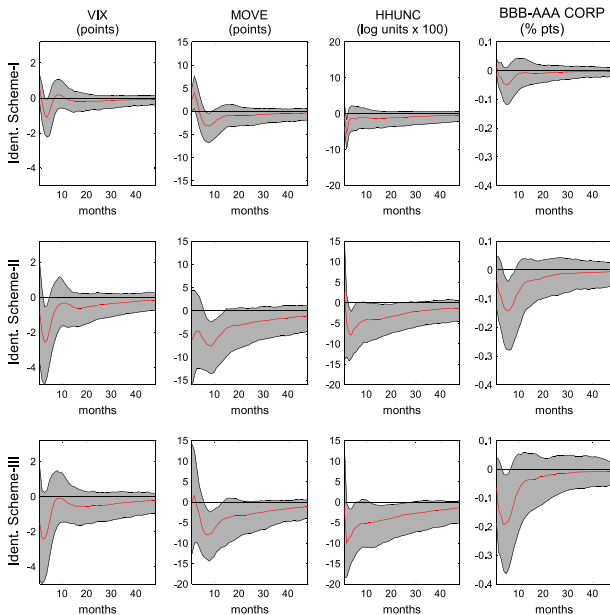
Hesse et al. (2018)

1. Investigate the macroeconomic impact of LSAPs and assess changes in its effectiveness
2. SVAR model with zero and sign restrictions to identify a MP shock
3. LSAP1-2 had significant positive macroeconomic effects, while those of the late ones were weaker
4. Only LSAP1-2 significantly lowered the VIX
5. Positive impact of LSAP on stock prices is significant and persistent throughout the entire programs

Hesse et al. (2018)
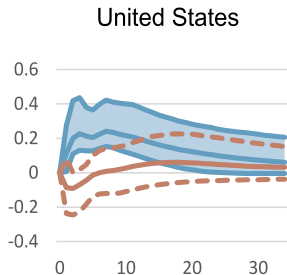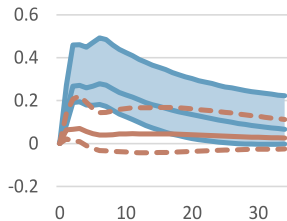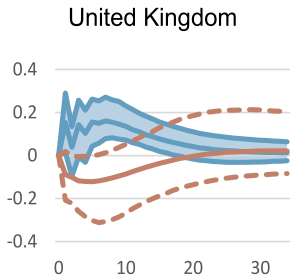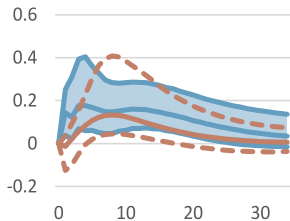
Hesse et al. (2018)

6. Reduced effectiveness seems to reflect in part better anticipation of LSAPs over time

GDP   CPI
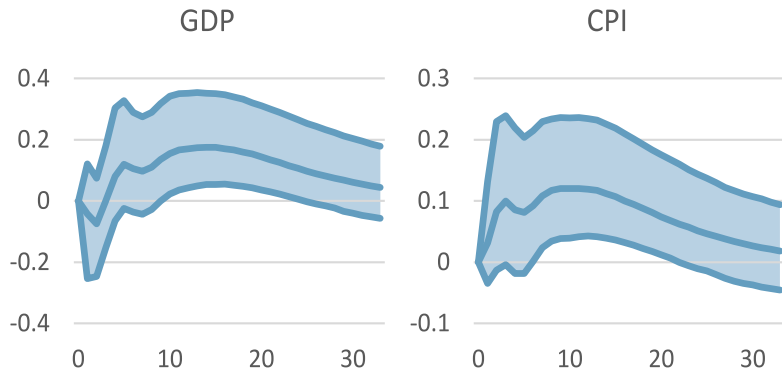
Benchmark Model

1. Benchmark model is a VAR model based on WW and HHW

$$Y_t = \alpha + \sum_{k=1}^{L} A_k Y_{t-k} + \varepsilon_t, \quad \varepsilon_t \sim \text{iid } N(0, \Sigma)$$

