PhD Project

UNCONVENTIONAL MONETARY POLICY AND HETEROGENEITY OF MONETARY TRANSMISSION

ABSTRACT

In response to global financial crisis and following the collapse of the Lehman Brothers, banks around the world started to pile up liquidity buffers and tightening up lending conditions, essentially causing the credit crunch. In response to that, the ECB reduced its refinancing rate by 375 basis points in the first year of crisis, reaching the historical low of 1 % by May 2009. Hence, in last four years, the ECB have run out of maneuver space in additional lowering of its main refinancing rate and had to resort to nonstandard measures. In this paper I summarize the stance of ECB monetary policy at the near zero lower bound by calculating the "shadow interest rate" in Krippner Affine Nelson Siegel Model (K-ANSM) framework. The K-ANSTM represents a class of Zero-Lower-Bound Gauss Affine Term Structure models. Next, the Eurosystem shadow rate is connected to the macroeconomic variables in Factor Augmented Vector-Autoregression Model (FAVAR) in order to quantify how effective have the nonstandard measures been in affecting the real economy. In addition to that, shadow rates for sample of individual EMU countries are estimated in order to estimate how effective has the ECB's policy been in providing liquidity to all EMU members. Primary results point at uneven monetary policy distribution across EMU periphery and core countries.

TOPIC OVERVIEW AND RESEARCH QUESTIONS

In response to global financial crisis and following the collapse of the Lehman Brothers, banks around the world started to pile up liquidity buffers and tightening up lending conditions, essentially causing the credit crunch. In bank based economies, such as the EU, this lead to alarming situation with potential historical disruptive consequences. Central banks throughout the world reacted upon this crisis by loosening monetary policy and pumping liquidity into banking and financial sector (Cour-Thimann & Winkler, 2013).

At first central banks resorted to their usual monetary policy instrument of interest rate (the Fed funding rate, ECB's overnight interbank rate EONIA, Libor, and others). In the first year of the crisis ECB already reduced its refinancing rate by 375 basis points, reaching the historical low of 1 % by May 2009. Similarly, the FED rapidly reduced the fund rate to historically low levels, eventually hitting the 0.25 % zero lower bound. Hence, in last four years, the central banks have complemented or better said substituted their interest rate instruments with unconventional policy measures (Peersman, 2013) (Cour-Thimann & Winkler, 2013).

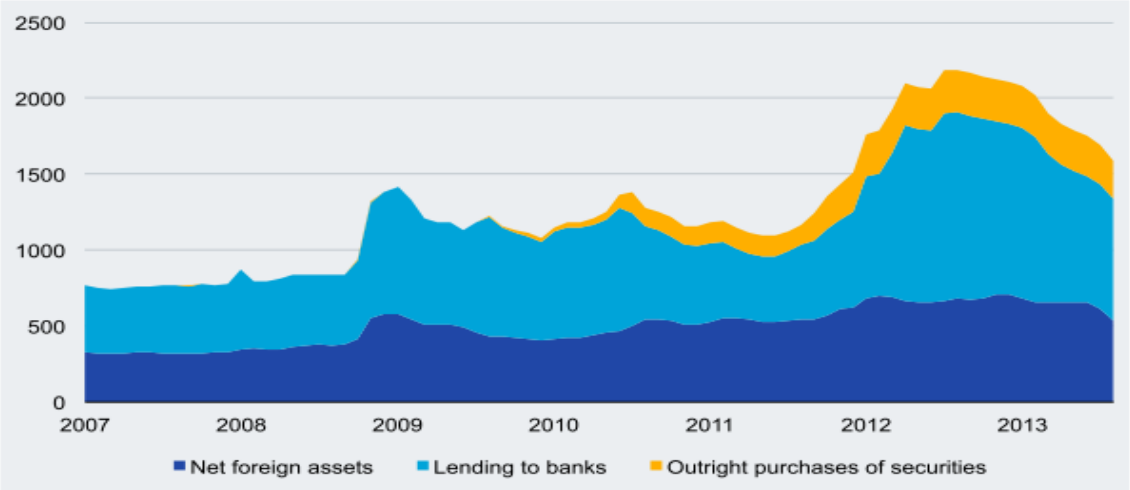
The unconventional measures undertaken, in order to complement the interest rate policies, have essentially differed among the central banks in accordance to nature and specificities of financing in particular economy. Thus, since Eurosystem consists of predominantly bank-based economies, the unconventional policies undertaken by ECB have been to a lesser extent oriented towards large asset purchasing programs compared to the FED's non-standard measures, where US financing structure is in essence capital based (Bauer & Rudebusch, 2014) (Curdia & Woodford, 2010).

