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Samuel Reynard*

Abstract

With quantitative easing, the U.S. Federal Reserve has provided broad money to the nonbank sector in exchange for debt securities. This paper estimates this broad money injection to be equivalent to a hypothetical negative policy (federal funds) interest rate of approximately 5 percentage points. Given the size of the Federal Reserve balance sheet and with other things being equal, the policy interest rate will have to be set higher during the exit relative to the pre-QE period to obtain a desired monetary policy stance.

JEL classification: E52; E58; E51; E41; E43

Keywords: Quantitative Easing; Negative Interest Rate; Exit; Monetary Policy Transmission; Money Supply; Banking

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1 Introduction

Although money and credit markets have been largely neglected in monetary policy analysis, the nature of the financial crisis that started in 2007 and the response of central banks (CBs) revealed prominent roles for money and credit markets. This paper uses monetary analysis to provide an equivalence between quantitative easing (QE) and standard interest rate monetary policy in the form of a hypothetical negative interest rate and characterizes the effect of QE on exit policy.

The framework presented in this paper allows us to jointly assess conventional and unconventional monetary policy. It characterizes how standard monetary policy, setting an interbank market interest rate or interest on reserves (IOR), must be adjusted to account for the effects of the CB's broad money injection. It provides a quantitative estimate of how much higher (relative to pre-QE) the interbank interest rate will have to be set during the exit for a given CB's balance sheet to obtain a desired monetary policy stance.¹ Or, in standard monetary policy analysis terms, how many percentage points must be added to a standard Taylor rule rate for a given CB's balance sheet?

The key fact is that, with QE, CBs have substituted for commercial banks in providing broad money in exchange for debt. The broad money supply depends only indirectly on standard interest rate monetary policy,

¹This is holding other things constant. For example, this could provide a partly offsetting force to a potential decline in the natural interest rate.

but directly on commercial banks' money creation and on the central bank's broad money creation through QE. In contrast to the LM curve and standard DSGE models' implied analysis, broad money is not supplied by central banks in normal (i.e., pre-crisis) times but should be a positive function of capital market interest rates. Bank lending and money creation can be integrated into a macroeconomic framework with a loan production function as presented in Goodfriend (2005) and Goodfriend and McCallum (2007). CBs influence lending and capital market conditions only indirectly through banks' financing costs, i.e., through the interbank market interest rate. It is then the banking system's behavior and attitude toward risk that influence broad money and credit markets. Money supply analysis leads to a direct link between QE and negative banks' financing costs.

In response to the financial crisis, CBs have dramatically increased their balance sheets by buying various types of assets, which has resulted in strong increases in reserves that commercial banks hold at CBs. The counterpart of CBs' asset purchases has partly been the nonbank sector. This has increased broad money supply which, in "normal times", CBs only influence indirectly by affecting commercial banks' funding conditions, i.e., the interbank market interest rate.² With QE, when the CB buys assets from the nonbank sector, commercial banks act as intermediaries. The result is like an increase in broad monetary aggregates in "normal times": the banking sector injects

²When the CB buys bonds from the nonbank sector, it does so via the bank of the seller, where the seller's deposit increases and reserves held by the bank at the CB increase.

broad money in the nonbank sector in exchange for bonds or mortgages. With this money creation there is less need to borrow within the nonbank sector, as more money is available and aggregate consumption can increase as more people hold money and can thus consume at the same time.

For example, households and hedge funds selling government or corporate bonds to the Federal Reserve (Fed) can buy corporate bonds, which is an actual behavior following QE documented in Carpenter et al. (2015). This puts downward pressure on mortgage and corporate debt yields. As long as capital market yields are above zero, money injections by withdrawing longer-term or risky debt from the market should lower capital market yields even though short-term interest rates on relatively safe assets are at the zero lower bound. With QE, the CB has thus de facto substituted for commercial banks in providing credit and broad money to the nonbank sector. It has injected broad money in the economy in exchange for debt; thus aggregate consumption can increase.

To quantify the effects of the Fed's direct money supply injections through QE, the effects of broad money supply shocks on GDP during QE are compared to the effects of federal funds rate shocks on GDP in "normal times", i.e., pre-QE. In terms of peak impulse-response effect on real GDP, a 2.5 percent increase in broad money (M2M) in the U.S. corresponds to a 1 percentage-point decrease in the federal funds rate. Broad money injections during QE, mostly driven by the Fed's asset purchases, have even slightly larger effects on GDP than pre-QE money shocks driven by com-

mercial banks' lending. With QE, banks' reserves at the Fed increased by USD 2,700 billion. As "households" (which include hedge funds, as described in Carpenter et al., 2015) were counterparts for about half of it, M2M increased by about USD 1,350 billion as a result, or 12 percent of M2M at the end of QE. According to this framework, QE thus corresponds to a 5 percentage-point decrease in the federal funds rate.