2. $Y_t = (GDP_t, CPI_t, SR_t, R_t, P_t)$
   i. GDP_t: Real GDP
   ii. CPI_t: CPI
   iii. SR_t: Shadow Rates
   iv. R_t: Long-term government bond yields
   v. P_t: Real stock prices

3. WW and HHW use cumulative asset purchase announcements (CAPA) divided by a nominal GDP

Benchmark Model

4. CAPA has been constant after Jan 2013
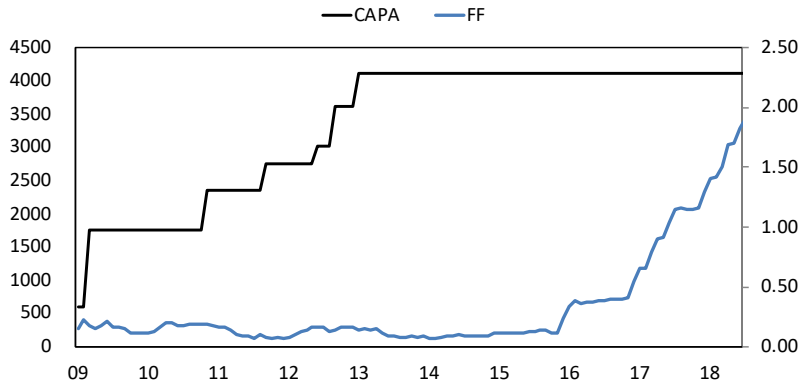
5. Fed set FF rates effectively at zero until Dec 2015 and started raising to normalize MP

6. No single variable can capture USMP btw 2009-18

Benchmark Model

7. SR term structure model (SRTSM) has been developed to overcome the zero lower bound (Ichiue and Ueno (2013); Krippner (2013); Bauer and Rudebusch (2016); Wu and Xia (2016))

8. SR can be a measure of the MP stance in zero lower bound environments (Bullard (2012); Krippner (2013); Wu and Xia (2016))

9. SR can capture MP expectation (Bauer and Rudebusch (2016))

Benchmark Model

10. Use the SR of Wu and Xia (2016) as a single measure of USMP
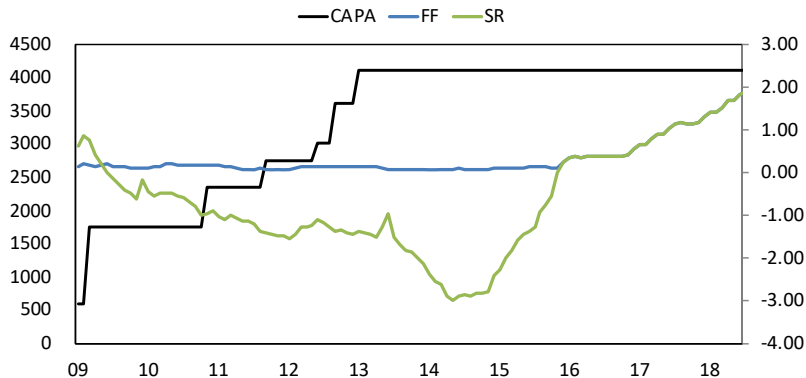
Markov Switching VAR (MSVAR) Model

1. Impacts of LSAPs may or may not have been changed
   i. WW: Including LSAP1 or not does not change the effectiveness of LSAPs
   ii. HHW: Effects of the late stage of LSAPs was weaker
2. Fed had started MP normalization over the last five years or so
3. Important to consider possible regime changes
4. Employ a Markov switching (MS) model with absorbing states to accommodate possible permanent regime changes

Markov Switching VAR (MSVAR) Model

5. Introduce Markov switching to the benchmark VAR model

$$Y_t = \alpha(s_t) + \sum_{k=1}^{L} A_k(s_t) Y_{t-k} + \varepsilon_t, \quad \varepsilon_t \sim \text{iid } N(0, \Sigma(s_t))$$