When describing the non-standard monetary policy measures undertaken by ECB, one has to consider two channels in which the crisis in EU developed. The first set of unconventional measures has been developed to address the liquidity issues and credit crunch following the Lehman collapse. The second set were developed to attack the sovereign debt crisis of some EU countries which caused the depreciation of some sovereign bonds prices (and thus weakened banks' balance sheet and depressed value of collateral in Repo markets) and pressure on rising yields and interest rates in those countries. The first set of measures encompassed the unlimited access to central bank liquidity, extension of longer term refinancing operation maturity (LTRO), extension of collateral eligibility, reduction in reserve ratio and covered bonds purchase program (CBPP). In order to deal with the sovereign debt crisis and to revitalize the government bond market the ECB established the Securities Markets Programme (SMP) which allowed among others government bonds purchases on the secondary market (End, Tabbae, Frost, & Haan, 2013).

Although CBPP and SMP brought considerable amount of liquidity into system, it is clear that the asset purchases played less important role as they did in case of FED's or BoE's

unconventional policy measures. All measures together amounted for more than €1.5 trillion additional freed liquidity in the system. The unconventional policies undertaken by ECB could probably be best reflected in the evolution of the ECB's balance sheet depicted in the Figure 1 below (Peersman, 2013):

Figure 1: Evolution of ECB's balance sheet



Source: Peersman 2013, adapted from ECB

This recent development naturally raises three research questions around which the doctoral research will be constructed:

1. **How effective have the ECB's unconventional policy measures been in affecting the real macroeconomic variables?**

Recent research by Wu & Xia (2013) showed that Fed's effort to stimulate economy by non-standard measures effectively reduced the unemployment rate by 0.23 % relative to the case where those measures would not take place. Considering that Euro system unconventional policies have differed, can we say that ECB measures were just as effective as Fed's were? Some research, i.e. Peersman (2011), claim that ECB unconventional policies can in fact stimulate economy, however none of the research investigating the Eurosystem, to my knowledge, have quantified the shadow rate equivalent of those measures in order to see how far has the ECB actually gone in conducting this loose monetary policy and how has it affect the real economy.

2. **How effective was the ECB in monetary policy transmission and in channeling induced liquidity to individual member states?**

The crisis period revealed the asymmetric distribution of monetary policy actions across Euro area member states. Namely, it was quite easy to observe, even for the laic audience, the fragmentation and uneven financial redistribution among individual countries, scarce liquidity in the periphery (i.e. Italy and Spain) and the financial and capital abundance in countries relatively less affected by the crisis, i.e. Germany (End, Tabbae, Frost, & Haan, 2013). This is clearly pointing towards the so called "flight-to-quality" phenomena, indicating that the excessive liquidity was likely to be invested in the safest possible investment instrument,

moving the capital and liquidity away from already most distressed countries. Therefore, this brings the motivation to conduct a research with purpose of investigating and quantifying the hypothetical instantaneous spot rates (rates that would be in place had countries still had their own sovereign monetary policy) for some of the countries of Euro area periphery in order to properly assess the ECB monetary policy transmission during the crisis (Bernanke, Getler, & Glichrist, 1996).

