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# Macroeconomic Effects of Unconventional Balance Sheet Policies in the United States and the Euro Area

**Summary:** Post Great Recession vector autoregression analysis revealed that the reserves' creation of the European Central Bank (ECB) until 2015 had an impact on the perceived credit risk that was either statistically insignificant or opposite to the expected one. The ECB's unconventional measures returned the real GDP growth merely to an equilibrium of nil growth. In the United States, unconventional balance sheet policies of the Federal Reserve System (the Fed) significantly increased the real GDP by between 3.2% and 5.3% and reduced the initial rise of the perceived credit risk. We argue that the plausible reason for the discrepancy between the Fed and the ECB's outcomes were the contrasting goals of both central banks. The major conclusion is that creation of money by the central bank may support the economy after a crisis, but it cannot deliver long-run prosperity. The positive effects of balance sheet policies were found to be short-lasting.

**Key words:** Unconventional monetary policy, Quantitative easing, Transmission mechanism, Uncertainty and growth, Central bank's money creation.

**JEL:** E31, E40, E58.

The goal of this article is examine the efficiency of the balance sheet policies of the European Central Bank (the ECB) and the Federal Reserve System (the Fed) in stimulating real GDP growth and reducing the perceived credit risk and a trial to reveal a stylized mechanism through which quantitative easing (QE) may influence the economy. The tested hypothesis is that exploiting the asset side of a central bank's balance sheet may be efficient in decreasing the perceived credit risk and boosting the real economy. We add new evidence to the inconclusive literature on the macroeconomic efficiency of QE (Timothy Sharpe and Martin Watts 2013). Our results contradict the most influential case study of Japan, which implied poor effects of QE on output at least until the most recent "Abenomics" era (Henrike Michaelis and Sebastian Watzka 2017).

This article is organized as follows: Sections 1 and 2 review the literature on the channels and macroeconomic effects of QE, respectively. Section 3 outlines the estimation methods. Section 4 describes the data. Section 5 discusses the consequences of the Fed's and the ECB's balance sheet policies for real growth and perceived credit

risk. Then, the plausible reasons for the discrepant macroeconomic results of the Fed and the ECB are discussed in Section 6. Section 7 concludes the paper.

## 1. Transmission Channels of Unconventional Monetary Policy

After the outbreak of the Great Recession, the nominal policy rates of major central banks moved towards their zero lower bound (ZLB), which is a situation when nominal interest rates remain either low or near zero. Escalated systemic risk in the United States (US) and the euro area (EA) prompted adoption of nonconventional solutions. Nevertheless, Kazuo Ueda (2012) warned that the Bank of Japan's traditional and non-traditional measures would fail to bring the economy out of deflation for two decades.

In the pre-crisis dynamic stochastic general equilibrium (DSGE) models, money played no direct role in affecting the real economy. Conversely, QE relies on large scale asset purchases, predominantly from non-bank financial companies, in return for central bank reserves to increase the amount of money in the economy (Michael McLeay, Amar Radia, and Thomas Ryland 2014). Despite such an apparent conflict between the early DSGE models (Gauti B. Eggertsson and Michael Woodford 2003) and QE, and although QE's channels were not recognized well, the tool has been used extensively by major central banks since the Great Recession of 2007-2009. The most basic DSGE model consists of three equations for aggregate supply, aggregate expenditure (both based on microeconomic foundations), and a monetary policy rule; they are typified by the Taylor-type model with no direct reference to money (for more details, see Woodford 2008).

QE has changed central banking abruptly, from relying on liabilities to exploiting the asset side of the balance sheet (Benjamin M. Friedman 2015). The ECB's balance sheet expanded to 2.7 trillion euro in December 2015, and the Fed's had expanded by more than $3.5 trillion by the end of October 2014. The unprecedented scale of the interventions and the importance of both central banks create a background for the unresolved discussion on the impact of balance sheet policies - especially that the declared goals of both central banks diverged, as did their economic results.

Central banks are expected to react to rising credit risk with a balance sheet growth, as in the study of Manfred Kremer (2015) for their composite indicator of systemic financial stress in the EA. This should lower the overall credit risk (Simon Gilchrist and Egon Zakrajšek 2013), which may help to combat the recession and deflation (George Kapetanios et al. 2012) by stimulating real GDP (Michael Joyce, Matthew Tong, and Robert Woods 2011). The most-advocated channel through which it may happen is the portfolio balance channel (Joseph Gagnon et al. 2011; Stefania D'Amico et al. 2012). According to that channel, QE raises the amount of deposits held by those companies and makes them wish to rebalance their portfolios of assets typically by purchasing high-yield assets. This should raise assets' prices and boost spending in the economy (McLeay, Radia, and Ryland 2014).

Another channel frequently analyzed in the literature is the signaling one, which works when forward-looking investors react immediately to credible QE announcements pricing the expected maturity structure of the securities (Michael D. Bauer and Glenn D. Rudebusch 2014). In general, the final effects of QE have been argued to depend on the kind of purchased assets (Arvind Krishnamurthy and Annette Vissing-

Jorgensen 2011), yield responses, the level of substitutability across international bonds (Bauer and Christopher J. Neely 2014), the horizon of excess returns (Robin Greenwood and Dimitri Vayanos 2014), and market institutional structures and central bank communication policies (Jens H. E. Christensen and Rudebusch 2012).

## 2. Macroeconomic Effects of Unconventional Monetary Policy

QE is known to have both positive and negative effects. Empirical studies suggest that positive effects of unconventional policies include lower yields (D'Amico and Thomas B. King 2013; Jagjit S. Chadha and Alex Waters 2014; António Afonso and João T. Jalles 2019), favorable expectations for Treasury and corporate bond yields (Carlo Altavilla and Domenico Giannone 2016), increased lending (James Benford et al. 2009; Carmela D'Avino 2018), reduced unemployment rates (Eric Engen, Thomas Laubach, and Dave Reifschneider 2015), reduced liquidity premia (Woon Wong, Iris Biefang-Frisancho Mariscal, and Peter Howells 2018), and raised inflation expectations (Willem Thorbecke 2018). On the other hand, D'Avino (2018) provides evidence that international banks may channel additional liquidity across borders and increase the debt levels in other countries. Moreover, Mahmoud Fatouh, Sheri Markose, and Simone Giansante (forthcoming) argue that the revival of bank lending with QE was not successful, as lower bond yields and Basel II/III capital requirements on banks discouraged big companies from borrowing from banks.

In spite of substantial empirical research on both the positive and the negative effects of QE, its macroeconomic effects during a typical business cycle frequency are not well-recognized. The few empirical papers that investigate the macroeconomic impact either analyze the international effects of US quantitative easing on, for example, Latin American economies (César Carrera and Nelson R. Ramírez-Rondán 2019) or investigate Japan (Heike Schenkelberg and Sebastian Watzka 2013; Junko Koeda 2019). However, it is doubtful whether the experience of the Bank of Japan, and that of the country characterized by the "Lost 20 Years", could be generalized to other countries.

Moreover, some empirical papers either employ models estimated on pre-crisis data or adopt a Taylor-type rule to close the system (Giannone et al. 2011). Taylor-type rules work well in various models; they have meaningful robustness advantages over more sophisticated rules (John B. Taylor and John C. Williams 2010), while their simplicity makes them a useful benchmark for policymakers. However, pre-crisis data are not a reliable source of information on the efficiency of unconventional stimulus, as exploiting the asset side of the balance sheet was not used before the 2007 crisis on an unconventional scale. Similarly, closing the system in a DSGE model with a Taylor-type rule may be not adequate during financial distress and ZLB (Jesper Lindé, Frank Smets, and Rafael Wouters 2016; Michael T. Kiley 2018). Low interest rates that are near the floor in major economies since the outbreak of the Great Recession have increased the risk of a liquidity trap (Lino Sau 2018). ZLB may limit the capacity of a central bank to stimulate the economic growth by further cuts in interest rates. The prolonged period with the near zero levels calls into question the usefulness of simple Taylor-type rules that link inflation and economic activity linearly with interest rates. In consequence, Taylor-type rules may lead to a deflationary spiral (Jess Benhabib,

Stephanie Schmitt-Grohé, and Martín Uribe 2001), not to mention the fact that they are sensitive to the estimation methods, data, and samples (Maciej Ryczkowski 2016).

Furthermore, Martin Weale and Tomasz Wieladek (2016) and Henning Hesse, Boris Hofmann, and James M. Weber (2018) analyze macro effects only in the short-run (high frequency data) near the dates of asset purchase announcements for the US and the United Kingdom (UK). According to their results, QE positively affected the real economy in the aforementioned countries. Conversely, the results of asset purchases for the EA were rather poor, especially in terms of lending (Jérôme Creel, Paul Hubert, and Mathilde Viennot 2016; David Beckworth 2017) and stimulatingv asset prices, housing prices in particular (Ryczkowski 2019).

