Inflation Expectations and Expected Real Interest Rates as Determinants of Nominal Interest Rates in PIGS

Rajmund Mirdala
Technical University of Kosice
Faculty of Economics, Department of Economics
Nemcovej 32
Košice, 04001
Slovakia
e-mail: rajmund.mirdala@tuke.sk

Abstract
Quantitative easing conducted by European central bank to fight persisting risks of deflation is drawing an attention of increasing number of empirical studies. Moreover, effectiveness of monetary policy at near zero inflation rates reveals lot of issues on whether interest rates really have a lower bound around zero percent. As a result, traditional views on the role of inflation expectations and expected real interest rates in the long-term interest rates determination face the challenge of fundamental revision. In the paper we analyze relative contributions of inflation expectations and expected real interest rates to long-term interest rates on government bonds leading path by employing SVAR methodology. We also decompose these long-term interest rates into transitory and permanent components. Our research revealed significant changes in the relative contribution of inflation expectations and expected real interest rates to the long-term interest rates determination in the periphery countries of the Euro Area in comparison with the core of Euro Area (France and Germany). The crisis period even intensified this trend.

Keywords: interest rates, inflation expectations, economic crisis, SVAR, impulse-response function
JEL codes: C32, E43, F41

1. Introduction

Recent macroeconomic development in the Euro Area is characterized by persisting deflationary pressures. As a result, deflationary environment induces fundamentally different background for the economic policy framework and related institutions experimenting with a convenient policy mix to provide growth incentives and improve growth perspectives in the Euro Area. While governments seek optimum compromise between growth stimulation and consolidation efforts that would provide crucial incentives to boost domestic demand while maintaining conditions for fiscal sustainability of public budgets, European central bank (ECB) conducts another wave of quantitative easing aiming an increase in the rate of inflation (Krishnamurthy and Vissing-Jorgensen, 2011). While increased inflation would reduce persisting risks of deflationary spiral, it should also stimulate an increase in the nominal interest rates from today’s near zero levels and improve the traditional signaling function of the price of money. Moreover, higher nominal interest rates should also help to boost real interest rates that are nowadays occasionally falling to unprecedentedly negative levels (Bindseil and Winkler, 2012).

Nominal interest rates in the Euro Area member countries followed generally criticized decreasing and mutually converging trend since the beginning of the Euro Area establishment (Acharya and Steffen, 2015). Introduction of single currency on a very heterogeneous group of countries induced undesirable convergence especially in the long-term interest rates on the government bonds. Reduction of differences among interest rates of the Euro Area member countries resulted from decreased expected risk premium recognized by financial markets being supported by (un)conventional operations of ECB that many economists criticized and indicated as one of the key design failures of the Euro Area (De Grauwe, 2013).

In the paper we examine influence of inflation expectations and expected real interest rates on the long-term nominal interest rates of government bonds with ten years maturity in PIGS countries by employing SVAR (structural vector autoregression) methodology. Impulse-response functions are calculated to estimate responsiveness of nominal long-term interest rates to the unexpected inflation expectations and ex-ante real interest rates shocks. We also decompose nominal interest rates on government bonds into inflation expectations and expected real interest rates components to examine a contribution of both components to the conditional variability of long-term nominal interest rates. Our results indicate that both components significantly determined main trends in the development of interest rates on government bonds since 2000. At the same time, relative contribution of both components revealed significant differences when comparing our results for PIGS countries with those of Germany and France.

2. Relationship between Interest Rates and Inflation

Questions associated with fundamental determinants of nominal interest rates are widely discussed in the recent empirical literature. Considering already mentioned deflationary pressures and near zero levels monetary policy conducted by ECB there exist a large number of research studies examining a relative importance of inflation expectations and expected real interest rates in the nominal interest rates determination (Vayanos and Vila, 2009). Key characteristics and implications resulted from the relationship between inflation and interest rates provide crucial information for monetary authorities.

Inflation and interest rates are interconnected. Traditional linkage between inflation and interest rates refers the causal (bi-directional) relationship well documented by both theoretical and empirical literature that operates via transmission mechanism. As a result, changes in inflation induce adjustments in interest rates (Crowder and Hoffman, 1996). Causal linkage between inflation and interest rates is regularly examined by central banks that preserve price stability and purchasing power of domestic currency by increasing interest rates during the periods of higher inflation following particular monetary policy rule (Fendel, 2009). On the other hand, inflation pressures are not necessarily associated with imbalanced demand driven economic growth where increased interest rates would prevent the economy from overheating. Increased inflation accompanies not just highly performing economies but may be also fueled by internal distortions or external shocks that the economies may experience even during the recession (Emiris, 2006). Deflationary environment provides quite specific fundamental background for the interest rates determination (Peersman, 2011). Near zero levels of nominal interest rates combined with increasing real interest rates induced by decreasing price level reduces maneuverability within existing operational framework of monetary authorities. As a result, central banks tend to employ unconventional instruments to accelerate inflation (Borio and Disyatat, 2009).

