

The implementation of monetary policy in the Euroarea, United Kingdom and USA: Evidence from financial crisis period*

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Abstract

This paper examines the monetary policy implementation before during and after the financial crisis for USA, UK and selected Eurozone countries. The empirical approach we follow is the Vector Error Correction model based on time series approach which examines analytically the monetary policy transmission mechanism. According to our results, the Euroarea monetary authorities are more inflation targeted comparing to USA and UK in the application of monetary policy strategy. Also, the analysis showed relatively high degree of European bond market integration before the crisis outbreak. We imply a structural break on our analysis for crisis period to examine the effect of the global market turbulence on monetary policy implementation. As we observed, the financial crisis distorted significantly the transmission channel and revealed different responses by central banks. However, the expansionary monetary strategy based on the implementation of unconventional measures prevented from an extended output contraction. Finally, we use some key macroeconomic variables to perform a comparison between the countries set and the Germany. Our results were significantly different from benchmark VEC framework indicating the existence of heterogeneity in the countries sample. So, the monetary authorities have to continue the use of unconventional measures to absorb the crisis repercussions, avoiding the fiscal expansion which deteriorated the market turmoil and results in increased debt level for the Eurozone countries.

Keywords: monetary policy, central banks, VEC, financial crisis

JEL classifications: E52, E58

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Introduction

The aim of the paper is the analysis of the monetary policy and the evaluation of the monetary policy transmission mechanism before, during and after the financial crisis of 2007-2009. The objective is determined by the need to render the monetary policy more efficient concerning the financial markets and the real economy. The monetary authorities must have the sufficient information and influence in order to make optimal monetary policy choices and attained the desired effects on the macroeconomy. However, due to the structural differences, the effects of monetary policy decisions may vary across countries.

This paper attempts to investigate whether the monetary policy transmission channel has altered after the financial crisis, and the extent that the unconventional monetary policy measures affected the real economy and the financial markets. Furthermore, particular attention is given to the study of the impact of monetary policy decisions to country specific heterogeneity and the level of the global integration in response to monetary policy shocks. In more detail, the analysis of this paper is focused on the study of European Central Bank (ECB), the Bank of England and the Federal Reserve actions as monetary authorities. The countries that we analyze are USA (fed), UK (BoE), and Germany, France, and Italy (ECB).

The monetary authorities traditionally use the determination of the level of short term interest rate to implement their policies, as their key conventional tool. The fundamental model of the monetary policy decision making is the Taylor rule (1993). According to Taylor, the monetary authorities focus both on the inflation and output gap to determine the level of short term interest rate. However, the information about the economy may be imperfect and becomes available with a lag and this may distort the time consistency of monetary policy decisions.

For Euroarea, the primary objective of the ECB's monetary policy is to maintain price stability and it is followed by a restriction on inflation increase, close to 2%, over the medium term. For the USA. the Federal reserve (FED) sets the monetary policy in order to promote maximum employment, stable prices, and moderate long term interest rates, but without a specific numerical target for these factors. For UK, the Bank of England's core purpose is monetary stability explained by stable prices - low inflation - and confidence in the currency.

As we mention, our paper pays particular attention on analyzing the financial crisis period by treating it as a structural break for monetary policy. The financial market turmoil of 2007-2009 has led to the most severe financial crisis since the Great Depression and had already great repercussions on the real economy. This crisis changed the monetary policy decisions making in EMU, UK, USA and globally and the macroeconomic imbalances and the adverse developments in financial sector had a negative impact on real economic activity. At the onset of the financial crisis, the main indicators for economic outlook worsened and appearance of negative real interest rates was signaling that conventional monetary policy measures reached their limits.

So, as the conventional monetary policy tools proved insufficient, the monetary authorities turned to use unconventional instruments such as quantitative easing, credit easing and the influence of long term interest rates. The main goal of the unconventional tools was the liquidity injection and the stimulation of aggregate demand along with the influence of long term interest rates and money supply growth. However, the uncertainty which prevailed after the crisis, diminished the liquidity in financial markets leading in a global turmoil. Some, empirical estimates showed that the unconventional measures have generally helped to deal with the liquidity crisis, but not with the confidence crisis in the Euro Area's sovereign debt market (ECB 2012).