Perhaps the closest study to our article is that of Leonardo Gambacorta, Hofmann, and Gert Peersman (2014). They also analyze macro effects of asset purchases on domestic output and inflation. However, we extend their approach by accounting for the impact of the perceived credit risk measured by the TED-type spreads. Indeed, perceived credit risk played a key part in influencing the counterparty risk and liquidity conditions during the crisis (William J. Burns, Ellen Peters, and Paul Slovic 2012), and blurred the signaling of the monetary policy stance (John Beirne 2012).

This article contributes significantly to the literature by analyzing the macroeconomic impact of QE. Unlike this article, most empirical studies have either investigated high frequency data and employed event-study methodologies (Dimitris Kenourgios, Stephanos Papadamou, and Dimitrios Dimitriou 2015; Daniel L. Thornton 2017; Shaen Corbet, John J. Dunne, and Charles Larkin 2019), analyzed the effects of QE solely on the yield curve (Bauer and Rudebusch 2014; Afonso and Jalles 2019; Mesut Turkay and Timur H. Gur 2019), or used models estimated on pre-crisis data (Michele Lenza, Huw Pill, and Lucrezia Reichlin 2010; Hess Chung et al. 2011). The latter models are not tailored for the new circumstances of the low interest rates and the sizably extended balance sheets of central banks. In consequence, the macroeconomic effects of balance sheet policies are not well-recognized.

The novelty, in particular, is the comparison of the two major central banks with clearly diversified monetary policy strategies. Whereas the Fed's strategy is considered to be a dual mandate with two major goals of price stability and maximum sustainable employment (Friedman 2008), the ECB's is a "two-pillar" monetary policy strategy focused primarily on inflation, with a monetary pillar used to cross-check the economic and monetary analyses (Philipp Hartmann and Frank Smets 2018). The discrepant approaches of both central banks constitute an interesting setup to compare the efficiency of their QE programs. Thus, the results are relevant for the proper design of monetary policy strategies (see Rudebusch and John C. Williams 2016) and for the evaluation of QE policies.

Finally, the few empirical papers that analyze the macroeconomic effects of the Fed and the ECB draw contradictory conclusions. For instance, Chung et al. (2012) estimate that Large Scale Asset Purchases (LSAP) increased real GDP by 3 percent till the second half of 2012, whereas Han Chen, Vasco Cúrdia, and Andrea Ferrero (2012) find a very low impact of asset purchases on the economy for the same period. According to their DSGE model enhanced with bond market segmentation, the Fed's second LSAP increased GDP by less than one third of one percentage point (p.p.) and left

inflation almost unchanged. In the case of the EA, Peersman (2011) argues that unconventional monetary policy shocks had a significant impact on output. Others point that the effect concerned primarily interest rates and not lending (Creel, Hubert, and Viennot 2016). Some studies find that either the ECB's unconventional measures are insufficient to avert a downturn in economic activity (Lenza, Pill, and Reichlin 2010) or the bank has done "too little, too late" to avoid the recession (Jörg Bibow 2015; Carlos Rodríguez and Carlos Carrasco 2016).

## 3. Methodology

Following Christiane Baumeister and Luca Benati (2013) and Hesse, Hofmann, and Weber (2018), we employ a vector autoregression (VAR) model to analyze the effectiveness of unconventional monetary policy. The model allows us to form multi-period predictions of jointly linked variables and to identify the effects of monetary policy shocks (Marek Jarociński and Bartosz Maćkowiak 2017). In particular, we analyze the impact of the asset purchases of the Fed and the ECB on the developments of the real GDP and the perceived credit risk. The choice of an unrestricted VAR is particularly useful if the true model of the economy remains unknown (Vito Polito and Mike Wickens 2010), which is typically true during large tensions on the financial market. Moreover, structural models are frequently misspecified in terms of defining exogenous variables. Thus, VAR models may be a tempting alternative (Chung-Ki Min 2019). Finally, VAR models seem to be especially useful, as we expect the unconventional stimulus to be withdrawn in line with the largely discussed "exit strategies" (Yi Wen 2014; Aleksander Berentsen, Sébastien Kraenzlin, and Benjamin Müller 2018). Therefore, for example, a vector error correction model does not seem to be an appropriate choice, as it introduces concepts related to the long-run and stable relationship (cointegration). A possible alternative to VAR could be a new DSGE model, which would account for the role of the financial sector. However, the subject literature has expressed doubts over how such a model should be specified or whether it would be possible to explain the Great Recession in a satisfactory way with such a model (Paul Willen 2015).

We assume that the relation between output, unconventional balance sheet policies, and financial strain in the US and the EA can be approximated by the $p$-lag vector autoregressive macro-financial multivariate time series model (VAR($p$)) with $t = 1, K, T$, where $T$ is the sample size:

$$A_0 Y_t = \sum_{i=1}^{p} A(i) Y_{t-p} + G X_t + \Phi D_t + \varepsilon_t, \tag{1}$$

$Y_t = (\Delta GDP, \Delta TA, \Delta CR)$ is a $3 \times 1$ vector of three endogenous variables: first differences of real GDP growth $\Delta GDP$, central bank's total assets $\Delta TA$, and perceived credit risk $\Delta CR$ measured by the Ted spread. The Ted spread for the US was defined after the Federal Reserve Bank of St. Louis (FRED) as the difference between a 3-Month London Interbank Offered Rate (LIBOR) based on US dollars and a 3-Month Treasury Bill - a risk free rate. Analogously, the "TED spread" for EA was calculated as a difference between the 3-month Euro LIBOR and 3-month German yields. To verify the EA's mechanism, we have experimented also with a spread between the main

refinancing operations (MRO) rate and the Euro OverNight Index Average (EONIA) rate. A matrix of exogenous variables $(X_t)$ consists of consumer inflation $\Delta CPI$ and investments $\Delta I$ measured by Gross Fixed Capital Formation ($GFCF$) and Gross Domestic Investments ($GDI$); $A(i)$ are coefficient matrices; $D_t$ is a matrix of deterministic components; $G$ and $\Phi$ are parameter matrices; and $\varepsilon_t$ is the vector of error terms.

Consumer prices have not been included in the list of endogenous variables, as Fredj Jawadi, Ricardo M. Sousa, and Raffaella Traverso (2016) found that positive shocks to the growth rate of central bank reserves did not have a substantial impact on consumer prices. The basic models do not account for the impact of interest rates, because their role close to ZLB was presumably marginal (Christopher Allsopp and David Vines 2015). Kristin J. Forbes and Michael W. Klein (2015) showed that the cuts of the interest rates made by central banks, together with other traditional responses to crises, yielded no significant improvements in growth, employment, and inflation in most countries during the recent financial crisis.

Indeed, Eladio Febrero, Jorge Uxó, and Óscar Dejuán (2015) show that, in the new turbulent conditions - the mainstream economics was not particularly useful - neither the link between the reserves and loans nor the link between reserves and inflation worked. Therefore, instead of the interest rate, we employ the new central bank tool - asset purchases $\Delta TA$ - following Gambacorta, Hofmann, and Peersman (2014) in this respect. Following Weale and Wieladek (2016), we include the real GDP in the basic model. Additionally, we account in the model for the perceived credit risk measures, namely the TED-type spreads, as they were shown to be an informative market barometer during the Great Recession of 2007-2009 (Kris Boudt, Ellen C. S. Paulus, and Dale W. R. Rosenthal 2017). Indeed, the evidence shows that the rise of risk aversion impairs the transmission of the cuts in policy rates (European Central Bank 2013). Similarly, many other authors have also included yield spreads in their VAR models (Kapetanios et al. 2012; Baumeister and Benati 2013).

In consequence, we have obtained a novel model tailored for exceptional times of financial stress and of unconventional creation of reserves. In comparison to VARs in normal circumstances, two out of the three endogenous variables from a core block have been dropped. Instead of interest rates and inflation rate, the asset side of a central bank's balance sheet and indicators of the perceived credit risk have been included because financial stress has adverse and substantial effects on economic activity (Gilchrist and Zakrajšek 2012), whereas creation of reserves is expected to have positive effects.

However, some recent studies point out either that the impact of interest rates on bank profitability may be positive (International Monetary Fund 2017) or that the cuts in interest rates are a part of optimal monetary policy (Jean-Pierre Danthine 2018). Low or even negative policy rates may induce an increase in asset prices and cause collateral values to rise (Seth Carpenter, Selva Demiralp, and Jens Eisenschmidt 2014) with relevant consequences for output growth, inflation and credit risk. Therefore, to make the findings robust, we have adjusted the results for the impact of nominal interest rates and the impact of inflation.

