A Structural Investigation of Quantitative Easing
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Abstract
Did the quantitative easing measures (QE) conducted during the Great Recession induce real effects? We seek to answer this question by estimating a medium scale DSGE model featuring a banking sector, financial frictions and the effective lower bound on nominal interest rates (ELB) and use it to decompose the last two decades of US macroeconomic data. The expected duration of the ELB is modeled to be endogenous. Using the filtered distribution of shocks for counterfactual analysis we conclude that from 2009 to 2015 the overall QE measures contributed about 0.5 percent to output. While the effects of the liquidity provision was negligible, both the bond and MBS purchases had positive impact on consumption. Other than the MBS purchases, government bond purchases had negative effects on investment and a negative net contribution to GDP. Whereas QE stimulates asset prices in the short-run, the persistent reduction of excess spreads can lower banks’ net worth, the loan supply, and hence real economic activity in the mid-run. Forecasts suggest that, through the link between banks balance sheet and investment, shutting down the QE program will have a strong recessionary "hangover" effect, leading to a net-decrease in output for the years after the end of QE.

Keywords: Quantitative Easing, Liquidity Facilities, Zero Lower Bound, Bayesian Estimation
JEL: E63, C63, E58, E32, C62

1 Introduction

In 2008, the financial sector in the US collapsed, causing a sharp drop in asset prices and credit supply as well as what is known today as the Great Recession. As a response the Federal Reserve reduced its Federal Fund Rate to zero and engaged in quantitative easing measures (QE) such as large scale purchases of government debt and Mortgage

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Backed Securities, and – even before – committed to major liquidity injections into the banking sector. The effects of these measures are subject to a controversial debate. While critics’ assessments range from “a drop in the bucket” (Cochrane, 2011) and not having “fulfilled its stated objective of stimulating the economy” (Taylor, 2014), its proponents have firmly stated that “evidence suggests that forward guidance and security purchases [...] did help spur consumption and business spending, lower the unemployment rate, and stave off disinflationary pressures” (Yellen, 2017).

While there is emerging consensus that QE measures had at least some impact on financial market indicators\(^1\), evidence for the effects of quantitative easing on the real economy is still sparse. We seek to fill this gap by employing a DSGE model, which incorporates several QE measures and takes account of the effective lower bound on nominal interest rates (ELB) as a lens to look at the data. The model is a hybrid of the models by Boehl and Strobel (2019) – which is a variant of Smets and Wouters (2007) – and Gertler and Karadi (2013). It thereby features all the bells and whistles that are necessary to make it suitable for estimation, it has properties that allow to remain at the ELB for an extended period of time, and includes the financial frictions needed to allow for effects of QE on the real economy. Quantitative easing in our model affects different parts of the balance sheet of the financial sector, capital holdings, bond holdings, and its liabilities. The effects are passed through to the real economy via the supply of loans to non-financial firms. After estimation, we analyse the drivers of macroeconomic dynamics in the aftermath of the Great Recession and quantitatively assess the effects of QE on the US economy.

We find that QE had a relevant impact on the US economy. According to our estimates, in its peak, QE raised aggregate output and labor hours by roughly 0.7%, consumption by 0.6%, and aggregate investment by 3%. The impact on inflation was very small. However, while we find that QE had a stimulating impact, this stimulus was small in comparison to the sharp and persistent drop in output and labor below the pre-crisis trend. Furthermore, our analysis suggests that the stimulating effects of QE are followed by a drag on the real economy once the balance sheet of the central bank shrinks. In our model this drag can be attributed to the persistent decline in excess spreads on capital assets and government bonds, which weakens the balance sheet of financial intermediaries and in turn reduces investment and output in the long run.

In a second step, we decompose the effects of QE into the effects of three separate policy measures: large-scale purchases of capital assets and bonds, as well as emergency liquidity injections into the banking sector. We find that the purchases of capital assets had the strongest effect in stimulating the economy. The purchases of bonds on the other hand, while slightly increasing consumption, crowded out investment and had a negative net-effect on output and labor. The effect of liquidity injections on asset prices and interest rate spreads is found to be sizable, but they die out quickly. Hence their long term effect on the real economy is negligible.