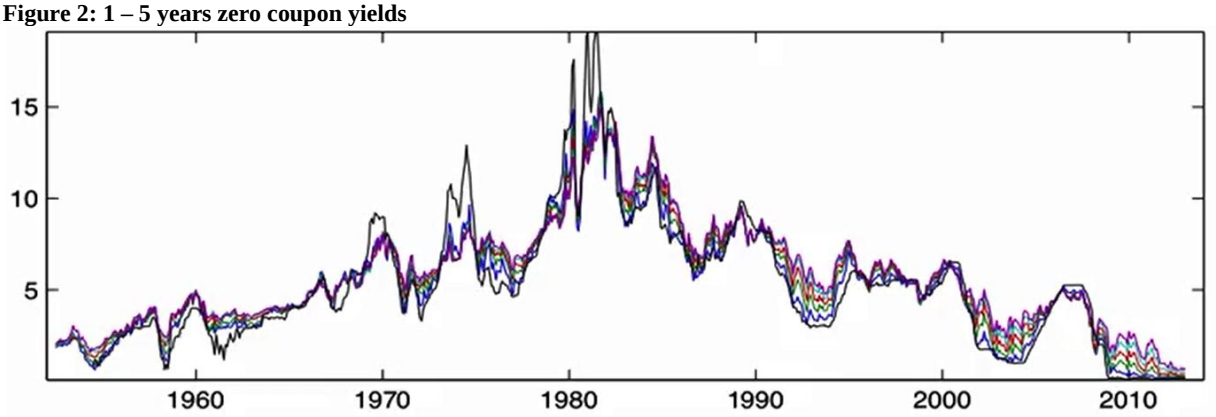
3. **Did single currency reduce incentive of individual member countries to properly address the crisis? Did individual Euro area member countries do their homework to help steer the monetary policy and liquidity channels?**

At the same time as different measures were introduced, ECB policy makers warned the national members that policies would fail to work without a proper assistance of the national governments and by that urging them to perform the necessary fiscal and macroeconomic adjustments to support the financial stability. It turned out that many countries did not use this time efficiently. Therefore, it would be the obvious path for this doctoral research to derive a deeper insight into individual responsibility of member countries by linking hypothetical spot rates of particular countries with their own measures taken to cope with the crisis and see the overall effect on the financial stability (Cour-Thimann & Winkler, 2013).

METHODOLOGY AND DATA

Probably the best point to start simultaneously analyzing the monetary policy in relation to the real economic activity is by observing the dynamics of the particular yield curve or term structure of the interest rate (Piazzesi & Cochrane, Decomposing the Yield Curve, 2008). We know that by the expectation hypothesis normal yield curves are increasing, meaning that the long term interest rates are just the expected future short rates. Thus, the inverted yield curve is a good predictor of the upcoming recessionary periods as short rates are expected to fall in the near future (reflecting the lower expected yields of investors in the future). Observing multiple interest rates time series at different maturity we can see that dynamics of interest rates is not a consequence of a random movement, but they move up and down together during the business cycles, indicating a strong factor structure (Cochrane, 2005).

Figure 2: 1 – 5 years zero coupon yields



Source: Cochrane, 2013

A natural way to start would be to represent the yields and prices statistically usually by conducting a factor analysis where theory suggests the three factor (level, slope and curvature) representation. However, the issue with basic statistical methods is that they are not complied with no-arbitrage condition and thus prevent the economic understanding of yields or prices (Cochrane, 2005). Therefore, yields must be represented analytically, which is usually done with the use of Affine Term Structure Models (ATSM), which relates zero coupon bond prices to the short term spot rate model (Bolder, 2001):

$$P(N,r) = e^{A(N)+B(N)r},$$

where zero coupon price is a function of maturity N and state variable r. A(N) and B(N) are obtained by solving the stochastic differential equation problem and are functions of parameters dependent on time to maturity. The best way to estimate parameters is to use Kalman filtering estimation method. This method is particularly useful, since it allows recovering predicted values for latent state variables (Pichler, 2007). We can specify a state variable process as the Cox-Ingerssol interest rate diffusion process of the following form (Duan & Simonato, 1999):