Nominal interest rates are not necessarily determined just by the rate of inflation (Booth and Ciner, 2000). It is due fact that nominal interest rates consists of two components - real value of money and inflation premium. As a result, changes in nominal interest rates may be caused not only by forces determining the rate of inflation, but also by a number of variables affecting real interest rates (expectations of agents included) (Eijffinger et al., 2000). Nominal price of money is determined by a wide variety of determinants, that is why it may not seem to be clear, whether the volatility of nominal interest rates is caused by changes in inflation expectations or expected real interest rates. Correct identification of the sources of the volatility of nominal interest rates is a crucial part of successful monetary policy decision-making (McGough et al., 2005). For example, an increase in the nominal interest rates caused by higher inflation expectations of agents represents a correct signal for monetary policy tightening. Corresponding increase in the rate of interest seems to be well suited decision for reduction of excessive inflation pressures. On the other hand, an increase in the nominal interest rates caused by higher expected real interest rates is usually associated with different monetary policy consequences.

3. Interest Rates Determination in Empirical Literature

Gerlach-Kristen and Rudolf (2010) compared three monetary operating procedures by examining optimal policy reaction functions, impulse responses and simulated volatilities of inflation, the output gap and the yield curve to examine volatility of interest rates and other main macroeconomic variables. Their results suggest that volatilities in key variables under different monetary-policy framework (commitment vs. discretion) are strongly dependent on general preconditions (normal times vs. financial distress). Eiffinger, Schaling and Vehagen (2000) analyzed the relevancy of the term structure of interest rates for the transmission process of the monetary policy. Authors identified and empirically tested the long-term interest rates as a crucial indicator for monetary policy discretionary changes. Emiris (2006) decomposed long-term interest rates into term premium and inflation premium to investigate the sources of average premium on ten years bonds variability. Author also examined responses of the term premia to the different shocks. Fendel (2009) intended to support the empirical findings on the information content of the term structure of interest rates for monetary policy. Kulish (2007) analyzed two roles (first, as a key determinant in the reaction function of the monetary authority; second, as instruments of policies) that long-term nominal interest rates can play in the conduct of the monetary policy. McGough et al. (2005) investigated the problem of short-term versus long-term interest rates suitability to operate as a monetary policy instrument. Authors highlight and discuss a crucial role of inflation expectations and real interest rate for selecting the most appropriate interest rate as a key pillar of a monetary policy framework. Michaud and Upper (2008) identified the origins of interbank interest rates volatility by examining the possible determinants of the risk premium contained in the money market interest rates. Rudebusch et al. (2007) examined the origins and implications of changes in bond term premiums for economic activity to analyze the stability of long-term interest rates. Authors also analyzed empirical relationship between short-term and long-term interest rates.

St-Amant (1996) employed bivariate SVAR model to analyze the impact of expected inflation and ex-ante real interest rates on the nominal interest rates volatility of government bonds with maturity one year and ten years in the U.S.A. Following author's results we may conclude that inflation expectations seems to prevailing determinant of nominal interest rate volatility since the beginning of 1970s till the middle of 1980s, whereas shifts in expected real interest rates substantially contributed to the nominal interest rates volatility during the first half of the 1990s. Deacon a Derry (1994) provided a variety of methods for identification of market interest rate and inflation premium from the interest rates associated with government bonds. Engsted (1995) implemented cointegration analysis and VAR methodology to examine properties of interest rates and inflation time series. Neely a Rapach (2008) analyzed time series for real interest rates employing growth equilibrium model. Authors dedicated extra effort to investigate a presence of persistence patterns especially in medium and long time period. Ragan (1995) analyzed time structure of nominal interest rates to estimate inflation expectations of agents. Results of his empirical investigation provided interpretation of the real interest rate volatility over time. Crowder a Hoffman (1996) analyzed mutual interconnections between inflation and interest rates. Implemented SVAR methodology helped authors to isolate permanent and temporary sources of volatility for nominal interest rates and inflation time series. Lai (2004) examined properties of time series for real interest rates. Author investigated conditions to maintain a time series stacionarity under changing length of base period. Garcia a Perron (1996) analyzed long-run features of time series for real interest rates in the U.S.A. Lanne (2002) verified a validity of Fisher effect following the results of long-run interconnections testing between inflation and nominal interest rates in the U.S.A.