From the angle of monetary aggregates, QE has thus been equivalent to a hypothetical 5 percentage-point negative interest rate. This is in the same order of magnitude as shadow rate estimates based on different approaches. Krippner (2015) estimates a shadow short rate of minus 5 percent at its lowest, and Wu and Xia (2014, updated by the Federal Reserve Bank of Atlanta) estimate a shadow rate around minus 3 percent at the end of QE3 with nonlinear term structure models. Lombardi and Zhu (2014) estimate a shadow rate at minus 5 percent at its lowest with a dynamic factor model.

Section 2 presents a conceptual framework that motivates and illustrates the quantitative analysis. Section 3 quantifies QE effects and their equivalent in terms of a hypothetical negative interest rate. Section 4 discusses the implications for exit, and section 5 presents the study's conclusions.

2 Jointly analyzing conventional and unconventional policy

2.1 Monetary policy, banking and interest rates

Figure 1 (a) represents the relationship between monetary policy, money and the interest rate as implicit in standard dynamic stochastic general equilibrium (DSGE) models used for monetary policy analysis. In such models, the CB sets a policy interest rate. The money demand curve reflects the Euler equation and a cash-in-advance constraint (or money in the utility function): when the CB decreases the interest rate, current aggregate consumption increases and thus money demand for transactions increases, which the CB accommodates.

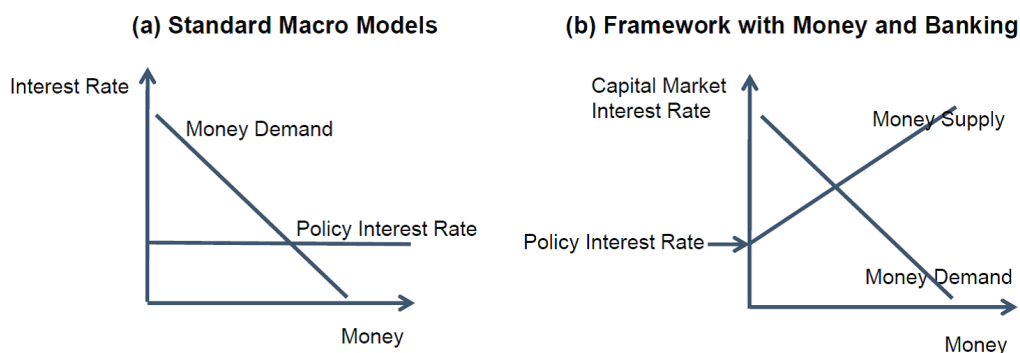


Figure 1: Standard vs. Banking Models

In this paper, money represents a broad monetary aggregate and will be defined as M2M (i.e. M2 minus time deposits) for the US in the empirical

analysis. M2M includes cash and zero maturity deposits that can be used directly (cash or checks) or indirectly (immediate transfer available at par and no cost, i.e., savings accounts) to buy goods and services. More details on the choice of monetary aggregate will be given in section 3. Here the conceptual difference between money and bonds as well as the link between money and lending activity are discussed with the purpose of relating QE to conventional monetary policy. Although the empirical section below is based on US data, this framework applies to any central bank.

Money differs from bonds (and other assets) in that it is the only means of payment. Bonds can be sold relatively quickly in exchange for money, directly or via repo, but it is costly to do so. As a consequence, in the US for example, people hold USD 11 trillion in money (M2M) that earns very little interest, i.e., well below the interest paid on short-term T-bills in “normal times”. Moreover, when money is exchanged within the nonbank sector via good or service transactions or is exchanged against debt, the means of transaction is transferred from one economic agent to another; thus, aggregate consumption cannot increase. Only when banks or the CB create money can aggregate consumption increase (for a given velocity of money, which is closely related to interest rates).

Money is actually supplied by commercial banks in “normal times”. Figure 1(b) represents the relationship between monetary policy, money and interest rates in a framework including banking. The money demand curve is downward sloping as a decrease in capital market rates increases the de-

mand for current consumption and money through aggregate borrowing as more projects become profitable. The upward sloping supply curve represents credit supply and money creation by commercial banks, where money supply is an increasing function of capital market interest rates. In this analysis, the capital market interest rate is identical to the banks' lending rate.

Conventional monetary policy influences the intercept of the money supply curve by influencing the interbank rate, e.g., the federal funds rate (FF) in the US, or setting the interest on reserves (IOR), i.e., the financing or opportunity cost of reserves for banks. If the policy rate is equal to the capital market rate, banks do not find it profitable to lend and money supply is zero. As the aggregate amount of lending increases, monitoring and balance sheet costs as well as the risk of default increase, thus, the marginal cost of loan production increases, as in Goodfriend (2005) and Goodfriend and McCallum (2007). The money supply curve has thus an upward slope, and shifts with changes in FF or IOR, lending costs, capital requirements, banks' lending standards and profitability shocks.³ In Figure 1(b), both the policy and market interest rates have the same maturity. As banks give mostly long-term loans, the policy interest rate can be interpreted as the expectation of future short-term policy rates.