$$dr = u_r(\cdot) + \sigma_r\sqrt{r}\, dz$$

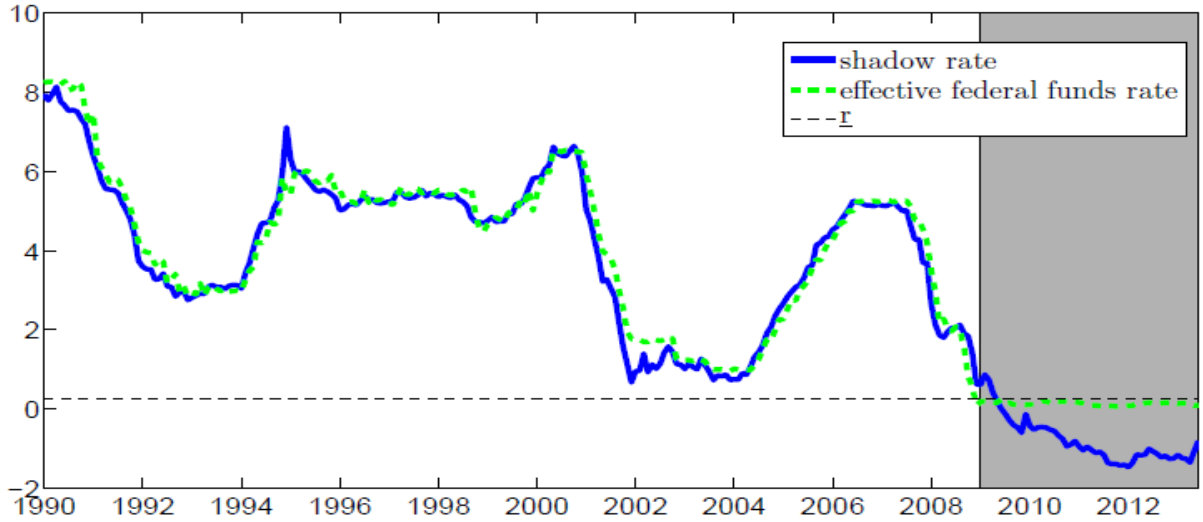
where $u_r(\cdot)$ represents a non-stochastic drift term, $\sigma_r dz$ represents a variance diffusion term which includes a Brownian motion *dz* term and a square root term which prevents negative short rates. What I have just described above is the most basic one factor term structure model which represents the basic idea of summarizing information contained in zero coupon bond yields in order to get a picture about the stance of monetary policy of country or area to which the bond yields refer to. Based on this idea, more elaborate, multifactor models can be built in order to better capture the stance of the monetary policy and its dynamics and transmission at the zero lower bound. Specifically, in my dissertation, I am going to base my calculations on the most recent K-GATSM (Krippner Gauss Affine Term Structure Models) and K-AFNSM (Krippner Affine Nelson-Siegel Model), developed by Leo Krippner (Krippner, 2013d; Krippner, 2014). In both types of models interest rates are going to be defined in the framework proposed by Black (1995). The black framework decomposes interest rates into the so called "**shadow short rate**", which is free to evolve with negative and positive values, and physical currency which is considered as an option against negative interests and ensures:

$$r_t^B = s_t + \max(-s_t, 0)$$

where r_t^B denotes Black short rate, s_t is a shadow rate at time t, and $\max(-s_t, 0)$ represents an option of holding physical currency against negative interests. In essence, when positive, the shadow rate equals the actual short rate, but it is free to evolve to negative values when actual short rate is truncated by the zero lower bound and disregards the existence of the physical currency. In example, when shadow rate is – 5 %, we can intuitively imagine the decomposition of Black yield curve with associated option effect as $\max(-s_t, 0) = \max(-(-5\,\%), 0) = 5\,\%$ and corresponding actual short rate $r_t^B = -5\% + 5\% = 0\%$