To our knowledge, the analysis of the effects of QE in a non-linearly estimated medium scale DSGE model is a novel contribution to the literature. In order to overcome the challenges associated with the estimation of a model at the effective lower bound, we employ the methods suggested by Boehl (2019), which are implemented in the in the pydsge package.

the linearized model is solved with the effective lower bound as an endogenous occasionally binding constraint. The likelihood is evaluated with an ensemble-type Kalman filter (the IPAS filter, which is a hybrid between Particle Filter and Iterative Kalman Filter)\(^3\), and full Bayesian estimation of the parameters it done using the Affine Invariant MCMC Ensemble sampler (Goodman and Weare, 2010). The IPAS is also used to extract shocks and initial states for our quantitative analysis.

The financial sector in our model builds on Gertler and Karadi (2011) and Gertler and Karadi (2013). In recent years, this general framework has often been adapted and extended to capture various aspects of the global financial crisis\(^4\). Within this model, the private securities purchased by the central bank as part of its QE programs are in essence claims on the productive capital stock, whereas the large bulk of non-government bond assets purchased by the Fed during the last decade were mortgage backed securities. Despite this discrepancy, we model the link between financial and real economy as in Gertler and Karadi (2013) since on the one hand it captures the key link between the balance sheet policy of the central bank and the decline in risk premia and lending rates in the economy, and on the other hand it facilitates an easy comparison to theoretical results in the literature. The effects of the asset purchases by the central bank are therefore largely similar to the effects in Gertler and Karadi (2013): they initially stimulate the economy, but a few years after the implementation of the policy measures the economy drops below the steady state. However, given the additional rigidities and our estimated parameter values, these QE effects are somewhat smaller than in the calibrated model. There are several other papers that analyze the effects of QE, however they do so in calibrated models. Chen et al. (2012) find that the effects of government bond purchases in a model with segmented bond markets are rather small, resulting in a 0.5 % increase in GDP and very little effect on inflation, whereas Del Negro et al. (2017) find that in response to a shock that raises the convenience yield, liquidity injections can have a sizable effect. Accordingly, our results are more in line with the modest effects of QE implied by Chen et al. (2012). Cúrdia and Woodford (2011) point out, that in a model, in which firms finance investment with long-term debt, the effect of QE, depends on which type of assets assets the central bank buys. Bond purchases are neutral in their framework, whereas purchases of assets from markets which are in distress can alleviate the pressure on the financial sector and stimulate the economy. In contrast, government bond purchases do have effects in our framework. Nonetheless, we confirm the assertion that purchases of capital assets are more effective. Both, bond and capital purchases, however lower investment in the long run according to our analysis. This is consistent with a different line of thought suggested by Brunnermeier and Koby (2018), who warn of potentially contractionary effects of QE. They argue that the persistently decreased net margins of the financial sector can induce a reduction of real activity. Our quantitative result of a hangover after the initial stimulus of QE is consistent with their theoretical argument. The design of this study is closely related to Boehl and Strobel (2019), where we focus on the effects of forward guidance in a medium-scale model without a financial

\(^2\)The package includes model parser, solution method, high level API to the smoother and estimation as well as tools for quantitative analysis and can be found at \url{https://github.com/gboehl/pydsge}.

\(^3\)A standalone implementation of the filter is available at \url{https://github.com/gboehl/econsieve}.

\(^4\)Some examples are Gertler et al. (2012), van der Kwaak and van Wijnbergen (2014), Gertler and Kiyotaki (2015), Kirchner and van Wijnbergen (2016), Rannenberg (2016), Meeks et al. (2017)
sector. We document that the most parameter estimates are largely unaffected by the introduction of a financial sector in ??.