Our econometric strategy involves the analysis of a Vector Error Correction model on a time series specification framework that treat the selected variables as endogenous. The analysis is elaborated in three stages. The first stage includes the main empirical analysis

comprised of the benchmark VEC model, the second stage is focused on the effects on the monetary policy mechanism after the imposition of the financial crisis structural break, and the third stage refers to the study of basic macroeconomic variables differentials between the USA, UK, France and Italy with Germany.

Data and methodology

Our dataset is comprised of monthly monetary and macroeconomic variables for six countries. We separate the countries set with the criterion if they have independent monetary authorities. So, the one set includes United Kingdom, United States and Euroarea which we called them "big" countries, and the other set involves Germany, France and Italy, which we called them "small" countries. The dataset covers the period from January 1990 to August 2012. The basic sources for data were FRED (Federal Reserve Economic Database), ECB Statistical Data Warehouse, Bank of England, Banca di Italia, Banque de France, ECB, Federal Reserve, and Datastream, Bloomberg as databases.

The variables we used as proxies for the key monetary policy rates are, the EONIA for Euroarea, the Sonia for UK and the Effective Fed funds rate for USA. We apply also the yield spread as the difference between the ten year bond rate and the three month treasury bill, as we wish to study the effect of key rates to the bond rates for "big" countries. For "small" countries we use the yield spread as a proxy monetary policy instrument as the short term three month Treasury bill rate is closely related to Eonia. Additionally, we use the bank profit spread (the difference between the bank lending and deposit rates) as main market rates in order to study the transmission mechanism of monetary policy. The yield spread and bank profit spread are applied for UK, USA, Germany, France and Italy.

We use also the unemployment rate for all the set of countries and the exchange rates of dollar to one euro, pound to one euro and dollar to one pound to have a broader view for the results. The variables above are analyzed by their first differences. Furthermore, we include in our analysis the inflation rate and the industrial production in order to examine the impact of monetary policy to prices and output respectively. The inflation rate is computed as the logarithmic change of CPI (Consumer Prices Index), and the industrial production growth is defined by the logarithmic change in industrial production index.

Econometric Methodology

Our econometric strategy is based on time series analysis by applying unrestricted Vector Autoregressive model. Vector Autoregressive models were popularized in econometrics by Sims (1980) and Litterman and Weiss (1984) as a combination of univariate time series model and simultaneous equations models and they are used as they capture the linear interdependencies among multiple time series.

The VAR models are widely used due to some specific advantages they have. First, the researcher does not need to specify which variables are endogenous or exogenous, as they are all treated as endogenous. Second, the unrestricted VAR models examine the impact in variables from the innovations by other variables and study their behaviour. Third, the VAR model allows the value of a variable to depend on more than its own lags or combinations of the white noise term.

We choose the VAR model as it can better explain the monetary policy transmission mechanism, and we can apply shocks by impulse response function to investigate the effects of the variables innovations. Our model specification based on Peersman, Smets (2001) has the following representation:

$$Y_t = a + \sum_{i=1}^k b_i Y_{t-i} + \varepsilon_t \quad (1)$$

where Y_t 's are vectors of endogenous I(1) variables, a is a $p \times 1$ vector of constants, b , is a $p \times p$ matrix of parameters to be estimated, the ε represents an uncorrelated vector of disturbances, $p \times 1$, and k is the order for the vector of variables X .

The next step in our analysis is to examine if they are cointegrated, that is the existence of linear interdependencies among the variables used. If the variables are cointegrated then their relationship can be analyzed in the Vector Error Correction framework. To examine the cointegration we perform Johansen Cointegration test which yields two likelihood ratio statistics for the number of cointegrating vectors, the maximum eigenvalue and the trace statistics.