(Krippner, A tractable framework for zero lower bound Gaussian term structure models, 2013).
In the Figure 3 we can observe the shadow rate estimates for US (produced by Wu & Xia, 2013) and effective Federal Funds Rate:

Figure 3: US shadow rate and effective federal funds rate



Source: Wu & Xia, 2013

For the purpose of investigating my first research question, the obtained shadow short rate for the ECB are going to be linked to real macro variables via the Factor augmented vector autoregression FAVAR, as proposed by Bernanke, Boivin, & Eliasz (2005) or most recently by Wu & Xia (2013). The factors will be extracted from the panel of more than 30 macroeconomic variables for the EMU. The effectiveness of unconventional ECB monetary policy will be observed through standard impulse response procedure. The model can be represented as:

$$\begin{bmatrix} x_t^m \\ s_t \end{bmatrix} = \begin{bmatrix} a_x \\ a_s \end{bmatrix} + \rho \begin{bmatrix} x_{t-1}^m \\ s_{t-1} \end{bmatrix} + \Sigma \begin{bmatrix} \varepsilon_t^m \\ \varepsilon_t^{MP} \end{bmatrix}, \begin{bmatrix} \varepsilon_t^m \\ \varepsilon_t^{MP} \end{bmatrix} \backsim N(0, I),$$

where x_t^m is a vector of macro factor variables, a_x and a_s intercepts, ρ is the autoregressive coefficient, Σ is the cholesky decomposition of the covariance matrix, and ε_t^{MP} is the monetary policy shock through which the unconventional policies are examined and potentially compared to the standard policy measures.

For the purpose of investigating how unevenly has the monetary policy been distributed among Eurosystem, country-specific shadow rates have to be calculated. In this setting, individual country shadow rates has to be interpreted as hypothetical spot rate, which would be imposed by individual central bank in case it still had its own monetary policy. The obvious step forward then is to analyze in detail shadow rate spreads among sample of "peripheral" countries (countries that endured sovereign debt crisis i.e. Italy and Spain) and control countries (Germany and France). At last the individual member countries' short rates (r_t^H, where t is the time subscript, and H stands for the hypothetical spot rate for individual country) will be linked to the following variables based on quarterly data: non-performing

loans - NPL (indicating effects of short rates on financial stability and vice-versa), public deficit – PDF (indicating government ability to make fiscal adjustments and its relation to drawing liquidity) and GDP data to control for macro environment. By doing this I want to assess direct impact of the increased bond yields on the financial system, and how have specific country's non-complience with excessive debt procedure influenced its monetary stance. The model takes the Vector Autoregressive (VAR) representation of the following form (Lütkepohl & Krätzig, 2004):