We have followed the standard procedure of defining the lag length by using the Akaike, Bayesian, and Hannan-Quinn information criteria (AIC, BIC, and HQC,

respectively). We have tested down from the maximum lag order of eight quarters. The reason for this is the long and variable lag in monetary policy (Juha Kilponen and Kai Leitemo 2011). The lag in monetary policy shock affects the output gap, with a peak effect after approximately one year, whereas, in the case of inflation, it may be longer (Nicoletta Batini and Edward Nelson 2001), even up to two years (Tomasz Chmielewski et al. 2018). In consequence, we applied the maximum lag length of two-years, especially as the lag related to the impact of asset purchases is not recognized well. When the information criteria suggested different lags, we made the results robust and estimated VAR models with other lags and discussed the results. Additionally, as a robustness check, we selected the maximum lag length of six years, following Weale and Wieladek (2016).

The causal impacts have been summarized with impulse response functions and forecast error variance decomposition. Impulse response functions are introduced to analyze the evolution of the variables to a shock (Christopher A. Sims 1980) in monetary policy. Variance decomposition is employed to assess how relevant the shock is in interpreting the variation in real GDP and perceived credit risk (Helmut Lütkepohl 2010).

We analyzed the overall efficiency of QE, irrespective of whether it worked through the flattened yield curve, signaling effects, or some other channel. As opposed to "event study methodologies", the analysis provided for inherent lags in the transmission mechanism. Andrew T. Foerster (2015) found that expectations about the exit strategy influence the initial effectiveness of purchases and that event studies may control for them inadequately. We, in turn, required no assumptions about any pre-announcement effects resulting from advance expectations. The robustness checks included enlargement of VARs by adding the nominal interest rate to the list of endogenous variables (the US: Effective Federal Funds Rate, EA: Marginal Lending Facility), analyzing the implications of the Taylor rule, and estimating VARs on specific subperiods. We also accounted for different measures of investments and perceived credit risk. Finally, we tried different VAR lag orders.

We used the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test and the augmented Dickey-Fuller (ADF) test (Table 1A) to verify whether the time series are stationary to avoid the misleading statistical evidence of a linear relationship between independent non-stationary variables (namely, "spurious regression"). The null hypothesis for the KPSS test assumes that the data are stationary, whereas the null hypothesis of the ADF test is that there exists a unit root of a univariate time series.

## 4. Data

Our data on real GDP and the consumer price index stem from the OECD. The data on the central bank's total assets come from the Fed and the ECB. The "TED spread" for the US is from FRED, whereas the TED spread for the EA was calculated using the ECB Warehouse and Investing.com. MROs and EONIA come from the ECB. The time series on GFCF for the EA was calculated using Eurostat and the ECB's data, whereas, for the US, it comes from OECD. Following, for example, Lorenzo Burlon, Alessandro Notarpietro, and Massimiliano Pisani (2019), we use quarterly time series.

The time series have been seasonally adjusted using the X-12-ARIMA procedure, except for policy rates and the central bank's total assets.

**Table 1** Selected Descriptive Statistics for the US Covering the Period from 3Q2007 to 4Q2015

| Descriptive statistic | Variable | | | | | |
|---|---|---|---|---|---|---|
| | Fed's total assets (millions of USD) | Perceived credit risk (%) | GDP (millions of USD) | CPI index (2010 = 100) | Investments (millions of USD) | Interest rate (%) |
| Maximum | 4,497,297 | 2.45 | 16,692,152 | 109.30 | 3,691,300 | 5.07 |
| Minimum | 871,863 | 0.15 | 14,530,969 | 95.36 | 2,437,800 | 0.07 |
| Average | 2,816,612 | 0.50 | 15,466,938 | 103.26 | 3,106,894 | 0.61 |
| Median | 2,846,116 | 0.26 | 15,290,232 | 103.89 | 3,132,200 | 0.14 |
| Standard deviation | 1,150,445 | 0.52 | 627,988 | 4.34 | 354,033 | 1.24 |
| Coefficient of variation | 40,84% | 103.64% | 4.06% | 4.21% | 11.40% | 201.53% |
| Average quarterly change | 6.24% | -0.03 p.p. | 0.30% | 0.40% | 0.42% | -0.15 p.p. |

**Notes:** I for the US are the GDI. The interest rate is the Effective Federal Funds Rate. Credit risk is the TED spread.

**Source:** Author's own calculations.

**Table 2** Selected Descriptive Statistics for the EA Covering the Period from 3Q2007 to 4Q2015

| Descriptive statistic | Variable | | | | | | |
|---|---|---|---|---|---|---|---|
| | ECB's total assets (millions of euros) | Perceived credit risk (%) | | GDP (millions of euros) | CPI index (2010 = 100) | Investments (millions of euros) | Interest rate (%) |
| | | a | b | | | | |
| Maximum | 3,087,115 | 1.18 | 1.46 | 2,662,589 | 107.80 | 562,646 | 5.25 |
| Minimum | 1,206,838 | 0.14 | 0.33 | 2,312,032 | 95.00 | 480,511 | 0.30 |
| Average | 2,140,173 | 0.46 | 0.99 | 2,456,901 | 102.76 | 508,007 | 1.90 |
| Median | 2,075,954 | 0.35 | 1.06 | 2,456,338 | 103.40 | 502,078 | 1.75 |
| Standard deviation | 479,039 | 0.28 | 0.38 | 90,857 | 4.04 | 23,192 | 1.47 |
| Coefficient of variation | 22.38% | 60.23% | 38.26% | 3.70% | 3.94% | 4.57% | 77.81% |
| Average quarterly change | 2.79% | -0.01 p.p. | -0.01 p.p. | 0.36% | 0.38% | -0.12% | -0.14 p.p. |

**Notes:** I for the EA are the GFCF. The interest rate is the Marginal Lending Facility. Credit risk is the difference between the 3-month Euro LIBOR and 3-month German yields (*a*) and a spread between MROs and EONIA (*b*).

**Source:** Author's own calculations.

The time series range from 3Q2007 to 4Q2015. According to the National Bureau of Economic Research, the starting date precedes the outbreak of the Great Recession in December 2007. The reason for this is that real GDP growth had decelerated considerably already in the third quarter of 2007. Exploiting the asset sides of central banks' balance sheets was not used as a policy tool before the Great Recession. Therefore, we incorporated only the period since the onset of the financial crisis, following Gambacorta, Hofmann, and Peersman (2014). The end date of 4Q 2015 allows to assess the results of QE during a typical length of a business cycle, that is from 1.5 to 8 years. Indeed, QE is expected to bring favorable outcomes for the real economy principally during the typical business cycle frequency.

# 5. Empirical Results

## 5.1 Basic Scenario: General Results and Real GDP Growth

Weale and Wieladek (2016) provided evidence of different quantitative easing (QE) transmission channels in the UK and the US. We found, in turn, differences between the US and the EA in respect of the effects of unconventional balance sheet policies and the stylized relations between real GDP growth, perceived credit risk, and timing and volume of reserves' creation. According to the estimated and stationary VARs, TED spread in the US Granger-caused and significantly impeded economic growth, possibly because lending crunched during financial instability. The Fed responded with reserves' creation, which significantly lowered the perceived credit risk. The reduced uncertainty seems to have created favorable conditions for the growth of the US economy (Tables 3-4, Figure 1A). In EA, a change of the "Ted spread" was followed by a change of reserves' creation in the same direction, but it was not sufficient to significantly affect the perception of the risk. Moreover, despite the ECB's QE Granger-caused real growth, the estimated coefficient had the opposite sign (Tables 3, 5). This implies considerable caution by the ECB in taking nonstandard steps and either underestimation of the required accommodation or assigning importance to goals other than direct stimulation of the economy.

**Table 3**  *F*-statistics and Their *p*-values in the US and the EA: 3Q2007-4Q2015

| Effect cause, all lags | ΔCR Perceived credit risk | ΔGDP Gross domestic product | ΔTA Central bank total assets |
|---|---|---|---|
| US, (VAR (1)) | | | |
| ΔCR | 0.52 [0.48] | **3.95 [0.06]** | 0.02 [0.89] |
| ΔGDP | 0.87 [0.36] | 0.12 [0.72] | 0.05 [0.82] |
| ΔTA | **8.00 [0.01]** | **3.40 [0.08]** | 0.15 [0.70] |
| EA, (VAR (1)) | | | |
| ΔCR | **3.05 [0.09]** | 0.05 [0.83] | **5.77 [0.02]** |
| ΔGDP | 0.002 [0.96] | 0.56 [0.46] | 0.04 [0.84] |
| ΔTA | 0.012 [0.91] | **3.25 [0.08]** | **8.99 [0.01]** |

**Notes:** *p*-values in square brackets. Credit risk for the EA is the difference between the 3-month Euro LIBOR and 3-month German yields. Credit risk for the US is the TED spread.