4. Econometric Model

VAR models represent dynamic systems of equations in which the current level of each variable depends on past movements of that variable and all other variables involved in the system. Residuals of vector ε_t represent unexplained movements in variables (effects of exogenous shocks hitting the model); however as complex functions of structural shocks effects they have no economic interpretation. Structural shocks can be still recovered using transformation of the true form representation into the reduced-form by imposing a number of identifying restrictions. Applied restrictions should reflect some general assumptions about the underlying structure of the economy and they are obviously derived from economic theory.

In the paper we employ methodology introduced by Blanchard a Quah (1988) who estimated bivariate model with two types of exogenous shocks. To identify structural shocks authors implemented identification scheme based on decomposing effects of the shocks into permanent and transitory components. Long-run identifying restrictions were applied on the variance-covariance matrix of reduced form VAR residuals.

Following our objective we estimate a model consisting of the vector of endogenous variables X_t and the same number of primitive (structural) shocks. Unrestricted true form of the model is represented by the following infinite moving average representation:

$$X_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + A_2\varepsilon_{t-2} + ... = \sum_{i=0}^{\infty} A_i\varepsilon_{t-i} = \sum_{i=0}^{\infty} A_i L^i \varepsilon_t \quad (1)$$

or

$$\begin{bmatrix} ir_{n,t} \\ p_t \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_{p^e,t} \\ \varepsilon_{ir_r^e,t} \end{bmatrix} \quad (2)$$

where $X_t = [ir_{n,t}, p_t]$ is n x 1 vector of the endogenous macroeconomic variables ($ir_{n,t}$ - long-term nominal interest rate, p_t - rate of inflation), $A(L)$ is a n x n polynomial consisting of the matrices of coefficients to be estimated in the lag operator L representing the relationship among variables on the lagged values, ε_t is n x 1 $\left(\varepsilon_t = \left[\varepsilon_{p^e,t}, \varepsilon_{ir_r^e,t}\right]\right)$ vector of identically normally distributed, serially uncorrelated and mutually orthogonal errors (white noise disturbances that represent the unexplained movements in the variables, reflecting the influence of exogenous shocks):

$$E(\varepsilon_t) = 0, \quad E(\varepsilon_t\varepsilon_t') = \Sigma_\varepsilon = \mathrm{I}, \quad E(\varepsilon_t\varepsilon_s') = [0] \quad \forall t \neq s \quad (3)$$

we assume two exogenous shocks that contemporaneously affects endogenous variables - inflation expectations shock $\left(\varepsilon_{p^e,t}\right)$ and expected real interest rates shock $\left(\varepsilon_{ir_r,t}\right)$.

Structural exogenous shocks from equation (1) are not directly observable due to the complexity of information included in true form VAR residuals. At the same time, the shocks in the reduced form are likely to be correlated so they cannot be considered as true structural shocks. As a result, structural shocks cannot by correctly identified. It is than necessary to transform true model into following reduced form:

$$X_t = u_t + C_1u_{t-1} + C_2u_{t-2} + ... = \sum_{i=0}^{\infty} C_i u_{t-i} = \sum_{i=0}^{\infty} C_i L^i u_t \quad (4)$$

or

$$\begin{bmatrix} ir_{n,t} \\ p_t \end{bmatrix} = \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} \begin{bmatrix} u_{i^e,t} \\ u_{ir_r^e,t} \end{bmatrix} \quad (5)$$

where $C(L)$ is a n x n polynomial of matrices with coefficients representing the relationship among variables on the lagged values and u_t is a n x 1 vector of normally distributed errors (shocks in reduced form) that are serially uncorrelated but not necessarily orthogonal:

$$E(u_t) = 0, \quad \Sigma_u = E(u_t u_t') = A_0 E(\varepsilon_t\varepsilon_t') A_0' = A_0A_0', \quad E(u_t u_s') = [0] \quad \forall t \neq s \quad (6)$$

Relationship between reduced-form VAR residuals (u_t) and structural shocks (ε_t) can be summarized from equations (1) and (4) as follows: $u_t = A_0\varepsilon_t$. Matrices C_i we obtain from estimated equation (1). Considering $A_i = C_iA_0$, we can now identify matrix A_0. To estimate coefficient of matrix A_0, it is necessary to impose four restrictions. Two restrictions are simple normalizations, which define the variance of the shocks $\varepsilon_{p^e,t}$ and $\varepsilon_{ir_r,t}$ (it follows the assumption that each of the disturbances has a unit variance, $\mathrm{var}(\varepsilon) = 1$). Third restriction comes from an assumption that identified shocks are orthogonal. Normalization together with an assumption of the orthogonality implies $A_0^{'}A_0 = \Sigma$, where Σ is the variance covariance matrix of $\varepsilon_{p^e,t}$ and $\varepsilon_{ir_r,t}$. The final restriction, which allows the matrix C to be uniquely defined, represents the long-run identifying restriction providing that a cumulative effect of expected real interest rate shock to the nominal interest rates variability is zero. Long-run identifying restrictions enable us to isolate temporary and permanent sources of nominal interest rates volatility and thus to distinguish effects of both structural shocks on endogenous variables of the model.