6. Variance of ε_t is also assumed to be regime dependent

7. s_t describes the regime, following Markov chain (MC)

8. Assume the MC has absorbing states to capture permanent regime changes, given the evolution of USMP over the last decade

Markov Switching VAR (MSVAR) Model

9. Example of a transition probability for 3 state MC

$$\mathbf{P} = \begin{bmatrix} p_{11} & 0 & 0 \\ 1 - p_{11} & p_{22} & 0 \\ 0 & 1 - p_{22} & 1 \end{bmatrix}$$

10. Regime can move from 1 to 2 and 2 to 3 with time

11. Can detect two structural changes within the sample period

Identification of MP shocks

1. Closely follow HHW to identify MP shocks
2. Use a combination of zero and sign restrictions
3. Assume that a MP shock has no immediate impact on output and prices
4. Classical assumption used by, for example, Christiano et al. (1999)
5. Contractionary MP shocks increase the SR and long-term bond yields, and reduce real stock prices
6. Similar identification is also used by one of WW's identifications
7. Sign restrictions are imposed on periods 0 and 1

Data and Estimation

1. Sample period: from Jan 2009 to Sep 2018
2. Monthly GDP data are obtained from Macroeconomic Advisor
3. SR data are taken from Wu's website
4. Other data are downloaded from FRED
5. L is set to two, following WW and HHW
6. Assume one regime contains at least two years of data
7. All models are estimated by Bayesian Gibbs sampler with diffuse priors

Results of Two Regime Models

1. Smoothed probabilities of regime 2
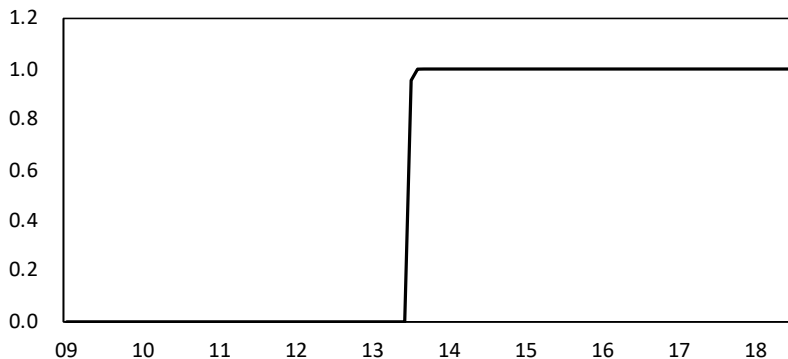
2. Two regime model detects a regime change around July 2013 immediately after BS

Results of Two Regime Models

3. Impulse responses to MP shocks in regime 1
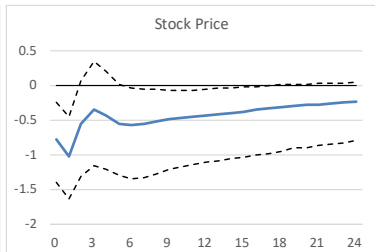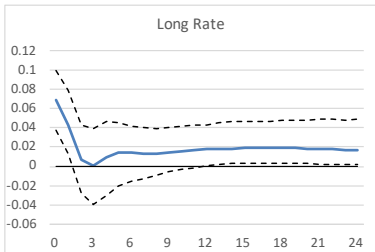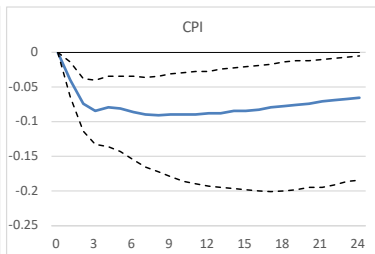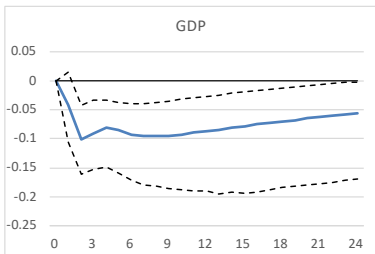
Results of Two Regime Models