**Source:** Author's own calculations, done with the use of Gretl Software (v. 1.9.92).

**Table 4**  U.S. VAR (U.S. Model 1) and Diagnostic Tests: 3Q2007 to 4Q2015

| | $\Delta TA_{t-1}$ | $\Delta CR_{t-1}$ | $\Delta GDP_{t-1}$ | ΔCPI | Δl | Time |
|---|---|---|---|---|---|---|
| Equation (1) ΔTA | -0.10 (0.27) | -20553.6 (141495) | 0.13 (0.55) | **-159790 (57650)** | -0.21 (0.53) | -3990.7 (4745.2) |
| | R-squared: 0.36, Adjusted R-squared: 0.10, Durbin-Watson: 1.32, Ljung-Box Q' = 4.36 with *p*-value = 0.36 | | | | | |
| Equation (2) ΔCR | **-9.96733e-07 (3.52389e-07)** | 0.13 (0.18) | 6.67287e-07 (7.15407e-07) | **-0.20 (0.07)** | 5.26880e-07 (6.84487e-07) | -0.004 (0.006) |
| | R-squared: 0.62, Adjusted R-squared: 0.46, Durbin-Watson: 1.17, Ljung-Box Q' = 9.67 with *p*-value = 0.05 | | | | | |
| Equation (3) ΔGDP | **0.11 (0.06)** | -63938.1 (32152.3) | -0.04 (0.13) | **31462.6 (13100)** | **0.94 (0.12)** | **2324.34 (1078.27)** |
| | R-squared: 0.88, Adjusted R-squared: 0.84, Durbin-Watson: 2.03, Ljung-Box Q' = 1.82 with *p*-value = 0.77 | | | | | |

**Notes:** Standard errors in round brackets. Bold values indicate significance at 0.1. For the US: BIC indicated a one quarter lag, whereas AIC and HQC suggested an annual lag. In the case of the EA, BIC and HQC suggested a lag of order one,

although AIC indicated an annual lag. VAR(1) was chosen both in the EA and in the the US (the AIC criterion asymptotically overestimates the order with positive probability). The simulation with the annual lag has not changed the general conclusions. For better  statistical properties of the model, the investments for the US were Gross Domestic Investments. Additionally, a time trend variable and seasonal dummies were added, although models with GFCF (and without *time* and seasonal dummies) delivered broadly similar results.

As opposed to the EA, the response of real GDP to the reserves' creation by the Fed was significant and positive, with a peak effect after two quarters (Figure 2A), similar to the findings of Gambacorta, Hofmann, and Peersman (2014) (although the effect was later reversed partially to reach a plateau after three quarters). The Fed's QE explained approximately one third of the variance in real growth (Figure 5A). According to the US VAR (Table 4), the actual rise of investments by 42.3 billion USD significantly explained the growth of real GDP between 3Q2007 and 4Q2015 in 25.3% (in the EA, the real GDP growth was merely 1.7%) (according to Equation (5), Table 4), growth of investment $\Delta I$ by 1 USD increases real GDP by 0.94 USD (the estimate of the $\Delta I$ coefficient). Between 3Q2007 and 4Q2015, $\Delta I$ equalled 42.3 billion USD. Thus, investments increased real GDP by 39.8 billion USD = 42.3 billion × 0.94. The value of 39.8 billion USD constitutes, in turn 25.3% of the total real GDP growth between 3Q2007 and 4Q2015).

Analogously, in line with the estimated US VAR, the 25.3% growth in real GDP was associated with the direct effect of asset purchases. The direct rise of consumer inflation explained 27% of the real growth of the US, presumably because inflation helped calm down the markets and convince the market participants that deflation had been avoided. Five percent of the real GDP growth was explained by an upward time trend mimicking the vanishing impact of the crisis. The remaining real growth was delivered by uncertainty reduction. An expansion of the Fed's balance sheet by 3.5 trillion USD (till the end of 2014) was responsible for the cumulative fall of the perceived credit risk, by 3.61 p.p. (according to Equation (2), Table 4), growth of the Fed's asset purchases $\Delta TA$ by 1 million USD decreases the TED spread by -9.96733e-07 p.p. (the estimate of the $\Delta TA$ coefficient). Between 3Q2007 and 4Q2015, $\Delta TA$ equalled 3.5 trillion USD. Thus, asset purchases decreased the perceived credit risk by 3.61 p.p.). This increased the real GDP by more than 23 million USD, according to the US VAR (according to Equation (3), Table 4), a fall of the perceived credit risk $\Delta CR$ by 1 p.p. increases real GDP by 63938.1 million USD (the estimate of the absolute value of the $\Delta CR$ coefficient). The decrease of the TED spread by 3.61 p.p, increased real GDP by 23 million USD = 3.61*63938.1 million USD. The growth of the real GDP by 23 million USD constitutes, in turn 14.7% of the total real GDP growth between 3Q2007 and 4Q2015. This represents 14.7% of the real GDP growth. The remaining reduction in uncertainty was the result of rising consumer prices (Equation (2), Table 4). The reduced uncertainty due to the avoided threat of inflation explained the remaining 2.76% of the real GDP growth. In sum, the US QE explained almost 40% of the real GDP growth (which reflected a real GDP growth of 4.16 p.p. between 3Q2007 and 4Q2015). Assuming that the rise of CPI was the sole result of the asset purchases, QE would be responsible for as much as 6.96 p.p. of the real GDP growth.

**Table 5** EA VAR (EA Model 1) and Diagnostic Tests: 3Q2007-4Q2015

| | $\Delta TA_{t-1}$ | $\Delta CR_{t-1}$ | $\Delta GDP_{t-1}$ | $\Delta CPI$ | $\Delta I$ |
|---|---|---|---|---|---|
| Equation (1) $\Delta CR$ | -5.10956e-08 (2.72105e-07) | **-0.42** **(0.20)** | 2.49525e-08 (6.60699e-07) | 0.01 (0.11) | 9.06687e-06 (7.22291e-06) |
| | R-squared: 0.22, Adjusted R-squared: 0.07, Durbin-Watson: 1.91, Ljung-Box Q' = 2.78 with $p$-value = P(Chi-square(4) > 2.78) = 0.60 | | | | |
| Equation (2) $\Delta TA$ | **0.61** **(0.20)** | **392112** **(143474)** | -0.05 (0.48) | -58510.7 (81378.1) | 2.37 (5.21) |
| | R-squared: 0.33, Adjusted R-squared: 0.20, Durbin-Watson: 2.20, Ljung-Box Q'= 2.93 with $p$-value = P(Chi-square(4) > 2.93) = 0.57 | | | | |
| Equation (3) $\Delta GDP$ | **-0.09** **(0.05)** | 1286.87 (36702.7) | -0.09 (0.12) | 5991.05 (20817.6) | **9.06** **(1.33)** |
| | R-squared: 0.84, Adjusted R-squared: 0.81, Durbin-Watson: 1.51, Ljung-Box Q' = 4.78 with $p$-value = P(Chi-square(4) > 4.78) = 0.31 | | | | |

**Notes:** See notes under Table 4. The investement was the Gross Fixed Capital Formation.

Source: Author's own calculations, done with the use of Gretl Software (v. 1.9.92).

The Fed's aggressive decreases of nominal interest rates in the initial phase of the crisis could have also accelerated the recovery. To account for them, we referred to the original Taylor rule (TR) (Taylor 1993) used as a popular benchmark for the Fed's decisions (2). An alternative approach, namely, adding interest rates into endogenous variables of VARs, delivered unreliable results. The reason for this was the positive correlation between the changes of nominal interest rates and real GDP growth and a negative correlation between interest rates and the perceived credit risk at the advent of the crisis. The TR may be presented in the following form:

$$r = p + 0.5y + 0.5(CPI - 2) + 2. \tag{2}$$

The largest fall of the policy rate $r$ in the analyzed time span, the range: max($r$)-min($r$), amounted to 5% (between 3Q2007 and 3Q2011). All else being equal and assuming that the reversed TR was valid, the value of 5% represents an amount by which the Fed would have to cut the rates to close the 2.5% output gap. The fall of interest rates would have then explained the real GDP growth maximally by 24% (2.5% / 10.4%). Nevertheless, the risk of deflation presumably encouraged the Fed to cut the rates to close not only the output gap but also the inflation gap. In consequence, falling interest rates were to close the output gap by less than 2.5%. Ultimately, the real GDP growth associated with factors other than nominal rates cuts would be a minimum of 7.9% (instead of the original value of 10.4%). This means that, to account for the impact of falling policy rates on the real growth, the impact of QE on the real growth must be decreased. In consequence, QE translated into real GDP growth by between 3.16 p.p. and 5.29 p.p. (the latter result appears if we assume that inflation resulted solely from asset purchases) during 3Q2007 and 4Q2015.