The equation (2) we can now rewrite to the following form:

$$\begin{bmatrix} ir_{n,t} \\ p_t \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ . & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{i^e,t} \\ \varepsilon_{ir_r^e,t} \end{bmatrix} \tag{7}$$

Correctly identified model can be finally estimated employing SVAR methodology. Variance decomposition and impulse-response functions are computed to observe a relative contribution of inflation expectations and expected real interest rates shocks to the nominal interest rates conditional variance as well as response of nominal interest rates to one standard deviation inflation expectations and expected real interest rates shocks.

5. Data and Results

We've estimated bi-variate SVAR model for PIGS countries, Germany and France to estimate the responsiveness of their long-term nominal interest rates to the positive one standard deviation inflation expectations and expected real interest rates shocks. Monthly data for the period of 2000M1-2007M12 (model A) consisting of 96 observations and for the period of 2000M1-2015M4 (model B) consisting of 184 observations were employed for the interest rates on government bonds with ten years maturity and inflation based on consumer prices. Estimation of two models for each individual country should be helpful in examining crisis related effects on calculated results. Time series for inflation were seasonally adjusted. Time series for all endogenous variables were collected from IMF database (International Financial Statistics, September 2015).

5.1 Testing Procedures

Estimation of both models and correct identification of structural shocks affecting both endogenous variables it is necessary to preserve stationarity of the VAR model. To test the stationarity of both models it is necessary to check the time series for unit roots and cointegration. To test the stability of the VAR model we have also applied a number of diagnostic tests of the VAR residuals (normality, serial correlation, heteroskedasticity).

Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were computed to test endogenous variables for the unit roots presence. Both ADF and PP tests indicate that all variables are non-stationary on values. As a result, the null hypothesis of a unit root presence cannot be rejected for any of time series. Testing variables on first differences indicates that time series are stationary. We may conclude that variables are integrated of order 1 I(1).

Because all endogenous variables have a unit root it is necessary to test time series for cointegration using the Johansen and Juselius cointegration test. The test for the cointegration was calculated using three lags as recommended by the AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion).

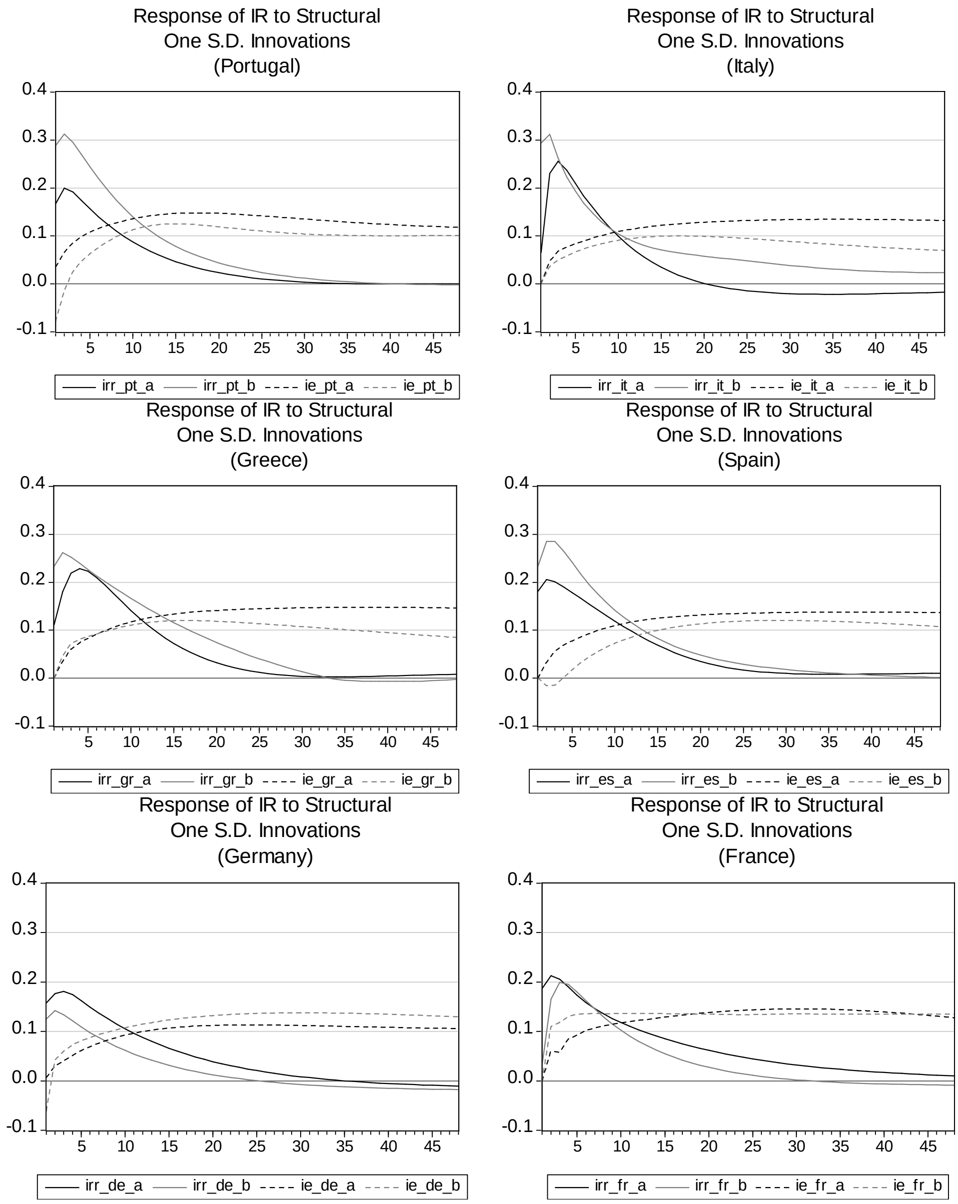
The results of Johansen cointegration tests confirmed our results of unit root tests. Both the trace statistics and maximum eigenvalue statistics (both at 0.05 level) indicate that there is no cointegration among endogenous variables of the model.