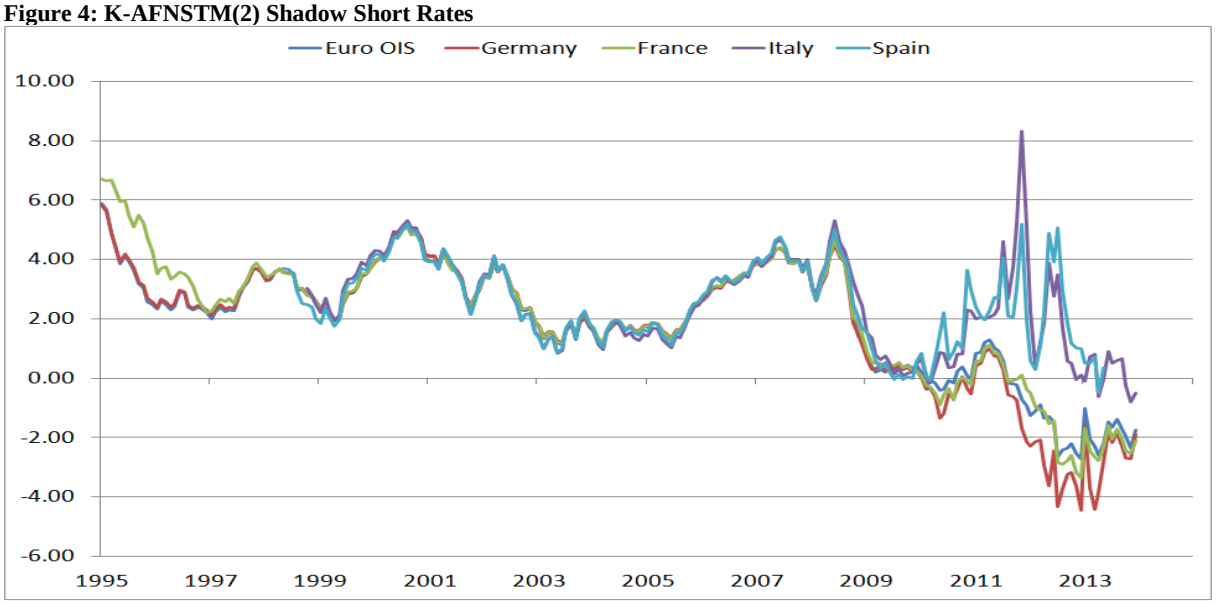
$$Y_t = \alpha + \alpha(l)Y_{t-1} + \varepsilon, \varepsilon \backsim iid(0, \Sigma)$$

where $Y_{it} = [r_t^H \quad NPL_t \quad PDF_t \quad GDP_t]'$, α includes deterministic terms, $\alpha(l)$ is a lag operator, and Σ is a cholesky decomposition covariance matrix.

PRIMARY FINDINGS

In this section I present first results of the Shadow short rates (SSR) for EMU, Germany, France, Italy and Spain. The estimates have been produced using two factor Krippner Affine Nelson Siegel Term Structure Model (K-AFNTSM(2)[1]). The SSR data have been produced based on Euro overnight indexed swaps, German sovereign data (from Jan-1995), French sovereign data (from Jan-1995), Spanish sovereign data (from May-1998) and Italian sovereign data (from Oct-1998). Graph shows the obvious gap between Germany and France on the one side and Italy and Spain on the other, indicating the uneven distribution of monetary policy transmission. The SSR data for Germany and France is a bit below the Euro OIS data, reflecting their core status, safety and obvious flight-to-quality effect, whereas Italy and Spain are well above the OIS rate, reflecting their default risk during the sovereign crisis. One thing to note from the graph is that following the lowering of ECB rate in November 2011 and July 2012 the SSR spreads exceeded 900 basis points:

Figure 4: K-AFNSTM(2) Shadow Short Rates



[1] Programming and code was provided by Mr. Leo Krippner

The obtained SSR estimates represent the input data for further examination of ECB monetary policy, during the crisis, and its transmission. For that purpose, the SSR data is going to be observed in relation to macroeconomic variables and structural factors as described before. Detailed results of overall empirical research are foreseen to be gathered by the time of the conference.

RESEARCH CONTRIBUTION

The doctoral dissertation is expected to give better understanding and empirical insight into dynamics and effectiveness of the monetary policy conduct at the zero lower bound. Further, by offering the methodology to estimate the transmission of the centralized monetary policy into individual member states, individual national central banks could calculate their own hypothetical interest rates in order to orient themselves better about the liquidity needs of their financial system. On the other hand the ECB could assess the asymmetry of its monetary policy transmission and effect of the flight-to-quality phenomena. At the end, the dissertation is hopefully going to offer an empirical insight into relationship between individual spot rates and some key macroeconomic and financial stability variables. Having knowledge about those would equip national governments with proper tool to steer monetary policy transmission and successfully draw liquidity induced by the ECB.

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