With both conventional monetary policy and QE, broad money, i.e. the means of payment, is always created against debt, which the banking sector

³In standard DSGE models, with the assumption that the CB controls the interest rate relevant for economic decisions, monetary policy actually implicitly does QE all the time, providing broad money to target the interest rate.

creates or buys from the nonbank sector. With conventional monetary policy, broad money is provided by the banking sector to the nonbank sector as banks provide loans or purchase existing bonds. In addition, with QE, broad money is provided by the CB when the latter buys bonds from the nonbank sector; the banking sector then acts as an intermediary and thus, as with conventional monetary policy, provides broad money to the nonbank sector in exchange for bonds. The only difference is that, with conventional monetary policy when the CB conducts outright bond purchases, the CB gets bonds for only a fraction (i.e., the reserves ratio) of broad money created through loans or banks' asset purchases, whereas with QE the CB gets bonds for the full amount of money created; this explains the strong decline in money multiplier with QE. The interbank market is just a way for the CB to control net financing conditions of banks, and thus indirectly the money supply (i.e. the intercept of the supply curve) with conventional monetary policy; with QE, the CB has a direct quantity effect.

2.2 QE and negative interest rates

This money market framework provides a straightforward way to relate QE to a hypothetical negative policy interest rate (HNPR). With conventional monetary policy, when the CB lowers the interbank market rate, the financing cost of banks decrease; thus, broad money supply increases as commercial banks find it profitable to lend (or buy bonds) at a lower capital market interest rate. Thus the money supply shifts to the right, as with the green

curve on Figure 2.

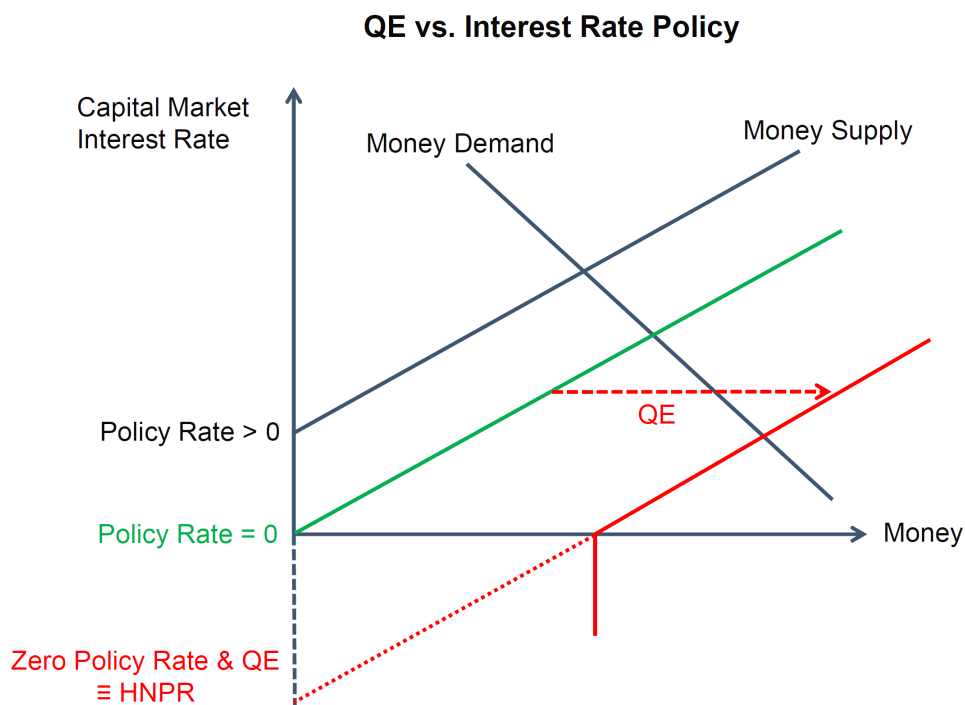


Figure 2: QE and Negative Interest Rate

Then, Figure 2 shows what happens when the central bank buys assets from the nonbank private sector via QE. Money supply increases, i.e., money supply shift to the right, corresponding to the red curve, similar to when commercial banks provide credit. As the CB money supply with QE is not a function of capital market interest rates, and as banks would not make any loans at negative capital market interest rates when the policy rate is zero, the money supply curve is vertical at negative capital market interest rates and corresponds to the amount of QE.

Money supply crosses the y-axis at the HNPR equivalent to QE: if the central bank could have decreased the interbank rate (or IOR) to negative territory, it would have been profitable for banks to start lending at a negative market interest rate above the interbank rate, which would shift money supply to the right as with QE. Thus, with QE, broad money directly increases by the amount of assets that the CB buys from the nonbank sector, and the effect of QE on capital market interest rates corresponds to a negative IOR.