To apply this test, we have to transform the VAR model into VEC model, so the above VAR model becomes:

$$\Delta Y_t = a + \Pi Y_{t-1} + \sum_{i=1}^{k-1} \Pi_i \Delta Y_{t-i} + \varepsilon_t \quad (2)$$

where $\Pi = \sum_{i=1}^k b_i - I_g$, $\Pi_i = \left(\sum_{i=1}^k b_i \right) - I_g$, a is a vector of constants, ΔY are the vectors of endogenous variables and ε is a vector of shocks or innovations of the model and Π 's are $p \times p$ vectors of coefficients. Our analysis is based on Peersman, Smets (2001) work but it differentiates as our specification is based on VEC model as it better explains our results and takes account the cointegration in the sample variables. By applying the VEC analysis, we determine the order of the specific variables. Also, our framework includes additional variables such as unemployment rate and exchange rates in order to have a broader view of our results. Furthermore, our innovation in the analysis of VEC model is the financial crisis impact examination by applying dummy variables in the sample. Finally, as the ordering plays important role and may alter the results, we impose some different orderings in order to examine whether our results remains similar to our main analysis results.

Preliminary Statistics analysis

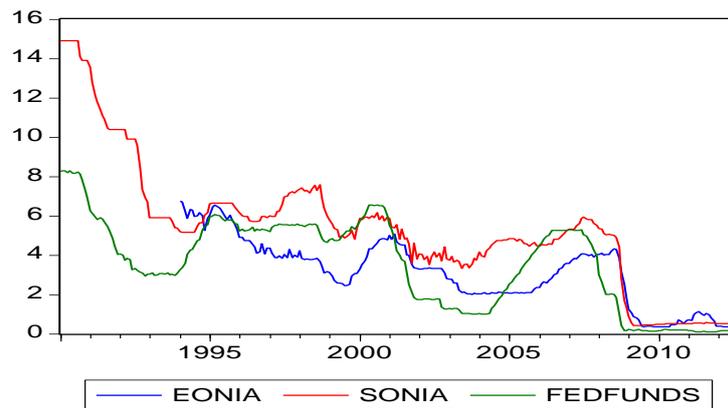
Key monetary policy rates

We start our analysis by the descriptive statistics investigation of key monetary policy rates. The results show that Sonia rate higher mean and maximum value which derived from the first observations after 1990. The lower rate value belongs to fed funds rate as the monetary authorities follow close to zero policy after the crisis. We observe that the Eonia variable is normally distributed as it is implied by the Jarque-Bera statistic. Contrary, the Sonia and fed funds rate variables are not normally distributed.

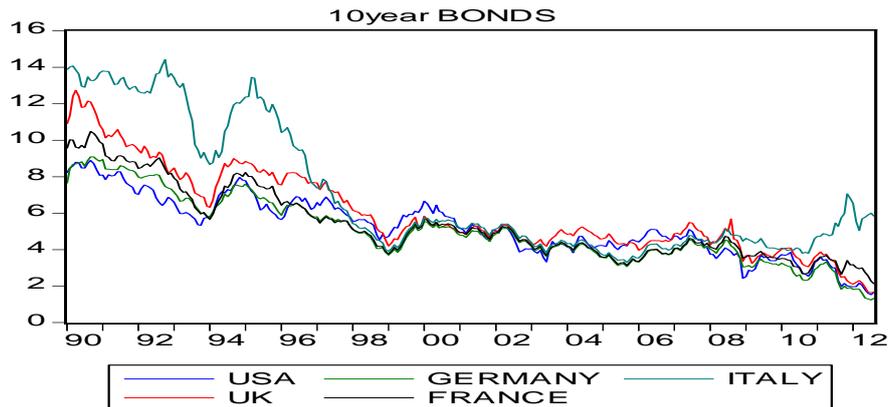
	EONIA	FEDFUNDS	SONIA
Mean	3.097397	3.559963	5.352246
Median	3.293150	3.990000	5.279050
Maximum	6.730000	8.290000	14.88000
Minimum	0.099300	0.070000	0.401300
Std. Dev.	1.692281	2.289252	3.277722
Skewness	0.008556	-0.116048	0.826252
Kurtosis	2.315361	1.914012	4.328639
Jarque-Bera	4.377557	13.97671	50.95527
Probability	0.112054	0.000923	0.000000
Observations	224	272	272

Graphs

The main monetary policy rates began at high levels at the early 1990s. After the outbreak of economic crisis at 2007, the interest rates dropped sharply in order to stimulate aggregate demand against the recession. As the key interest rates approached the zero point the conventional tools of monetary policy implementation proved insufficient (especially as the real interest rates became negative). As the graph indicate, the EONIA and Fedfunds rate are significantly low at late 2012, but the SONIA rate is slightly higher as we remarked higher inflation rate for UK in this period.