4. Impulse responses to MP shocks in regime 2
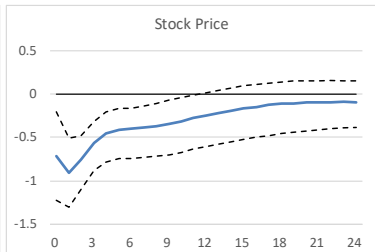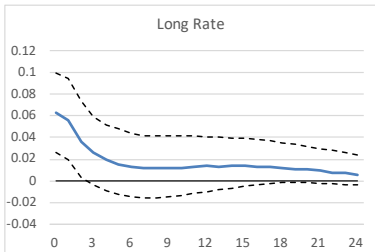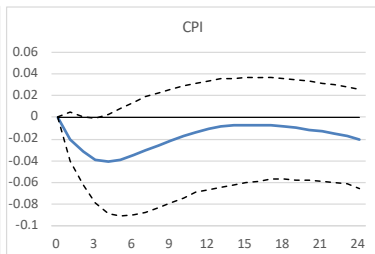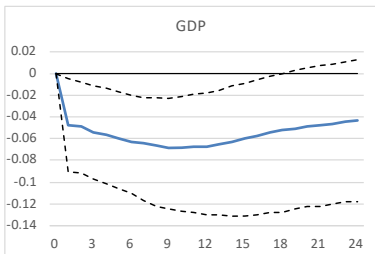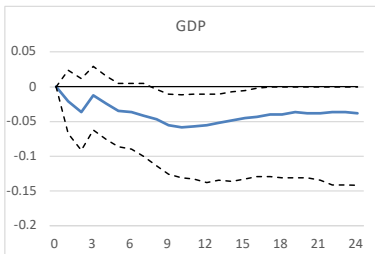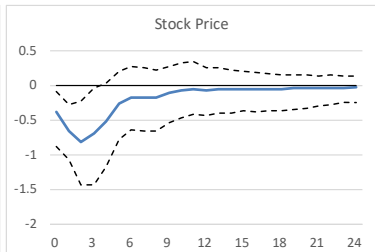
Results of Three Regime Models

1. Smoothed probabilities
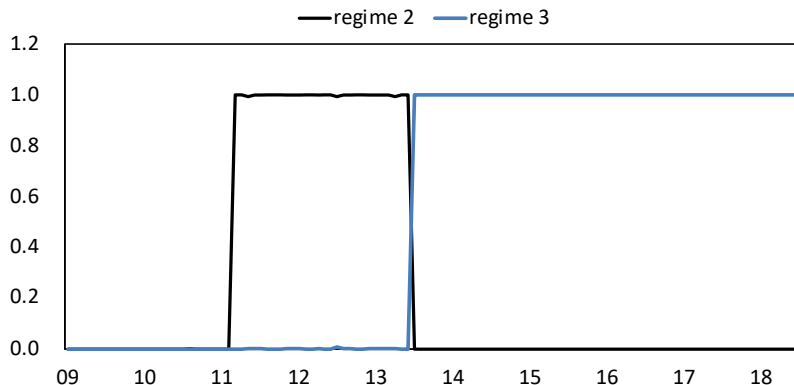
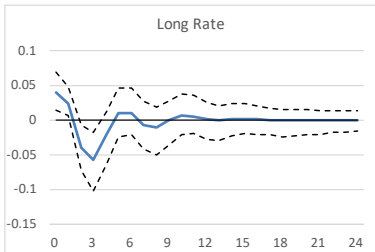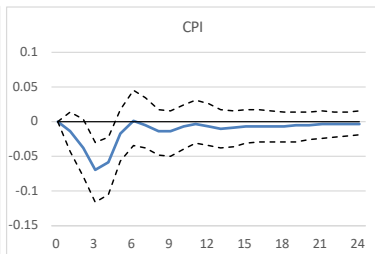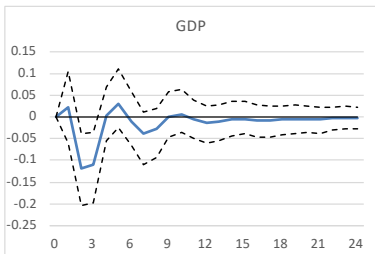2. Three regime model detects regime changes around the beginning of 2011 and Jul 2013