To test the stability of VAR models we also employed a number of diagnostic tests. We found no evidence of serial correlation, heteroskedasticity and autoregressive conditional heteroskedasticity effect in disturbances. The model also passes the Jarque-Bera normality test, so that errors seem to be normally distributed. VAR models seem to be stable also because inverted roots of the model for each country lie inside the unit circle. Detailed results of time series testing procedures are not reported here to save space. Like any other results, they are available upon request from the author.

5.2 Impulse-Response Functions

Figure 1 summarizes responses of nominal interest rates on ten years government bonds to the positive one s.d. shocks of inflation expectations and expected real interest rates in PIGS countries, Germany and France during pre-crisis (model A) and extended (model B) periods.

Figure 1: Responses of Long-term Interest Rates to Shocks of Inflation Expectations and Expected Real Interest Rates



Note: Curves represent responses of long-term nominal interest rates (IR) to the positive one standard deviation inflation expectations shock (ie) and expected real interest rates shock (irr) in models A (2000M1-2007M12) and B (2000M1-2015M4).

Source: author's calculations

Impulse-response functions of long-term nominal interest rates revealed mostly similar response patterns of interest rates on ten years government bonds to the underlying shocks across all countries though we have observed some differences between peripheral economies (PIGS) and two Euro Area core countries. Moreover, differences between both groups of countries are present in both models covering pre-crisis and extended periods.

Expected real interest rates dominated in determining long-term interest rates during almost whole first year since the shock in all six countries. Nominal interest rates immediately increased after the positive expected real interest rate shock. However, responsiveness of nominal interest rates to the shock of expected real interest rates was slightly higher in the peripheral countries. Effect of the shock culminated within first three months and then steadily died out during subsequent two years since the shock in the whole group of countries. Comparison of the results for pre-crisis and extended periods revealed interesting differences between peripheral and the core Euro Area members too. Despite some minor differences, responsiveness of long-term interest rates to the shock of expected real interest rates in peripheral countries during the extended period slightly increased (effect is clear especially during first months since the shock), while France and Germany experienced opposite trend. We suggest that investors required higher risk premium (associated with higher expected real interest rates) to hold risky government bonds of PIGS countries considering that these countries were exposed the most to the threat of default during the crises period.

Effects of inflation expectations on long-term nominal interest rates seem to be much stable in all six countries. While short-term (within first twelve months since the shock) response of interest rates to the shock of inflation expectations was generally lower than in case of expected real interest rates, it remained positive and stable with increasing lag and even permanent in the long run. Crises period affected responsiveness of interest rate on ten years government bonds to the shock of inflations expectations in both groups of countries. While the vulnerability of long-term nominal interest rates to the shock of inflation expectations in periphery countries decreased, Germany and France experienced opposite scenario. Economies of PIGS countries suffered the most during the crisis period. We suggest that the reasonable risk of deflation and deflationary spiral reduced the role of inflation expectations for the nominal interest rates determination.