The reason the equilibrium capital market interest rate decreases with QE through an increase in aggregate money supply is similar to the standard QE interpretation as the CB removes debt from the secondary market, and can be understood as follows. To get more means of payment, i.e., to increase aggregate consumption, the nonbank sector has to provide debt claims (mortgages or bonds) to the banking sector with conventional monetary policy, or to the CB with QE. Capital market rates decrease when broad money increases against bonds for the same reason as interbank market rates decrease when the CB injects reserves in exchange for collateral with conventional monetary policy. With QE, the CB increases the amount of broad money that can be lent and borrowed among the nonbank sector; thus, economic agents need to borrow less on aggregate. Capital market rates should decline relative to the expected policy interest rate as aggregate lending risk decreases with less need to borrow.

Section 3 quantifies the hypothetical negative policy interest rate equivalent of QE and section 4 presents the implications for exit.

3 Quantitative effects of QE

This section quantifies the correspondence between QE and conventional monetary policy for the US. It quantifies the effects of the Fed’s direct money supply injections through QE by comparing the effects of broad money supply shocks on GDP during QE to the effects of federal funds rate shocks on GDP in “normal times”, i.e., pre-QE. To account for general equilibrium effects and endogeneity, a VAR model is estimated. The variables included are standard for a monetary macro VAR model, i.e. the log levels of the price of industrial commodities (LCOMPI), GDP price deflator (GDPDEFL), real GDP (LGDPR), M2M (LM2M), as well as the federal funds rate (FF) in percentage points.

The monetary aggregate M2M corresponds to M2 minus small time deposits, and includes cash, demand and checking deposits, savings accounts, money market deposit accounts, and retail money market funds. It includes assets with yields below the 3-month risk-free rate and providing direct or indirect transaction services. An aggregate composed of such assets is the most likely to exhibit a close and stable relationship to nominal GDP.⁴ Moreover, such an aggregate gives the right monetary policy stance signal, i.e. it increases when the policy rate decreases and vice versa, as interest rates paid on transaction accounts are relatively sticky and move only with persistent changes in the 3-month market rate. Broader monetary aggregates do not

⁴See Reynard (2004, 2007).

necessarily provide the right stance signal, as the additional assets included in them with yields at or above the 3-month rate are positively correlated with the policy rate. Monetary aggregates defined according to this transaction concept are characterized by an estimated unitary income elasticity.

Two estimation periods are considered. First a sample before the financial crisis, from 1977Q1 until 2007Q2, as aggregate money demand showed signs of instability prior to 1977 and has been stable since.⁵ And second a sample since the beginning of QE, i.e. 2008Q4-2018Q1, without FF as it was essentially flat. The VAR model includes one lag⁶ of each variable. Shocks' identification is done via Cholesky decomposition with variables ordered according to the variables' description above, i.e., with FF last. The results are robust to variables' ordering as well as to generalized impulses. Figures 3 and 4 present impulse response functions (IRFs) with 95% standard error bands. Figure 3 displays the IRFs to interest and money shocks before the financial crisis, and Figure 4 displays the IRFs to money shocks since the beginning of QE. The complete sets of IRFs are displayed in the appendix.

⁵See Reynard (2004, 2007).

⁶One lag is chosen according to the Schwarz information criterion in the second sample. That criterion suggests two lags in the first sample, but results are unaffected.