The ten year government bond rates followed a path similar to the 3 month Treasury bill rates and we remark that after the introduction of euro the yields of government bonds were very close mainly for euro area bill rates. However, after the outbreak of financial crisis, the yields of 10 year bonds started to diverge, as the market participants increased their demand for secure bonds from countries with good macroeconomic data. In parallel, they reduced their demand for unsecured bonds. As a result, the bond yield spreads between European countries increased significantly (mainly in Italy in our sample), due to the macroeconomic imbalances and the market turbulence.



The European monetary union created a single and unified bond market, where the risk measure was common among countries despite the idiosyncratic characteristics of each country. The financial crisis in 2007-2009 demonstrated the specific credit and liquidity risks for each country and the bond yield spreads increased significantly, but lower than the pre EMU period. Additionally, the common target for the price stability, lead to the similar inflation level for all Eurozone countries and as a result the long term interest rates for the Eurozone countries followed similar path. Also, the elimination of the exchange rate risk across countries and the convergence in fiscal policy targets has driven the overall bond market convergence. We also observe that the convergence in bond rates took place for Eurozone countries but also for USA and UK, indicating a wider convergence in financial markets and the common measures of the monetary policy implementation of the main central banks.

Basic Estimation Results (1990-2012 period)

The main analysis is based on the implementation of impulse response functions. Impulse response functions (IRFs) are shocks to a VAR/VEC system.

For big countries (independent monetary authorities), we take the key monetary policy rates as the main monetary policy instruments and we examine the impact of interest rate innovations to other variables. For the "small" countries, as they have not independent monetary instruments, we treat the yield spread as the monetary instrument in order to examine the impact in variables to the specific shocks, as the correlation between the 3month treasury rates and 10year bond rates with the Eonia rate is high.

We begin our analysis with the responses of key monetary policy rates in shocks from the other variables. The impact of unit volatility shock by inflation rate affects positively the key monetary policy rates, as the implementation of monetary policy is based on the Taylor rule. So, for the three "big" countries, the key rates react positively from an increase in inflation rate. The effects of the other variables on key rates depend on the country. The impact of industrial production on key rates is negative but relatively low for ECB, BoE, comparing to the inflation effect and we see that the monetary authorities strategy are more inflation targeted that output targeted. In case of FED the greater significance is given to the output level targeting.

As the impulse response functions suggests, in case of the "big" countries, the responses of bank profit spread to shocks from monetary policy rates are positive. As the transmission mechanism works, the increase in monetary policy rates leads to the increase in lending and deposit rates, but the increase is higher on lending rates and as a result the bank profit spread increases. In addition, the responses of bank profit spread to innovation from the inflation rate are positive, as the financial institutions do not wish the real lending rates to fall. However, for the "small" countries, the response of bank profit spread to inflation is positive only for Italy. The corresponding responses for Germany and France are negative.

As regards to the inflation rate, the impulse responses functions show, that for all the set of countries, a positive shock from industrial production leads to the increase in inflation rate. The fact that industries augment their production means that there is adequate demand by consumers which the industries aim to cover. This suggests inflationary pressures in the economy.

In case of industrial production growth, the impulse responses functions show that the responses of industrial production to inflation rate innovations are positive. The increase in price level (money supply) rises total output and widens the profit spread for businesses and as a result they increase their productivity. Our results confirms the Keynesian view at least in the short run, as the increase in money supply (M2) raises aggregate demand and has positive impact on output. As a result the neutrality of money (classical view) has negligible impact on our sample in the short run, as the prices fell to adjust immediately (sticky prices).

Despite the literature findings, the responses of industrial production to shocks from key monetary rates are positive for the three "big" countries. In addition for the "small" countries, the effect is similar, as the proxy monetary instrument, the yield spread has negative relation with output. We suppose, that firms suggest that a rise in interest rates gives signal for predicted economic overheating. The responses of unemployment rate to innovations from the industrial production are negative, as we expected. The increases in productivity lead to more job positions and the fall in unemployment rate. Furthermore, we have not find evidence of any trade off existence between inflation and unemployment rate (Philipps curve) as these variables behavior differentiates depending on the specific country.