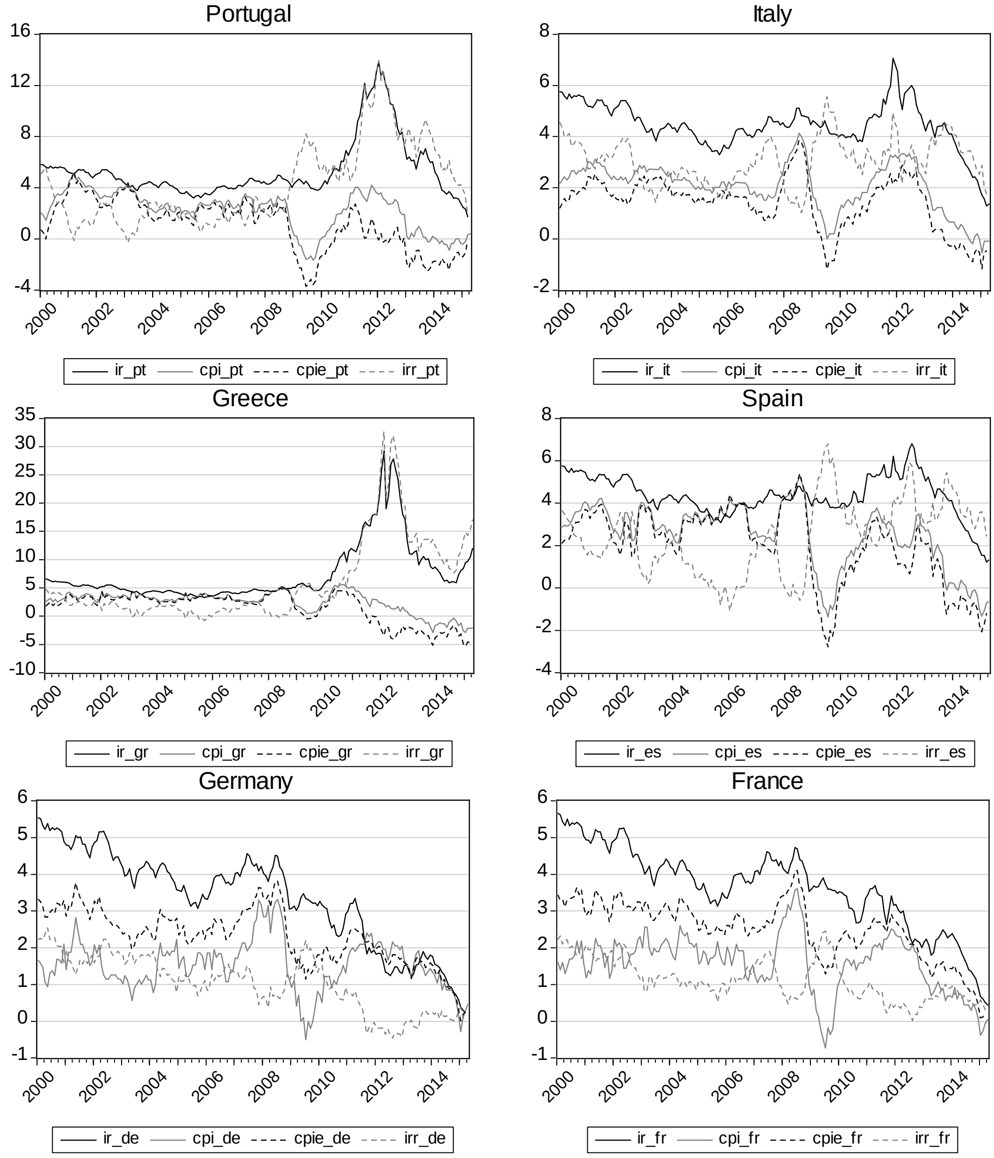
While the low number of countries included in our sample does not enable us to postulate generalized policy recommendations that would result from our conclusions, existing differences in the relative contributions of inflation expectations to the long-term interest rates leading path between periphery countries and the core of the Euro Area represented by Germany and France reveals many opened questions associated with suitability of monetary policy conducted by ECB in the single currency area consisting of significantly heterogeneous countries. Implications of quantitative easing accompanied by near zero levels of the key interest rates aiming to boost the inflation may be biased due to existing differences in the inflation expectations between North and South of the Euro Area.

5.3 Decomposition of Long-term Nominal Interest Rates

Following examination of the responsiveness of the long-term nominal interest rates on ten years government bonds to the unexpected shocks of inflation expectations and expected real interest rates we provide decomposition of long-term interest rates into inflation expectations and expected real interest rates components in this section. Stationary and permanent components of the long-term interest rates are calculated by the accumulation of the effect of both structural shocks. Estimation of expected real interest rates is calculated by adding the stationary to the mean of difference between observed long-term interest rates and contemporaneous rate of inflation[1] (St-Amant, 1996). Estimation of inflation expectations is calculated by subtracting already calculated expected real interest rates from the nominal long-term interest rates.