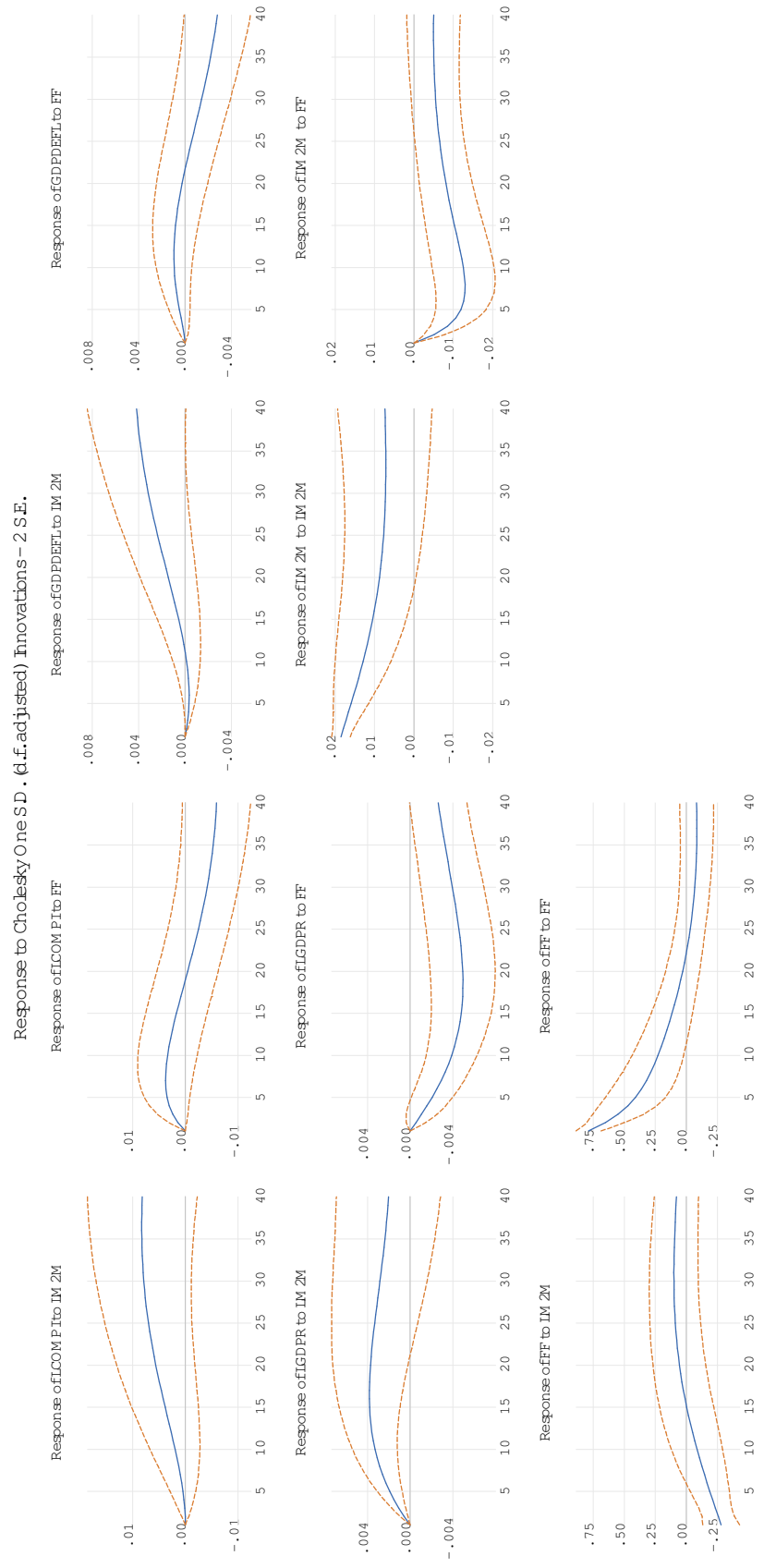


Figure 3: Impulse Response Functions 1977-2007

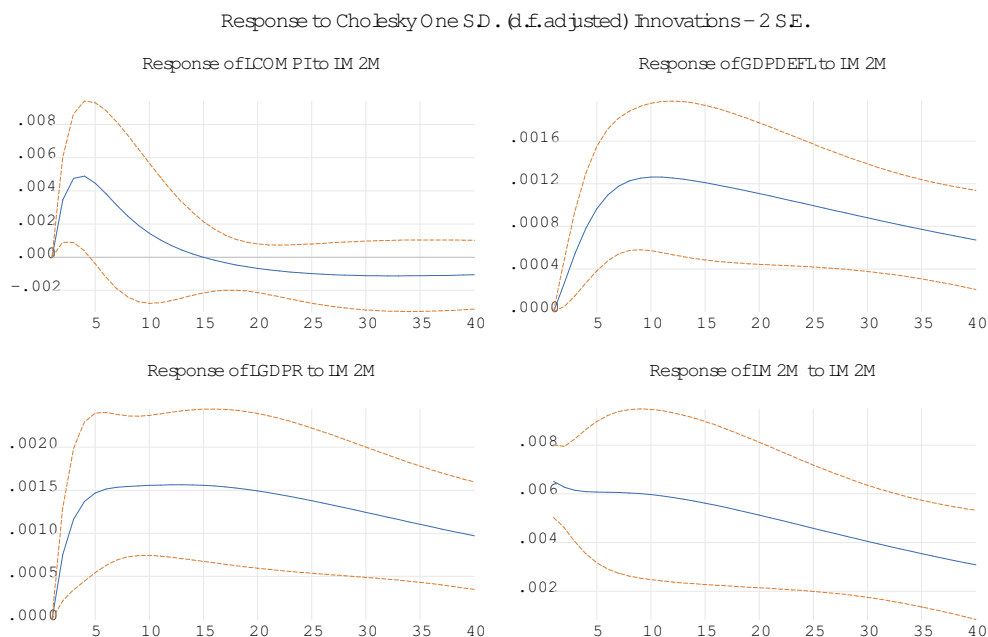


Figure 4: Impulse Response Functions 2008-2018

The responses of the different variables to money and interest rate shocks are in line with standard results from monetary VAR models. A positive interest rate shock causes a decline in real GDP and a decline in money. As illustrated in section 2, when the FF is raised this increases commercial banks' financing costs and thus equilibrium lending rates. A decline in lending decreases money supply. A positive money shock increases real GDP and the price level. It also has the standard liquidity effect of a decrease in interest rate.