Structural break: The financial crisis of 2007-2009

After applying the benchmark VEC model, we performed the structural stability Chow tests, in order to examine any instability issues in the estimation sample. According to the obtained results, we observed structural breaks at a selected benchmark year 2008, for all countries except France. Our procedure, was to re-estimate the model in order to study the impact of financial crisis on our framework. In this case we apply VAR model for the period 2008-2009 as the variables for this period are not cointegrated. The econometric strategy includes the analysis of VAR model and impulse responses functions with the addition of a dummy variable in vector of X's of the endogenous variables of the benchmark model, which indicate the crisis period. The crisis period is defined from January 2008 to December 2009, so

the dummy variable is zero before and after the period and one for this period.

The analysis we elaborate assert the effectiveness of monetary policy transmission mechanism and the effect on macroeconomic variables. The results demonstrated that the monetary policy transmission channel has changed during the financial crisis period. Especially, as we found, the financial crisis effect show the following findings: the key monetary policy rates in the applied period declined, and the yield spread for the euroarea countries (Germany, France, Italy) increased, as the short term rates reduces according to the movements of key policy rates. The bank profit spread also decreased as lending rates declined following the fall in key rates. As we expected the industrial production for all the set of countries reduces significantly and unemployment rate increased sharply (except for Germany). Finally, the inflation rate increased for all countries despite the fall in consumption, as the central banks increased the money supply to stimulate the economy.

By applying the VAR analysis we found responses of the variables that are opposite to the main empirical VEC findings. More specifically, for USA, the increase in fed funds rate lead to industrial production decline and rise in unemployment rate contrary to the main findings. The increase in inflation is followed by increase by fed funds rate and yield spread decline. Also, the increase in unemployment rate increases the fed funds rate. For Euroarea, the increase in Eonia rate is followed by decline in industrial production. Also, the rise in inflation rate leads to eonia decline and unemployment increase. In case of UK, the increase in Sonia rate augments the inflation rate, and contrary the increase in inflation rate leads to Sonia rate decrease.

In case of the Eurozone countries, in Germany, the increase in yield spread is followed by the increase in unemployment rate, but the unemployment rate increase has negative impact on yield spread. The increase in industrial production leads to inflation rate decline, and the rise in bank profit spread is followed by inflation rate increase. For Italy, we found that increase in inflation rate leads to unemployment decrease. Also, the industrial production increase is followed by inflation decline and upward movement for unemployment rate. In case of France, despite the fact that Chow tests did not imply a structural change, the application of VAR for this period resulted in some different findings compared to VEC. The increase in industrial production is followed by decline in inflation rate, and the rise in unemployment rate leads to increase in industrial production and inflation, contrary to the main empirical findings.

The implementation of non-standard measures by central banks

We treat as an additional issue the effect of unconventional measures that arose by central banks during and after the financial crisis period. Our specification includes the selection of representative measures from central banks' balance sheets and examine their effect on economy. After the financial crisis, the conventional monetary policy tools proved insufficient and the central banks increased their balance sheets (more than double) in order to implement the quantitative easing policy against financial turmoil. The non-standard

measures we used cover significant part of the central banks' balance sheet concerning their magnitude in order to have representative results concerning the central banks' actions during the crisis. We select ratios between tools and total assets to examine the magnitude of their effects.

For USA we choose the U.S. Treasury securities ratio which consist of the treasury notes held by FED to total assets. After the financial crisis outbreak the FED increased the number of securities held in order to reduce the term premia of long term interest rates. Additionally, its actions targeted to promote a stronger pace of economic recovery along with inflation control. In case of UK, we choose the ratio of total reserves to total assets. After the crisis, the BoE reserves increased significantly as they were used for funding the key unconventional strategy, the Asset Purchase Facility program implemented by monetary authorities to economic recovery and credit easing. In Euroarea we select as representative measure the ratio of securities held by ECB to total assets. The securities held by ECB rose sharply after the crisis outbreak as part of the Securities Market Programme (SMP) implemented by monetary authorities. Its objective was to restore the transmission mechanism and to provide liquidity in public and private debt securities market.