This paper is also linked to empirical work on the effects of QE. Using a Bayesian VAR, Hesse et al. (2017) investigate the effects of announcements of asset purchases. They find that these announcements had rather moderate effects. Shocks normalized to 1% of GDP, increase GDP and CPI by roughly 0.2% for both the US and the UK. Additionally they find that the earlier purchase programs had slightly stronger effects in the US and in the UK than the later programs, as they had a larger surprise effect on market participants. For the UK, VAR studies for Kapetanios et al. (2012) find larger effects of QE. Their results suggest peak effects of 1.5% on GDP and 1.25% on annualized CPI. For Japan Schenkelberg and Watzka (2013) find rather small effects of QE on the real economy. All considered, our finding of significant positive macroeconomic effects are broadly in line with the VAR literature on this topic. The literature on the effects of QE on financial variables focusses on the announcement effects of QE in daily or high-frequency data. Gilchrist and Zakrajscek (2013) find that announcements of large scale asset purchases (LSAPs) led to a significant reduction in corporate credit risk, as measured by CDS indexes. Swanson (2017) separately identifies the effects of forward guidance and LSAP announcements on financial market variables and finds that forward guidance is more successful at moving short-term Treasury yields, whereas LSAP had a larger effect on long-term yields. The finding that QE had important effects on financial conditions is corroborated by Borio and Zabai (2016) and Kuttner (2018). In contrast Greenlaw et al. (2018) exploit the movement of financial variables on FOMC dates and other days of large bond yield movements and conclude that the role of QE for financial markets is rather small. In our paper, we use quarterly data instead of high-frequency data and realized policy measures instead of announcements. Therefore the results are not directly comparable, however our results that LSAPs had indeed a sizable impact on risk premia speaks to the findings of the bulk of this literature.

Apart from our results regarding the effects of monetary policy measures, our findings suggest that the dynamics of macroeconomic and financial variables were mainly driven by risk premium shocks. While Beraja et al. (2016) point out that the effects and the importance of different shocks for the US business cycle and in particular for labor market variables depend on the degree of disaggregation of the data, the important role of risk premium shocks for the post-Great Recession era finding appears to be a robust result in structural estimations on US-wide aggregate data (see, e.g. results in Gust et al. (2017), Kulish et al. (2017), Linde et al. (2017), and Boehl and Strobel (2019)). In contrast to Christiano et al. (2015), who analyze the Great Recession within a framework with a detailed modelling of the labor market, we abstain in this paper from including a fine-grained labor market in our model in order to facilitate an easier comparison with theoretical results in the literature on the effects of QE on the business cycle.

Section ?? presents the model in use. Section ?? includes a brief description of the data, as well as of the solution, filtering and estimation methodology, and presents and discusses the estimation results. Section ?? entails our analysis of the drivers of the US economy, as well as a detailed discussion of the effects of QE measures. Lastly, Section 2 concludes.
2 Conclusion

In this paper, we develop a medium scale DSGE model with a financial sector and use it to analyse the effects of several quantitative easing measures. For this purpose, we solve the model with an occasionally binding effective lower bound, and filter and estimate the model non-linearly. The methods we employ enable us to make statements about the effects of QE in the US during the Great Recession and in the subsequent years, in which the effective lower bound on the nominal interest rate was binding. In modelling the real economy and the financial sector we stay close to popular workhorse models to ensure comparability with the existing literature.

We find that the effects of quantitative easing are relatively small in comparison to the effects of non-policy shocks, in particular, exogenous variations in the risk premium. Nonetheless, the effects are economically meaningful. We find that the most effective tool for stimulating real activity in the short-run are central bank purchases of claims on the private capital stock. According to our analysis, central bank liquidity injections had the smallest and most short-lived effect on the US economy. Government bond purchases, while lowering the real rate on safe deposits did not support economic growth but rather led to a decline in investment and GDP.

We document that the overall stimulating effects of QE are followed by an implied economic slump that we dub the hangover effect of QE. In our model this is due to the declining profitability of the financial sector due to the decrease in excess spreads on assets purchased by the central bank. As a consequence the weakened financial sector contracts its loan supply in the long run. This mechanism is loosely related to the argument of the reversal rate made by Brunnermeier and Koby (2018).

Other sceptics of QE have argued that the uncertainty surrounding the unwinding QE created uncertainty and contributed to the slow recovery of the US economy following the Great Recession (see, e.g. Taylor, 2014). This and other aspects such as the signalling content of monetary policy decisions are not captured in our analysis. Investigating how the effects of QE in the US as implied by a nonlinearly estimated model hinge on the incorporated financial sector, an inclusion of a housing market or a more detailed modelling of labor market dynamics, is a promising route for future research.

References

References


Appendix commented out to meet file-size constraints. Available upon request.