Results of Three Regime Models

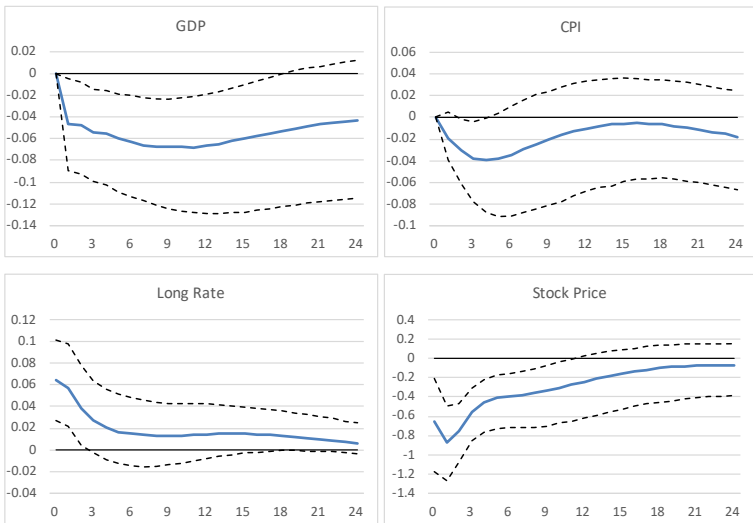### 3. Impulse responses to MP shocks in regime 1
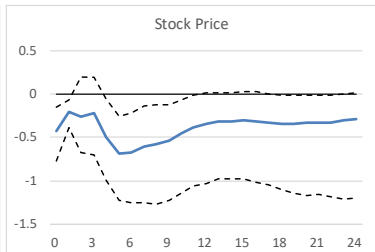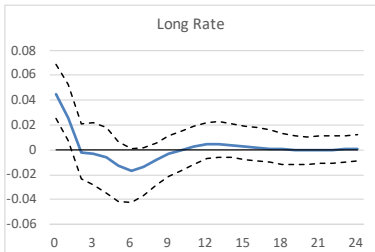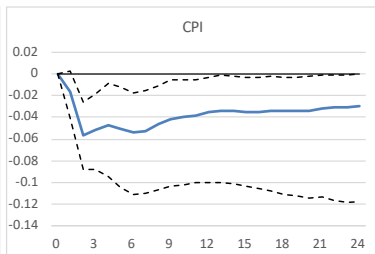
Results of Three Regime Models

4. Impulse responses to MP shocks in regime 2

Results of Three Regime Models
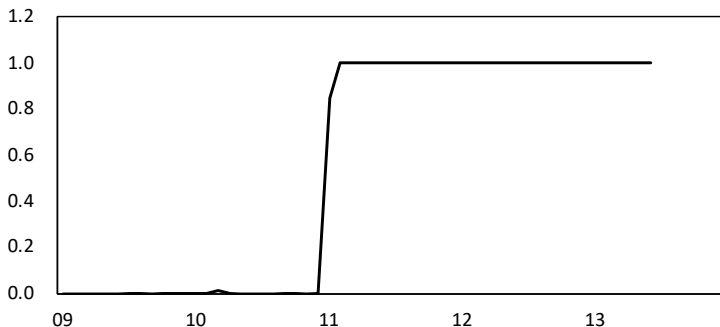
5. Impulse responses to MP shocks in regime 3