Performing an analogous analysis for EA is pointless, as the estimates of the "balance sheet coefficient" had the "wrong" sign (Equation (3), Table 5). The "wrong sign" could be explained by the rise of central bank total assets in the EA until the fourth quarter of 2012, while the quarterly real GDP growth was relatively weak (0.15%), and by a subsequent, still not satisfactory, development of real output accompanied by a rapid fall of the ECB's total assets by almost one third until the second half of 2014. Our findings are in line with studies that show that unconventional policies of the ECB affected interest rates primarily and not lending (Creel, Hubert, and Viennot 2016) and that the stimulus was both insufficient and too late (Bibow 2015;

Rodríguez and Carrasco 2016), resulting in economic stagnation and destructive dis-inflation (Athanasios Orphanides 2014). Moreover, Anastassios A. Drakos and Geor-gios P. Kouretas (2015) found a structural break in the monetary policy of the ECB during the peak of the crisis and ascertained that the ECB did not follow the Taylor rule after the crisis.

## 5.2 Basic Scenario: Perceived Credit Risk

According to the US VAR (Table 4), taking into account the volume of the Fed's re-serves' creation till the end of 2009, asset purchases significantly and directly reduced the perceived credit risk by 1.32 p.p. (the quarterly peak: 2.45%) (according to Equa-tion (2), Table 4), growth of the Fed's asset purchases ΔTA by 1 million USD de-creases the perceived credit risk by -9.96733e-07 p.p. (the estimate of the ΔCR coeffi-cient). Between 3Q2007 and 4Q2009, ΔTA equalled 1.3 trillion USD. Thus, asset pur-chases decreased the perceived credit risk by 1.32 p.p. (1.3 trillion × 9.96733e-07). The remaining fall of the perceived credit risk, in line with the VAR, was explained by the rise of inflation. The successes of the Fed in avoiding deflation presumably reinforced favorable expectations about the incoming recovery. Ultimately, already in the second half of 2009, the perceived credit risk hit its pre-crisis levels.

The response of the Ted spread to an impulse in the Fed's balance sheet caused an instant drop of the perceived credit risk. It seems that market participants quickly discounted the news about the monetary policy accommodation and revised their un-certainty perception downward. The optimistic overreaction was captured by the sub-sequent rise of the TED spread in the second quarter, though by a smaller amount than the initial fall (Figure 2A). In sum, we showed that the unconventional policies of the US removed financial market dysfunction (Lenza, Pill, and Reichlin 2010) and ten-sions (John H. Rogers, Chiara Scotti, and Jonathan H. Wright 2014), which could have created favorable conditions for the growth of the US economy. The discovered mech-anism conformed surprisingly well to the Fed's official declarations to "put downward pressure on yields of a wide range of longer-term securities, support mortgage markets, and promote a stronger economic recovery" (Federal Reserve System 2017).

In the EA, the impulse in QE also created an instant fall of the "Ted spread". Nevertheless, within one-and-a-half years, the perception of the risk returned to its initial values. The effects of the ECB's unconventional actions were not durable (Fig-ures 3A-4A) and were insignificant (Table 5). This leaves us to choose between the unsatisfactory performance of the ECB's QE or the possibility that some other spread could be more appropriate to the EA. After all, Lenza, Pill, and Reichlin (2010) ascer-tained that the ECB's actions were sufficient to manage the money market tensions. To verify this, in the next section, we have estimated the EA VAR with the alternative MROs-EONIA spread. We have also carried out yet another robustness check; specif-ically, we have estimated VARs only for the periods when policy rates in the US and the EA were relatively close to their ZLBs.

## 5.3 Alternate EA Spread and the US/EA Time Span

As opposed to the "Ted spread" in the basic EA VAR (Tables 3, 5 and Figure 6A), the MROs-EONIA spread had a significant impact on output (Tables 6-7, Figure 7A). The cumulated impulse response of real GDP to an impulse in the spread translated into a fall of real GDP (Figure 4A). This result is in line with the evidence of Sushanta K. Mallick and Sousa (2013) for their financial stress measure.

The ECB responded to the growth of the MROs-EONIA spread with asset purchases (Tables 6-7). From October 2008, the bank implemented tender operations with fixed-rate full allotments to create conditions of excess liquidity, which widened the spread of MROs-EONIA, as the MRO rate moved towards the ECB's deposit facility rate (Kremer 2015). Nevertheless, in 2011, lower levels of outstanding LTROs were not accompanied by alternative non-standard measures. In this respect, wide spreads may have resulted from liquidity deficit (or insufficiently expansionary monetary policy) as it happened from mid-2004 to mid-2006 (Tobias Linzert and Sandra Schmidt 2011). No sooner than since late 2013 did the MROs-EONIA spread start shrinking due to the earlier repayment of long-term refinancing operations (LTROs) by commercial banks (Rodríguez and Carrasco 2016). This could explain why the response of real GDP growth to an asset side balance sheet impulse returned the real GDP growth to the equilibrium of nil growth but did not stimulate it any further (Figures 3A-4A). Our results are discrepant with those of Romanos Priftis and Lukas Vogel (2016), who found that the ECB's QE contributed significantly and directly to the growth of real GDP by approximately 0.3 percent until the end of 2016 (the EA's real GDP growth between 3Q2007 and 4Q2015 was 1.7%).

Alternate VARs estimated after interest rates in the US and the EA reached low levels (the US: since 1Q 2009, Tables 8-9; the EA: since 2Q 2009, Tables 10-11) confirmed the earlier results. In the US, QE stimulated real GDP with a one quarter lag, but the effect of the QE's impulse diminished after five quarters (Figure 8A). In the EA, the unconventional accommodation was not enough to decrease the spread, and the sign of the coefficient was opposite to that expected. The ECB's reserves' creation also had no significant impact on real growth (Figure 9A).

**Table 6**   F-statistics and Their *p*-values in the EA: 3Q2007-4Q2015 (Model 2)

| Effect cause, all lags | ΔCR^alt Perceived credit risk | ΔGDP Gross domestic product | ΔTA Central bank total assets |
|---|---|---|---|
| ΔCR^alt | 11.65 [0.0021] | 3.19 [0.09] | 6.96 [0.01] |
| ΔGDP | 3.03 [0.09] | 0.17 [0.69] | 2.04 [0.17] |
| ΔTA | 17.40 [0.0003] | 4.28 [0.05] | 5.63 [0.02] |

**Notes:** *p*-values in square brackets; BIC suggested a lag of order 1. AIC and HQ indicated a lag of order three. Alternative simulation with the lag of three quarters has not changed the basic conclusions. Δ*CR*^alt stands for the first difference of a spread between MROs and EONIA.

**Source:** Author's own calculations, done with the use of Gretl Software (v. 1.9.92).

**Table 7** EA VAR (Model 2) and Diagnostic Tests - Alternate Credit Risk Indicator: 3Q2007-4Q2015

| | $\Delta TA_{t-1}$ | $\Delta CR_{t-1}^{alt}$ | $\Delta GDP_{t-1}$ | $\Delta CPI$ | $\Delta I$ |
|---|---|---|---|---|---|
| Equation (1), $\Delta TA$ | **0.44** (0.18) | **399691 (151524)** | 0.85 (0.60) | -79256.2 (83587.3) | -2.22 (5.69) |
| | R-squared: 0.32, Adjusted R-squared: 0.19, Durbin-Watson: 1.99, Ljung-Box Q' = 3.20 with p-value = 0.52 | | | | |
| Equation (2), $\Delta CR^{alt}$ | **7.76259e-07 (1.86193e-07)** | **-0.52 (0.15)** | **-1.05604e-06 (6.06468e-07)** | 0.03 (0.08) | 2.86764e-06 (5.76569e-06) |
| | R-squared: 0.62, Adjusted R-squared: 0.55, Durbin-Watson: 1.88, Ljung-Box Q' = 4.58 with p-value = 0.33 | | | | |
| Equation (3), $\Delta GDP$ | **-0.09 (0.04)** | **64859.1 (36301.7)** | 0.06 (0.14) | -2490.88 (20025.6) | **8.10 (1.36)** |
| | R-squared: 0.86, Adjusted R-squared: 0.83, Durbin-Watson: 1.74, Ljung-Box Q' = 5.99 with p-value = 0.2 | | | | |