To compute the hypothetical negative interest rate corresponding to QE, the peak response of real GDP to money shocks in the QE sample is compared

to the peak response of real GDP to FF shocks in the pre-crisis sample. This provides an equivalence in terms of interest rate and money shock sizes to produce a given peak GDP response. This approach leads to the following equivalence: a 2.5 percent money increase corresponds to a 1 percentage-point decrease in the federal funds rate. Broad money injections during QE, mostly driven by the Fed's asset purchases, have even slightly larger effects on GDP than pre-QE money shocks driven by commercial banks' money creation through lending. Before the crisis, a 3 percent increase in broad money corresponds to a 1 percentage-point decrease in FF. The overall estimated effect of money injections through QE presented in the next paragraph thus represents a lower bound estimate of QE effects as part of the money shocks in the QE sample are also due to commercial banks' lending activity.

With QE, commercial banks' reserves at the Federal Reserve increased by USD 2,700 billion. As "households" (which include hedge funds) were counterparts for about half of it (see Carpenter et al., 2015), M2M increased by about USD 1,350 billion as a result, or 12 percent of M2M at the end of QE programs by the last quarter of 2014. QE thus corresponds to a 5 percentage points decrease in FF.

4 Implications for exit

Figure 5 illustrates the consequences of QE for monetary policy exit, i.e., post-QE monetary policy normalization. If the CB sells its bonds portfolio

(Figure 5a), the pre-QE spread between the capital market rate and the interbank market rate (federal funds rate, FFR) will be restored, as the latter will be (close to) zero like just before QE was started. If however the CB tightens monetary policy by raising the interest on reserves (IOR) as on Figure 5b, that spread will remain smaller other things equal, i.e., capital market interest rates will be lower for a given interbank interest rate as the CB is a provider of broad money (a consequence of QE) in addition to commercial banks.

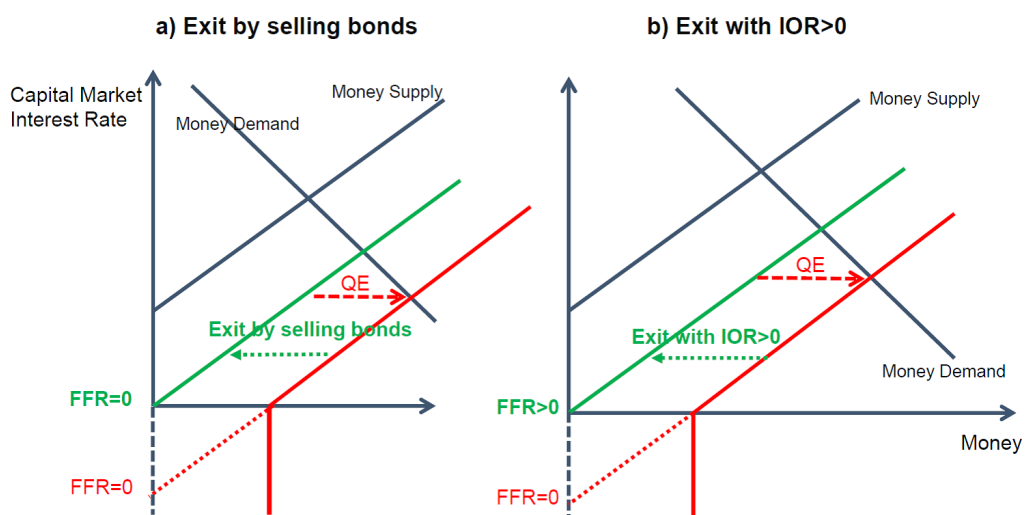


Figure 5: Exit and Interest Rate Policy

The intercept of the green curve would then correspond to an interbank rate larger than zero on Figure 5(b), in contrast to Figure 5(a) where the CB would sell bonds. For a desired monetary policy stance or capital market interest rate, and other things equal, the CB will thus have to raise the

interbank market rate higher than pre-QE to compensate for the stimulating economic effect of QE. Quantitative effects will depend on the speed at which the CB balance sheet is reduced, and offsetting effects of a decline in the natural interest rate.

5 Conclusion

The analysis provided in this paper allows to jointly assess standard interest rate policy and QE policy. It presents and estimates a framework that can compare both types of policy by relating the central bank's direct money supply through QE to the banking sector supply of broad money. During the exit, central banks will have to account for the effects of past QE policies as the interest rate change equivalent to the money supplied by central banks has been substantial. Other things equal, when the economic situation normalizes, short-term monetary policy interest rates will have to be set higher than before the financial crisis to achieve a desired monetary policy stance. Given the size of QE in many countries, this could offset declines in natural real interest rates. The framework presented in this paper allows us to estimate the consequences of past QE policies on monetary policy exit for different countries and for different evolutions of central banks' balance sheets.

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Appendix

Response to Cholesky One SD . (l.f. adjusted) Innovations - 2 S.E.