Additional Analysis

1. Analysis based on the SR suggests that there are at least two distinct regimes

   i. LSAP regime: Jan 2009 to Jun 2013

   ii. Normalization regime: July 2013 to Sep 2018

2. SR is used for a proxy of MP instruments for both regimes

3. Instructive to examine each regime using the more direct MP measures

   i. LSAP: AP

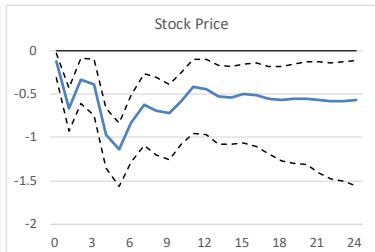   ii. Normalization: AP and FF rates
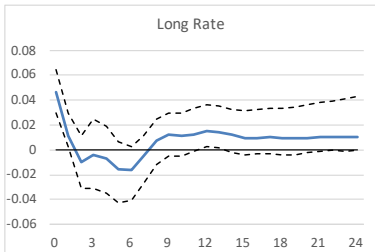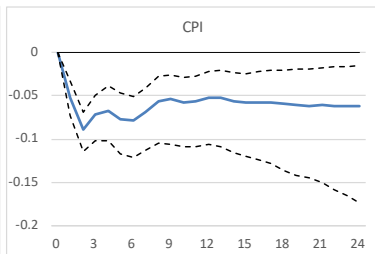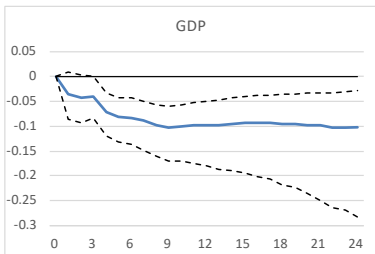
Results of LSAP Regime

1. Estimate two regime MSVAR model with CAPA/GDP as a MP measure

2. Smoothed probabilities of regime 2

3. Two regime model detects a regime change around the beginning of 2011
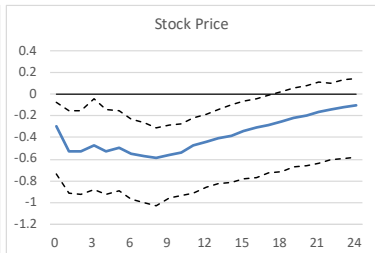
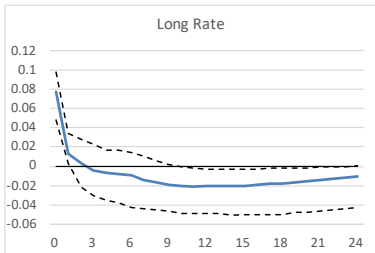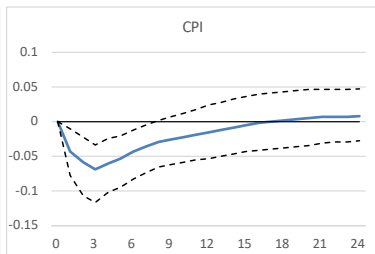# Results of Two Regime Models