Our econometric procedure involves the application of a VAR model, against benchmark VEC, as we observed no cointegration in the sample.

For USA, the IRFs show that the increase in treasury purchases ratio in FED balance sheet lead to increase in industrial production as the quantitative easing helped the output recovery. In addition, the results show that the increase in securities ratio reduced unemployment rate. Furthermore, the results show decline in yield spread as the FED implemented operation twist strategy which was followed by reduce in long term bond rates. Also, the implementation of non standard measures lead to inflation increase and to bank profits increase as the risk premia on lending rates increased.

For UK, the imposition of unconventional measures lead to industrial production increase but temporarily, as afterwards the industrial production falls (after two periods). The results show also an increase in unemployment rate as the measure failed to promote employment. In addition, we observed inflation decline along with bank profit spread decline.

For Euroarea, the implementation of non standard measures lead to decline in inflation and industrial production, but after three periods both of them increase, indicating that the unconventional measures worked to a point. Also, the results show a temporary rise in unemployment rate but after three periods the unemployment falls and converges to zero. In case of Germany, the implementation of non standard tools were followed by increase in inflation, fall in industrial production and temporary fall in unemployment rate. The bank profit spread declined as the lending rates adjusted to the short term rates decline. For France, the unconventional measures lead to inflation and unemployment increase, fall in industrial production but increase in bank profit spread. For Italy, the effect of non standard tools were followed by increase in bank profit spread, in inflation rate and unemployment and fall in industrial production.

The result show that in USA the implementation of unconventional measures helped at industrial production increase and the reduction of unemployment rate, indicating that contributed to the economic recovery. Also, the long term rates declined giving the signal of expansionary future monetary policy. Contrary, in UK and Euroarea the non standard tools boosted the industrial production but temporary. Also, the unemployment rate in UK, Euroarea and in specific countries increased. As the result show the industrial activity in Germany, France and Italy reduced significantly.

The result also show that for all the countries the implementation of unconventional measures lead in inflation increase, as the money supply increased. The monetary authorities targeted to inflation sustainability with the control in price level (despite the recession) against the negative effect of a possible deflation, which would further reduce consumption and investments. Furthermore, the unconventional effect show a generally increase in bank profit spread, i.e. the rise in lending rates. The increase in money supply fail to lower the lending rates as the term risk premia augmented (Germany, UK are exceptions). This result indicated a shrink in credit growth dynamic, which implied fail in stimulating aggregate demand. So, the unconventional strategies did not manage to promote consumption and investments.

In general, the implementation of non-standard measures improved the economic conditions in countries. The effect is greater in USA where the stimulation packages were massive and their magnitude more significant. Contrary, in UK and Euroarea, the unconventional measures improved the economic activity however, their effect was relatively temporary. This fact is explained as the Bank of England quantitative easing was based mainly on asset purchases and the magnitude on real economy was limited. The European Central Bank was implemented a wide range of unconventional measures that helped partly the economic conditions, but, its actions were quickly sterilized after their implementation.

Conclusion

We have specified and estimated the monetary policy transmission mechanism before and after the financial crisis of 2007-2009, based on a VEC model with macroeconomic and financial variables. We perform three stages VEC analysis, where initially we used the benchmark VEC model in order to specify the conduction of monetary policy by central banks. Secondly, we introduce the financial crisis effect on our model to examine the behavior of the central banks, and thirdly we elaborate an alternative VEC by adding variables differentials. By applying these strategies, we showed that the monetary policy transmission mechanism has changed and remains dysfunctional for the period after the financial crisis. As a result, the conventional monetary policy instruments become ineffective.

For example, a monetary expansion with the decrease in key nominal interest rate, has limited effect especially for countries in periphery (Italy), as the results show that bank and bond rates have relatively low correlation with Eonia. So, the central bank authorities have to preserve the unconventional monetary policy tools or expand them with increased money supply to boost the anemic economic growth. By analyzing the impulse responses, we also confirmed the assumption that ECB strategy is mainly inflation targeted rather

than output targeted. Contrary, the FED aims more to output growth and less to inflation. The bank of England has moderate impact both for inflation and output, with somewhat slightly higher reflexes on inflation innovations.

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