**Notes:** The investment was the gross fixed capital formation. See notes to Table 6.

**Source:** The author's own calculations, done with the use of Gretl Software (v. 1.9.92).

**Table 8** F-statistics and Their p-values in the US: 1Q2009-4Q2015 (Model 2)

| Effect cause, all lags | $\Delta TA$ Central bank total assets | $\Delta GDP$ Gross domestic product |
|---|---|---|
| $\Delta TA$ | **13.65 [0.0002]** | **4.01 [0.04]** |
| $\Delta GDP$ | 1.90 [0.18] | 2.04 [0.16] |

**Notes:** p-values in square brackets.

**Source:** Author's own calculations, done with the use of Gretl Software (v. 1.9.92).

**Table 9** The US VAR (Model 2) and Diagnostic Tests: 1Q2009-4Q2015

| Eq. coeff. | | Equation (1) $\Delta TA$ Central bank total assets | Equation (2), $\Delta GDP$ Gross domestic product |
|---|---|---|---|
| $\Delta TA_{t-l}$ | l =1 | **0.80 (0.18)** | **-0.26 (0.13)** |
| | l = 2 | -0.07 (0.18) | **0.37 (0.13)** |
| $\Delta GDP_{t-l}$ | l = 1 | -0.39 (0.26) | -0.35 (0.19) |
| | l = 2 | -0.39 (0.24) | -0.22 (0.17) |
| $\Delta CPI$ | | 34030.7 (35129.2) | -43031.0 (25453.6) |
| $\Delta I$ | | **-3.87 (2.03)** | **2.73 (1.47)** |
| Diag. tests | | R-squared: 0.67, Adjusted R-sq.: 0.56, Durbin-Watson: 2.14, Ljung-Box Q' = 0.71 with p-value = 0.95 | R-squared: 0.51, Adjusted R-sq.: 0.34, Durbin-Watson: 2.26, Ljung-Box Q' = 1.54 with p-value = 0.82 |

**Notes:** Standard errors in round brackets. l stands for lag operator. Bold values indicate significance at 0.1. AIC and HQC criteria pointed to a lag order of 2, whereas BIC pointed to a lag order of 1. Ted spread was eliminated from the VAR system, because, since 2009, it was under control and reached stable and low values. See notes to Table 7.

**Source:** Author's own calculations, done with the use of Gretl Software (v. 1.9.92).

**Table 10** F-statistics and Their p-values in EA: 2Q2009-4Q2015 (Model 3)

| Effect cause, all lags | $\Delta TA$ Central bank total assets | $\Delta CR^{alt}$ Perceived credit risk | $\Delta GDP$ Gross domestic product |
|---|---|---|---|
| $\Delta TA$ | **17.37 [0.0005]** | **6.53 [0.02]** | 2.02 [0.17] |
| $\Delta CR^{alt}$ | 0.29 [0.60] | 0.03 [0.86] | 0.41 [0.53] |
| $\Delta GDP$ | 0.02 [0.89] | 0.01 [0.91] | **5.53 [0.03]** |

**Notes:** p-values in square brackets. See notes to Table 6.

**Source:** The author's own calculations, done with the use of Gretl Software (v. 1.9.92).

**Table 11** The EA VAR (Model 3) and Diagnostic Tests: 2Q2009-4Q2015

| | $\Delta TA_{t-1}$ | $\Delta CR_{t-1}^{alt}$ | $\Delta GDP_{t-1}$ | $\Delta CPI$ | $\Delta I$ |
|---|---|---|---|---|---|
| Equation (1), $\Delta TA$ | **0.72** **(0.17)** | 110057 (204608) | −0.08 (0.60) | 27646.4 (34010.5) | 7.92 (4.98) |
| | R-squared: 0.61, Adjusted R-squared: 0.51, Durbin-Watson: 1.48, Ljung-Box Q' = 6.94 with *p*-value = 0.14 | | | | |
| Equation (2), $\Delta CR^{alt}$ | **4.68611e-07** **(1.83289e-07)** | -0.04 (0.22) | -7.19714e-08 (6.36458e-07) | -0.03 (0.04) | -1.68890e-06 (5.26790e-06) |
| | R-squared: 0.35, Adjusted R-squared: 0.18, Durbin-Watson: 2.24, Ljung-Box Q' = 5.73 with *p*-value = 0.22 | | | | |
| Equation (3), $\Delta GDP$ | -0.06 (0.04) | 29315.9 (45928) | **0.32** **(0.14)** | 12982.6 (7634.2) | **5.04** **(1.11)** |
| | R-squared: 0.76, Adjusted R-squared: 0.70, Durbin-Watson: 1.92, Ljung-Box Q' = 1.52 with *p*-value = 0.82 | | | | |

**Notes:** See, notes under Tables 7, 9. BIC pointed to a lag order of 1. A lag of order 2 (AIC and HQC criteria) has not altered the general conclusions, with even more unfavorable outcomes of EQ. QE stopped being the Granger cause of the spread of MROs-EONIA.

**Source:** Author's own calculations, done with the use of Gretl Software (v. 1.9.92).

## 6. Discussion

One may argue that the diversified financial market structures (Tobias Adrian and Hyun Song Shin 2009; Peersman 2011), the European sovereign debt crisis, the highly heterogeneous transmission of monetary policy over bank lending in the Eurozone (Roberto A. De Santis and Paolo Surico 2013), and the different levels of monetary policy stress between "core" and peripheral EA countries (Paweł Gajewski 2015) were responsible for the distinct performances of balance sheet policies in the US and the EA. We believe that a more reliable explanation is, however, the clearly contrasting goals of the Fed and the ECB. The ECB distributed liquidity unevenly depending on strain and financial stress, under the assumption that, in a bank-based financial system, the counter-party risk was greater than was the valuation risk. The Fed targeted asset prices and market-based inflation expectations instead and aimed to provide additional monetary stimulus (Philippine Cour-Thimann and Bernhard Winkler 2012). The inferior efficiency of the ECB's balance sheet policies in affecting the credit risk and real growth was captured by the estimated VARs.

Indeed, the US communication strategy was to change the public perception of the reaction function (Engen, Laubach, and Reifschneider 2015). Meanwhile, the ECB has never been interested in even its temporary suspension (Peter Praet 2013). This is apparent in the ECB's statements, such as in the one referring to the asset purchase program scheduled until the end of March 2017, when the Governing Council declared continuation of the purchases until "a sustained adjustment in the path of inflation that is consistent with its aim of achieving inflation rates below, but close to 2% over the medium-term". In consequence, the ECB used outright asset purchases in dysfunctional markets to improve their functioning (Lenza, Pill, and Reichlin 2010) and not to expand liquidity to prompt portfolio re-allocation in the private sector. Indeed, asset purchases under the SMP were offset by specific fine-tuning operations that absorbed liquidity (Giannone et al. 2011). The suspension of SMP sterilization was announced only in 2014. In line with that, the goal of outright asset purchases was not to stimulate the recovery but to safeguard the transmission mechanism (European Central Bank 2017). Therefore, Peersman (2011) perceives the ECB responses to the crisis as not fully "unconventional", whereas Giannone et al. (2011) regards the ECB expansion of

its balance sheet only as a by-product of a support directed at the crucial segments of the financial market to grease the transmission mechanism and to complement interest rate decisions, rather than to replace them (as opposed to the Fed). Ultimately, the ECB's statements and actions could be viewed as distinct from the expansionary approach, which was also reflected in the discrepant behavior of monetary aggregates in the US and the EA.

We interpret our results as showing that, the ECB, to achieve better macroeconomic outcomes in stimulating real GDP growth and reducing perceived credit risk, should abandon its current legal framework, at least temporarily. Instead of assigning primary importance to a price stability mandate, the ECB ought to focus more on maximizing employment while paying attention to the banking supervision and improving micro and macroprudential regulations at the same time. A more expansionary approach would presumably allow monetary authorities to avoid economic stagnation and could have prevented the fall in the ECB's total assets, whereas credit and money growth would possibly show a clear upward trend. After 2015, the ECB's policies became more expansionary, which seems to have brought more favorable macroeconomic outcomes (Stefan Hohberger, Priftis, and Vogel 2019). The clear expansionary approach could have also helped to better manage the agents' expectations, as communication is particularly effective during an unconventional monetary stimulus (Burlon, Notarpietro, and Pisani 2019).