4. Impulse responses to MP shocks in regime 1

Results of LSAP Regime

5. Impulse responses to MP shocks in regime 2
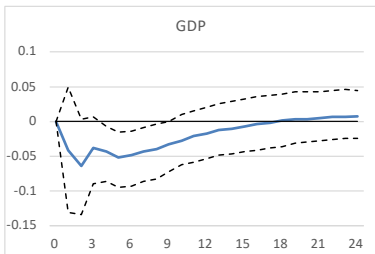
Results of Two Regime Models

6. Impulse responses of GDP components to MP shocks in regime 1
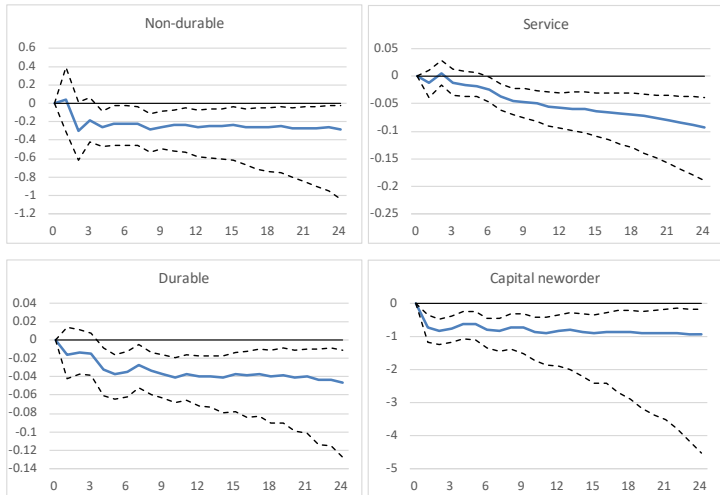
Results of LSAP Regime

7. Impulse responses of GDP components to MP shocks in regime 2
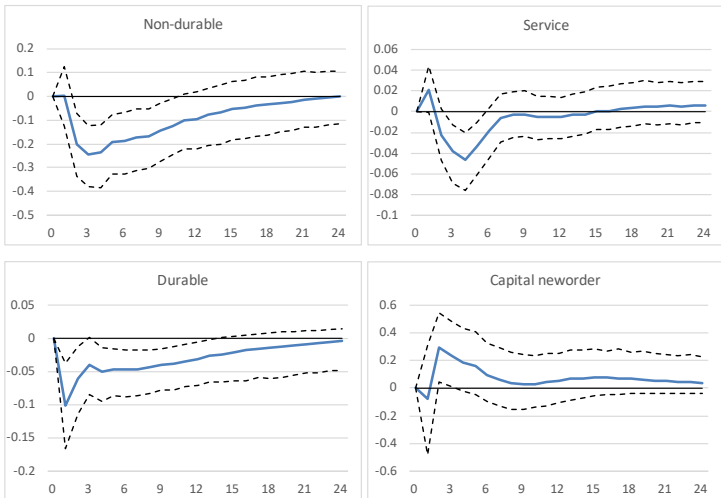
Results of Normalization Regime

1. Estimate 5-variate VAR model with FF rates or total asset to GDP ratio as a MP measure
2. Impulse responses to FF12 rate shocks
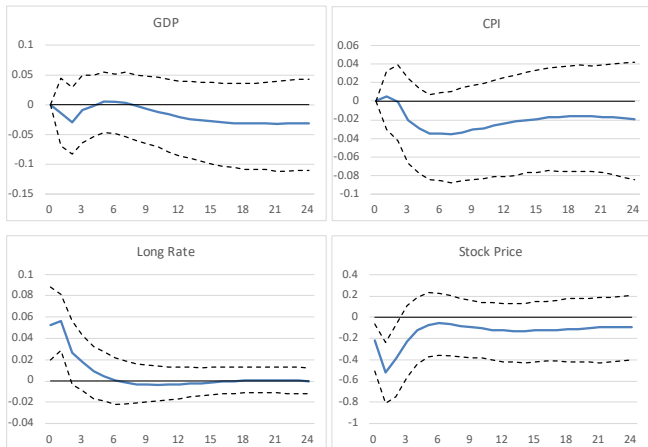
Results of Normalization Regime