[1] Portugal (3.13%), Italy (2.39%), Greece (5.01%), Spain (1.89%), Germany (1.81%), France (2.06%).

Figure 2: Decomposition of Long-term Interest Rates on Government Bonds



Note: Curves represent development of nominal interest rate of ten years government bonds (ir), inflation measured by CPI (cpi) and estimated components of inflation expectations (cpie) and expected real interest rates (irr).

Source: author's calculations

Decomposition of long-term interest rates on ten years government bonds in the periphery countries, Germany and France revealed interesting differences in the (a) relative contributions of inflation expectations and expected real interest rates into nominal interest rates leading path since the establishment of the Euro Area as well as (b) relationship between inflation rates and inflation expectations in the above mentioned countries. Downward trend in long-term interest rates in the Euro Area member countries and related convergence in their development between North and South was associated with decrease in inflation expectations while expected real interest rates remained relatively stable (Figure 2). First crucial implication resulted from our estimations is represented by clear differences between inflation and inflation expectations derived from long-term interest rates between periphery economies and the core of Euro Area (Germany and France). Inflation expectations tend to undershoot a trajectory of inflation path during the whole pre-crisis period. Moreover, this trend was even intensified during the crisis period. We suggest that increased uncertainty on the markets together with crisis related problems (recession, risk of default, fiscal unsustainability, etc.) clearly reduced inflation expectations below recent rates of inflation. As a result, risk of deflation during the periods of decreasing inflation expectations that even undershoot low inflation target clearly increases. Moreover, low inflation expectations that undershot true inflation in periphery countries of the Euro Area induce higher expected real interest rates in comparison with their true levels. Similarly to our results from impulse-response analysis we suggest that undershooting patterns in inflation expectations result from increased fear of deflation and slumping real economy in light of tightening financial conditions that boost expected real interest rates up.

Decomposition of interest rates on government bonds in Germany and France revealed different picture about the relative importance of inflation expectations and expected real interest rates in long-term interest rates determination. Inflation expectations tend to overshoot the long-term path of inflation in both countries during the whole period. This pattern is more significant during the pre-crisis period. Higher inflation expectations than recent inflation that did not induce excessive inflation pressures are good signal for central bank in good times though during periods of persisting deflationary pressures combined with recession it may decrease the chance to boost inflation up and possibly worsen the deflationary spiral. However, mismatch between inflation expectations and recent inflation decreased during the crisis period. On the other hand, lower expected real interest rates, as a component of nominal long-term interest rates, may improve liquidity of government bonds in both countries and soften the conditions on their sovereign debt markets.

5. Conclusion

Examination of the relative importance of inflation expectations and expected real interest rates in determining long-term nominal interest rates on ten years government bonds in periphery (Portugal, Italy, Greece, Spain) and the core (Germany, France) countries of the Euro Area revealed interesting implications of existing economic differences between both groups of countries. Increased contributions of expected real interest rates to the development of long-term interest rates together with undershooting patterns in inflation expectations in periphery countries represent clear signal of markets to policy makers and possible scenarios of boosting inflation (ECB) and economic growth (national governments) in the Euro Area.

Higher expected real interest rates than actual real interest rates together with increased exposure of holding risky government bonds of periphery countries of the Euro area may force governments to undertake internal devaluation (with all risks associated with deflationary spiral) or to increase nominal interest rates on government bonds (with negative implications on costs of sovereign debt). We suggest that more dynamic convergence of periphery Euro Area member countries to the core countries together with strengthening of fiscal sustainability would help to reduce perceived risk of periphery countries followed by a reduction in expected real interest rates from government bonds.

Acknowledgement

This paper was written in connection with scientific project VEGA no. 1/0892/13 and 1/0994/15. Financial support from this Ministry of Education's scheme is also gratefully acknowledged.

References

ACHARYA, V.V., STEFFEN, S. (2015). The "Greatest" Carry Trade Ever? Understanding Eurozone Bank Risks. *Journal of Financial Economics*, vol. 115, no. 2, pp. 215–236.

BINDSEIL, U., WINKLER, A. (2012). *Dual Liquidity Crises Under Alternative Monetary Frameworks: A Financial Accounts Perspective*. ECB Working Paper no. 1478. Frankfurt am Main: European Central Bank.

BLANCHARD, O.J., QUAH, D. (1988). *The Dynamic Effects of Aggregate Demand and Aggregate Supply Disturbances*. National Bureau of Economic Research Working Paper No. 4637. New York: National Bureau of Economic Research.

BOOTH, G.G., CINER, C. (2000). The Relationship between Nominal Interest Rates and Inflation: International Evidence. *Journal of Multinational Financial Management*, vol. 11, no. 2001, pp. 269–280.