## 7. Conclusions

This article has contributed to the still not well recognized influence of central banks' unconventional balance sheet policies on the economy. The novelty concerns the choice of two prominent central banks and following them in a completely different way. Vector autoregressions tailored for the exceptional times of financial stress, zero lower-bound on nominal interest rates, and unconventional reserves' creation provided new insights into the macroeconomic effects of unconventional balance sheet policies. We found that unconventional balance sheet policies in the US explained the growth of the real economy by between 3.2% and 5.3% during 3Q2007 and 4Q2015 and reduced considerably the already perceived credit risk until the end of 2009. Thus, we accepted the hypothesis that unconventional monetary policy may be efficient in stimulating the recovery and in alleviating the perceived credit risk. Despite that, in the EA, reserves' creation after the Great Recession did not translate into real economic growth until 2015. An impulse in asset purchases has only returned the real GDP growth to an equilibrium of nil growth. We argue that the plausible reason for the discrepant outcomes in the US and the EA is the clearly contrasting goals disclosed in the official declarations of both central banks. The declarations were mirrored surprisingly well in the interrelations between the scale of the unconventional interventions, real GDP growth, and interest spreads in both economies. While the Fed aimed to boost the recovery and reduce the spreads, the ECB kept to its existing monetary policy strategy and focused on improving the transmission mechanism. This suggests that, to achieve better macroeconomic outcomes in stimulating real GDP growth and reducing perceived credit risk, the ECB should, at least temporarily, abandon its current legal framework and increase the value of asset purchases. In sum, the impact of

unconventional balance sheet policies on the economy depended on quantities, the pace of purchases, and the intentions and willingness of a central bank to switch its strategy from one focused on inflation to a more expansionary one. The positive effects of the balance sheet policies (if present) were, however, temporary and lasted from one to six quarters. This leads to the basic conclusion that quantitative easing is not capable of stimulating long-run growth, but it may be used to buy time for the necessary adjustments when a boost of the real economy and a reduction of uncertainty are the main needs. The article has not accounted for the impact of forward guidance (Ryczkowski 2017), although most of the non-standard policy measures have led to expansion of the balance sheet. The article ignored possible nonlinearities in the dynamics of economic variables, which may be especially relevant during financial instability. Finally, the aggregated approach has not allowed us to study the detailed conditions of particular markets where unconventional interventions took place, and all the limitations of this study constitute an important area for future research.

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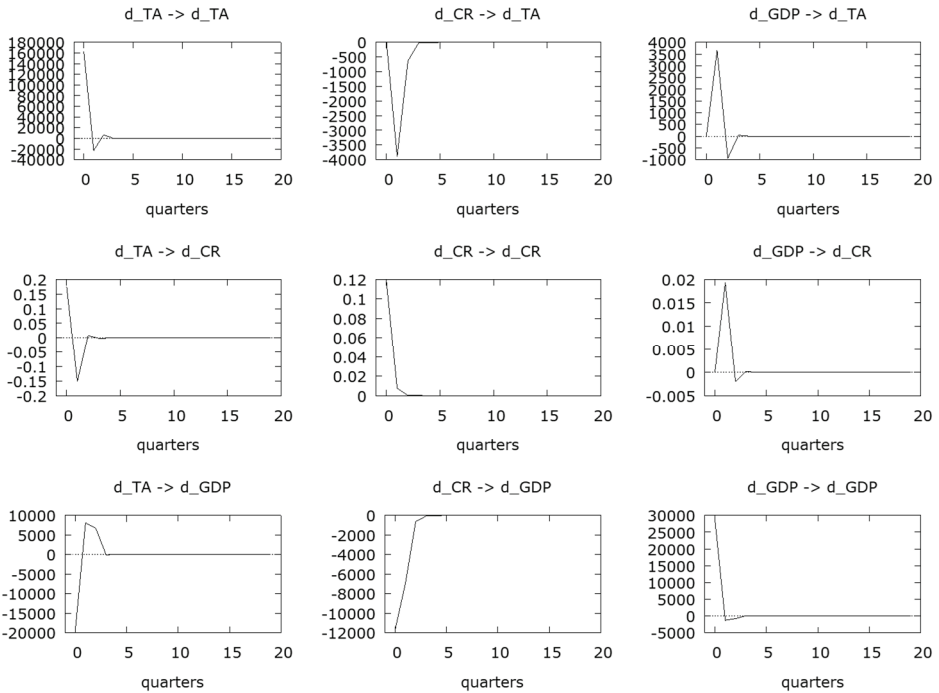
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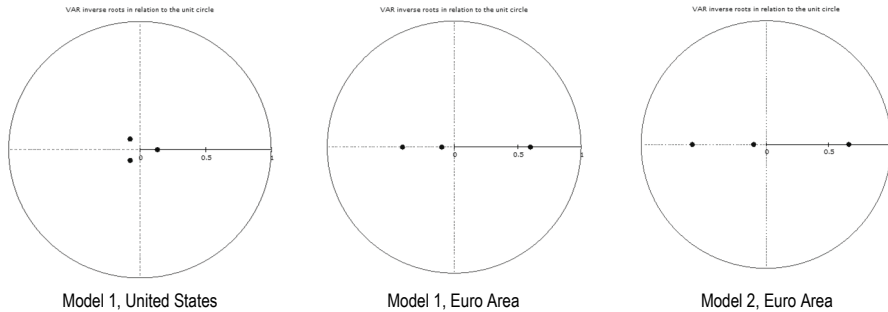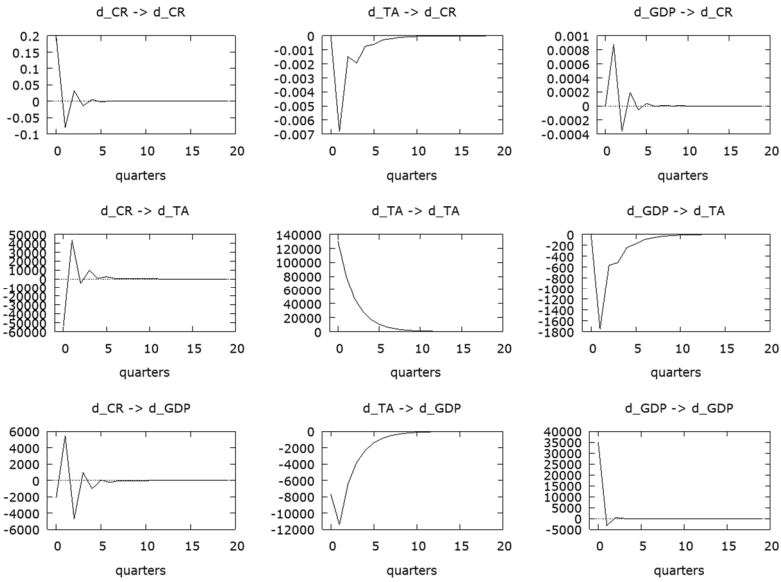
# Appendix



Model 1, United States        Model 1, Euro Area        Model 2, Euro Area

**Figure 1A** VAR Inverse Roots in Relation to the Unit Circle

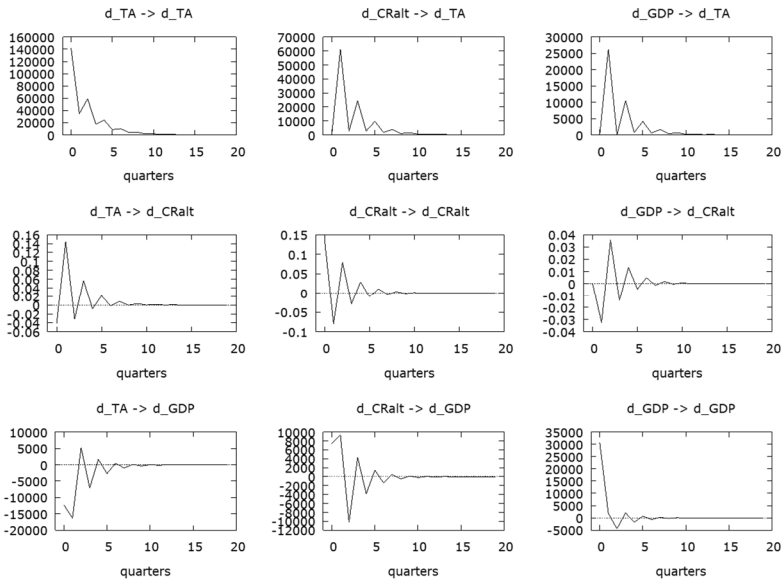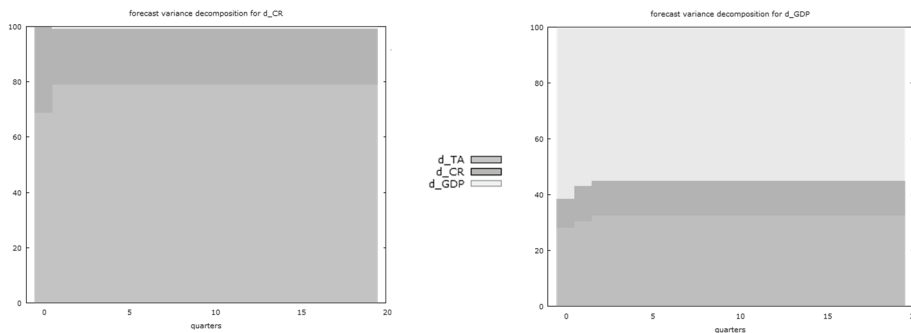**Figure 2A** Impulse Response Functions, Model 1 for the United States