3. Impulse responses to AP shocks

Results of Normalization Regime
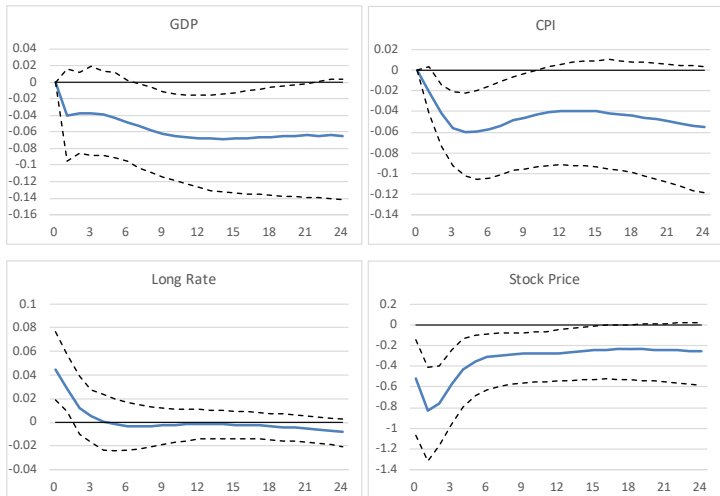
4. Impulse responses of GDP components to interest rate shocks
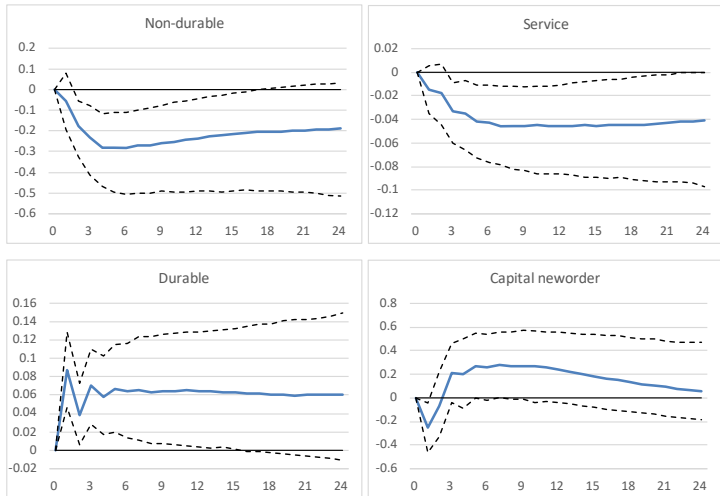
Results of Normalization Regime

5. Impulse responses of GDP components to AP shocks
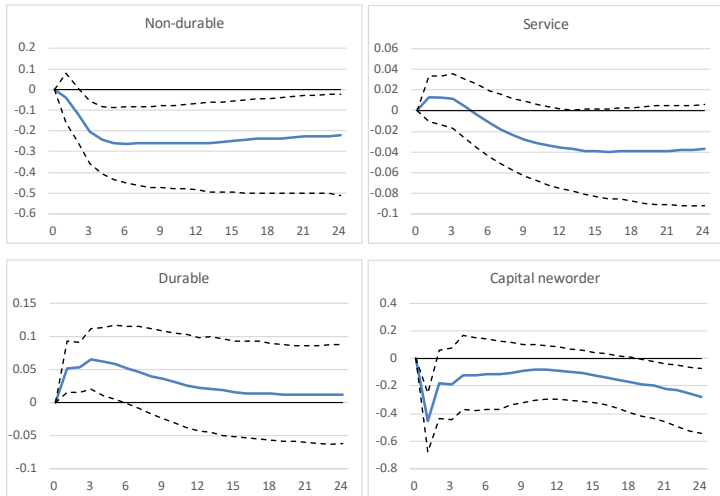
Conclusions

1. Empirically assess the macroeconomic effects of LSAPs and normalization of USMP
2. Detect possible regime changes using a Markov switching model and a shadow rate (SR) as a measure of USMP stance
3. Clear evidence of a structural change around BS
4. Another structural change is detected around the beginning of 2011
5. LSAP1 had a solid monetary policy effects on real economy and inflation
6. Late stage of LSAPs had weaker and less persistent impacts

Contribution and Results

7. USMP seems to be less influential after BS

8. USMP normalization had marginal effects on real economy and inflation

9. Fed's balance sheet shocks had slightly weaker (stronger) effects than during the early (late) stage of the LSAPs

10. Expectations of FF rate hike had few contractionary effects on real economy and inflation

11. FF rate shocks have positive impacts on durables, offsetting negative impacts on non-durables and service

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