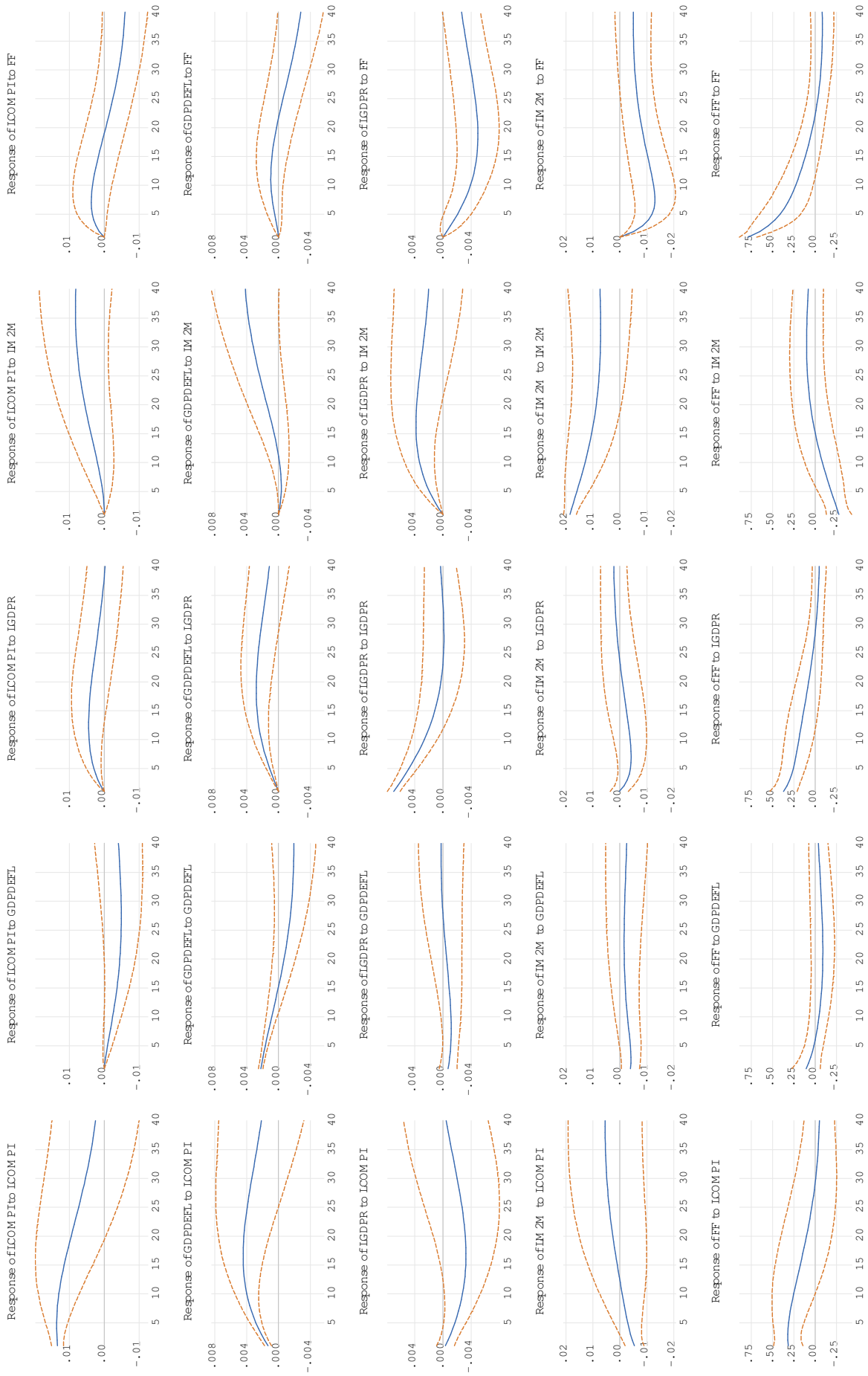


Figure 6: Impulse Response Functions 1977-2007

Response to Cholesky One S.D. (d.f. adjusted) Innovations - 2 S.E.