**Source:** The author's own calculations, done with the use of Gretl Software (v. 1.9.92).

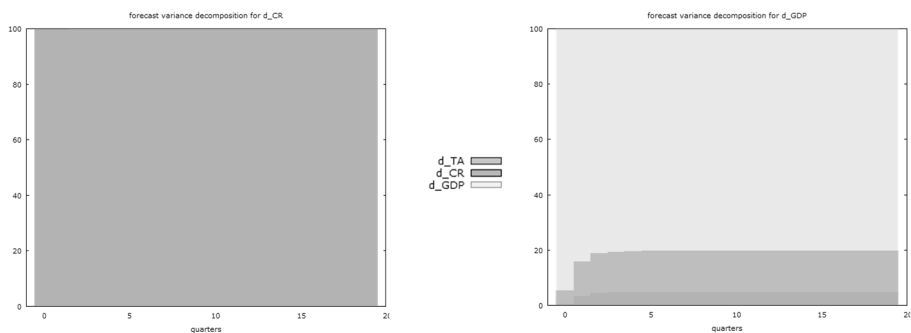**Figure 3A** Impulse Response Functions, Model 1 for the Euro Area



**Source:** The author's own calculations, done with the use of Gretl Software (v. 1.9.92).

**Figure 4A** Impulse Response Functions, Model 2 for the Euro Area
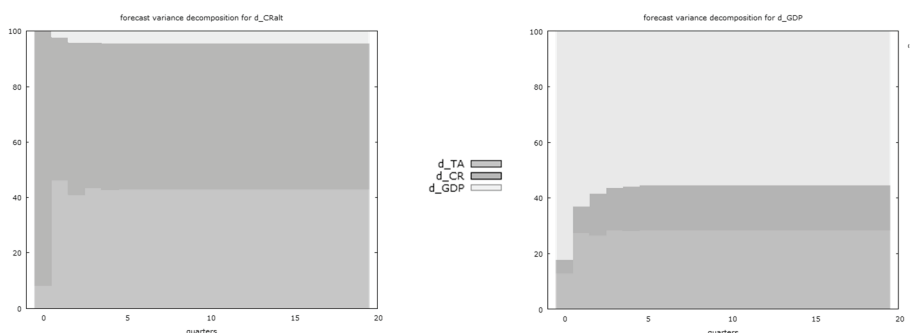
Source: The author's own calculations done, with the use of Gretl Software (v. 1.9.92).

**Figure 5A**    Forecast Variance Decomposition of the Ted Spread (a) and Real GDP Growth (b),
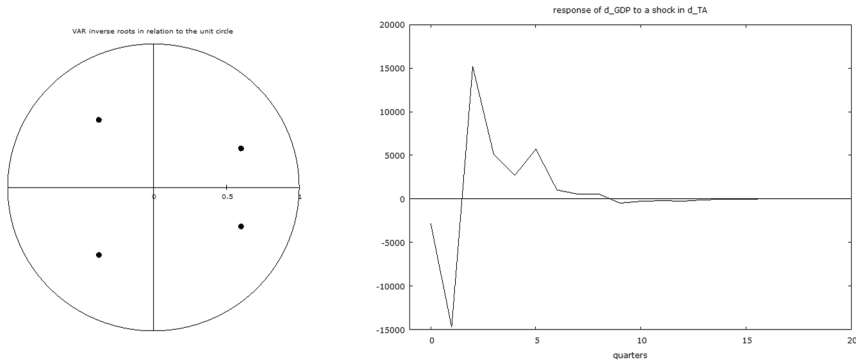Model 1 for the United States



Source: The author's own calculations, done with the use of Gretl Software (v. 1.9.92).

**Figure 6A**    Forecast Variance Decomposition of the "European Ted Spread" (a) and Real GDP
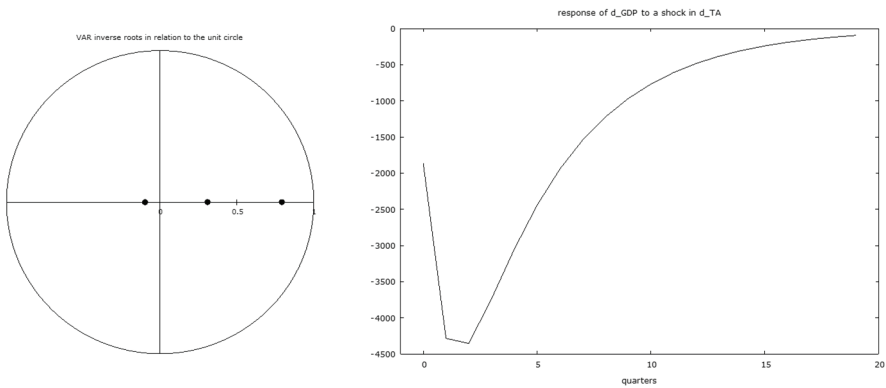Growth (b), Model 1 for the Euro Area



Source: The author's own calculations, done with the use of Gretl Software (v. 1.9.92).

**Figure 7A**    Forecast Variance Decomposition of the MROs-EONIA Spread (a) and Real GDP Growth
(b), Model 2 for the Euro Area

**Source:** The author's own calculations, done with the use of Gretl Software (v. 1.9.92).

**Figure 8A**  VAR Inverse Roots in Relation to the Unit Circle and Impulse Response Function of the Change of the Real GDP Growth to a Change in QE, Alternative Model (U.S. Model 2) for the United States: 1Q2009-4Q2015



**Source:** The author's own calculations, done with the use of Gretl Software (v. 1.9.92).

**Figure 9A**  VAR Inverse Roots in Relation to the Unit Circle and Impulse Response Function of the Change of the Real GDP Growth to a Change in QE, Alternative Model (EA Model 3) for the Euro Area: 2Q2009-4Q2015

**Table 1A**  KPSS and ADF Unit Root Tests for U.S. and EA since 3Q2007 to 4Q2015

| Symbol | KPSS test statistic (0.05 crit. value: 0.48) | KPSS test statistic including trend (0.05 crit. value: 0.15, 0.01 crit. value: 0.21) | ADF (test with const.), test statistic | ADF (test with const. and trend), test statistic |
|---|---|---|---|---|
| **U.S.** | | | | |
| $\Delta TA$ | 0.07 | 0.06 | -3.58 (.01) | -3.59 (.03) |
| $\Delta CR$ | 0.10 | 0.07 | -2.7 (.076) | -2.95 (.146) |
| $\Delta GDP$ | 0.40 | 0.08 | -3.45 (.02) | -4.09 (.02) |
| $\Delta CPI$ | 0.15 | 0.07 | -4.5 (.001) | -4.60 (.001) |
| $\Delta I$ | 0.46 | 0.12 | -2.46 (.13) | -2.92 (.17) |
| $\Delta GDI$ | 0.36 | 0.11 | -2.3 (.168) | -2.77 (.2) |
| **EA** | | | | |
| $\Delta TA$ | 0.10 | 0.06 | -3.01 (.03) | -3.34 (.059) |
| $\Delta CR$ | 0.09 | 0.07 | -7.29 (.00) | -7.18 (.00) |
| $\Delta CR^{alt}$ | 0.15 | 0.06 | -3.7 (.003) | -4.01 (.001) |
| $\Delta GDP$ | 0.20 | 0.05 | -1.08 (0.7) | -4.77 (.0004) |
| $\Delta CPI$ | 0.31 | 0.10 | -1.8 (0.36) | -3.90 (.01) |
| $\Delta I$ | 0.23 | 0.05 | -2.8 (.07) | -4.25 (.003) |

**Notes:** It was assumed that all the variables could be treated as stationary, as, for all them, at least one test (KPSS, ADF) indicated stationarity. ADF test asymptotic *p*-values are presented in round brackets, while the Akaike criterion was used to decide on the lag length. A lag of 8 quarters was selected and tested down from the maximum lag order.

**Source:** The author's own calculations, done with the use of Gretl Software (v. 1.9.92).

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