BORIO, C., DISYATAT, P. (2009). *Unconventional Monetary Policies: An Appraisal*. BIS Working

Paper no. 292. Basel: Bank for International Settlements.
CROWDER, W.J., HOFFMAN, D.L. (1996). The Long–Run Relationship between Nominal Interest Rates and Inflation: The Fisher Equation Revisited. *Journal of Money, Credit and Banking*, vol. 28, no. 1, pp. 102–118.
DE GRAUWE, P. (2013). *Design Failures in the Eurozone: Can they be fixed?* LSE "Europe in Question" Discussion Paper no. 57. London: London School of Economics.
DEACON, M., DERRY, A. (1994). Estimating Market Interest Rate and Inflation Expectations from the Prices of UK Government Bonds. *Bank of England Quarterly Bulletin*, vol. 34, pp. 232–240.
EIJFFINGER, S., SCHALING, E., VERHAGEN, W. (2000). *The Term Structure of Interest Rates and Inflation Forecast Targeting*. CEPR Discussion Paper 2375. London: CEPR.
EMIRIS, M. (2006). *The Term Structure of Interest Rates in a DSGE Model*. National Bank of Belgium Working Paper Research No. 88. Brussels: National Bank of Belgium.
ENGSTED, T. (1995). Does the Long–Term Interest Rate Predict Future Inflation? A Multi–Country Analysis. *The Review of Economics and Statistics*, vol. 77, no. 1, pp. 42–54.
FENDEL, R. (2009). Note on Taylor Rules and the Term Structure. *Applied Economics Letters*, vol. 16, no. 11, pp. 1097–1101.
GARCIA, R., PERRON, P. (1996). An Analysis of the Real Interest Rate under Regime Shifts. *Review of Economics and Statistics*, vol. 78, no. 1, pp. 111–125.
GERLACH–KRISTEN, P., RUDOLF, B. (2010). *Macroeconomic and Interest Rate Volatility under Alternative Monetary Operating Procedures*. Swiss National Bank Working Paper No. 2010–1. Zurich: Swiss National Bank.
KRISHNAMURTHY, A., VISSING–JORGENSEN, A. (2011). *The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy*. National Bureau of Economic Research Working Paper No. 17555. New York: National Bureau of Economic Research.
KULISH, M. (2007). Should Monetary Policy Use Long–term Rates? *B.E. Journal of Macroeconomics*, vol. 7, no. 1, pp. 1–26.
LAI, K.S. (2004). On Structural Shifts and Stationarity of the Ex Ante Real Interest Rate. *International Review of Economics and Finance*, vol. 13, no. 2, pp. 217–228.
LANNE, M. (2001). Near Unit Root and the Relationship between Inflation and Interest rates: A Reexamination of the Fisher Effect. *Empirical Economics*, vol. 26, no. 2, pp. 357–366.
MCGOUGH, B., RUDEBUSCH, G., WILLIAMS, J.C. (2005). Using a Long–term Interest Rates as the Monetary Policy Instrument. *Journal of Monetary Economics*, vol. 52, no. 5, pp. 855–879.
MICHAUD, F.–L., UPPER, CH. (2008). What Drives Interbank Rates? Evidence from the Libor Panel. *BIS Quarterly Review*, vol. March 2008, pp. 47–58.
NEELY, CH.J., RAPACH, D.E. (2008). Real Interest Rates Persistence: Evidence and Implications. *Federal Reserve Bank of St. Louis Review*, vol. 90, no. 6, pp. 609–641.
PEERSMAN, G. (2011). *Macroeconomic Effects of Unconventional Monetary Policy in the Euro Area*. ECB Working Paper no. 1397. Frankfurt am Main: European Central Bank.
RAGAN, C. (1995). *Deriving Agents' Inflation Forecasts from the Term Structure of Interest Rates*. Bank of Canada Working Paper No. 1/1995. Ottawa: Bank of Canada.
RUDEBUSCH, G.D., SACK, B.P., SWANSON, E.T. (2006). *Macroeconomic Implications of Changes in the Term Premium*. Federal Reserve Bank of San Francisco, Working Paper No.46/2006. San Francisco: Federal Reserve Bank of San Francisco.
ST–AMANT, P. (1996). *Decomposing U.S. Nominal Interest Rates into Expected Inflation and Ex Ante Real Interest Rates Using Structural VAR Methodology*. Bank of Canada Working Paper No. 2/1996. Ottawa: Bank of Canada.
VAYANOS D., VILA, J.L. (2009). *A Preferred–Habitat Model of the Term Structure of Interest Rates*. National Bureau of Economic Research Working Paper No. 15487. New York: National Bureau of Economic Research.