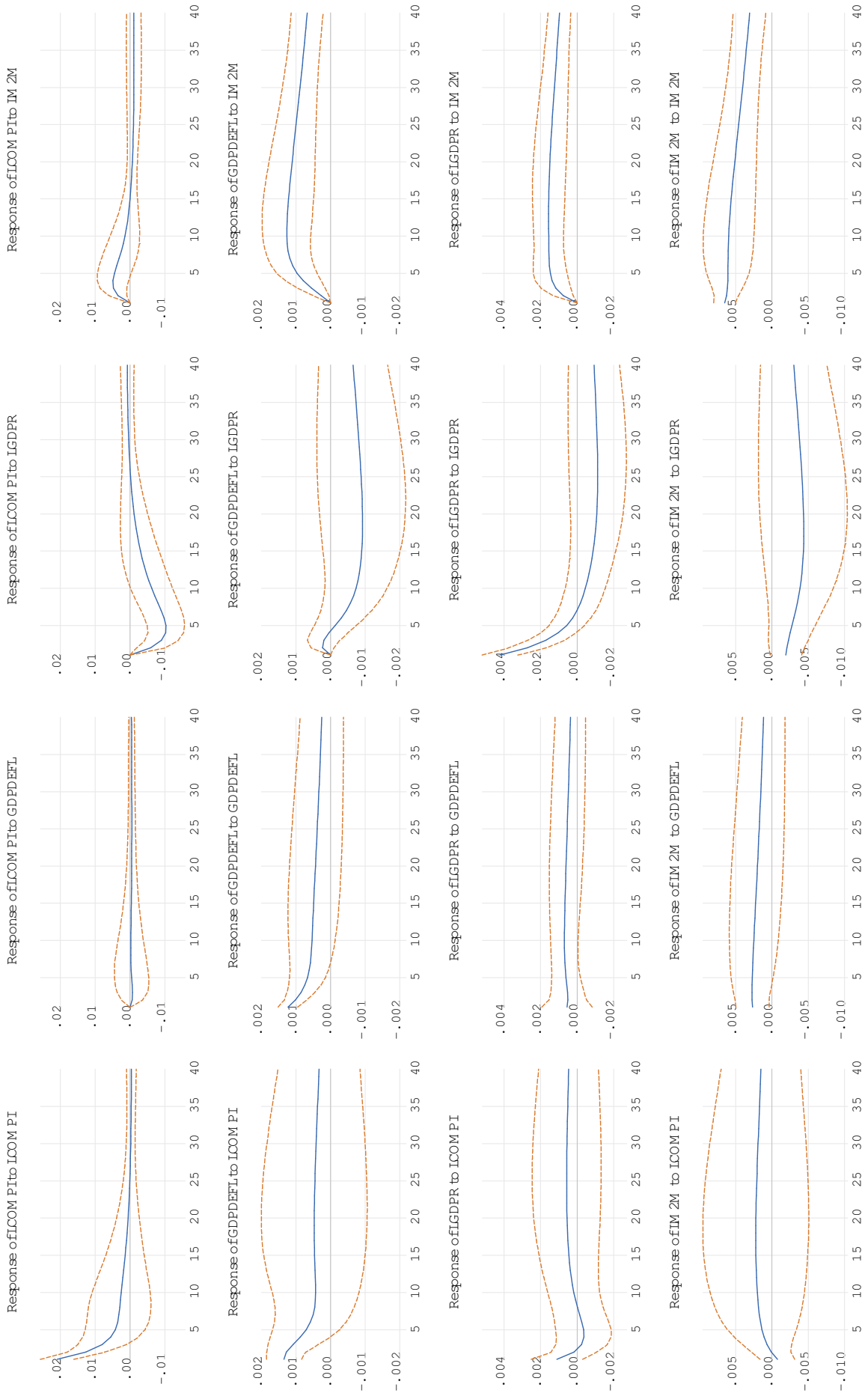
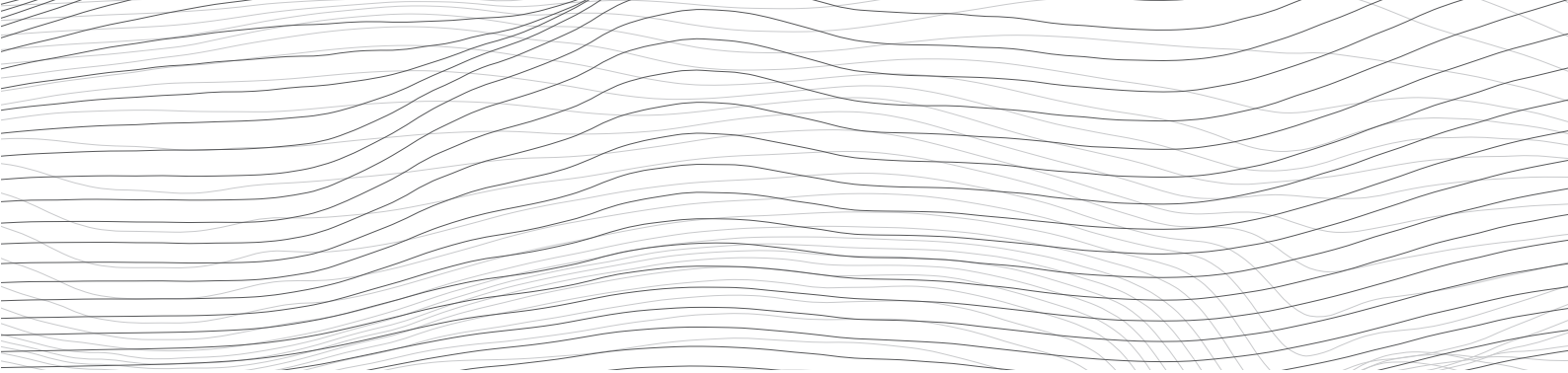


Figure 7: Impulse Response Functions 2008-2018

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