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Heterogeneous distribution of money supply across the euro area

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Abstract

Jitka Poměnková, Svatopluk Kapounek: **Heterogeneous distribution of money supply across the euro area**

The recent economic crisis is regarded as symmetric shock which negatively affects all Eurozone member countries. Even if the whole euro area is in recession the probability of asymmetric shock arises on the monetary side of the economy. The issue is that money supply is unevenly distributed across the euro area. Different credit money creation increases inflationary pressures not only in long run but also in short-term, especially in house prices. The combination of credit money creation and increases in asset prices contributes to financial instability.

The empirical part of the paper is based on the analysis in time-frequency domain. The authors apply wavelet analysis to identify increasing differences of co-movements in money supply between the selected old Eurozone member states and peripheral countries. The authors use the contribution of different member countries to the monetary aggregate M3 as the proxy of money supply distribution across the euro area.

Key words

wavelet analysis, financial stability, asset prices, monetary aggregates

JEL: E51, F36

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Introduction

The European Central Bank (ECB) announced two main pillars of the monetary policy strategy in October 1998. The first pillar, economic analysis, consisted in short-term to medium-term targeting of macroeconomic indicators, especially inflation rates of 0-2%. The second one, monetary analysis, were based on the fact that monetary growth and inflation are closely related in the medium to long run. The monetary aggregate M3 was used by the ECB as the reference value (the yearly average yearly growth is 4,5%). The macroeconomic theory states, that if growth of money is so rapid that the quantity of money supplied is maintained in excess of the quantity demanded, then the necessary sufficient condition for inflation will exist. However, experiences in real-time monetary analysis provided very poor results. De Grauwe (2007) argues that money supply statistics are full of noises which are significant in low-inflation economies (where inflation rate does not exceed 6%). We assume that money market in the euro area is instable because the upper limit of credit money creation is vanished in the large currency areas. The argumentation is based on the money endogeneity assumption where money supply is determined by credit money demand. Within this idea, the money demand and supply are balanced by money velocity changes. Subsequently, the money velocity changes are significant in the euro area member countries, compared to low inflation. (Kapounek, 2011)

It was not surprised that ECB redefined the monetary policy strategy in May 2003. The Governor Council emphasized that there is not strict link between short-term monetary development and monetary policy decision. The reference value of M3 growth was cancelled and time-frame of monetary analysis shifted from medium to long-term trends. As before the year 2003, monetary analysis take into account the development of monetary aggregate M3 but monetary policy would not react mechanically to deviations of M3 at this new framework. (Trichet, 2003)

Leeper and Roush (2003) showed that money plays an important role in the transmission mechanism. When monetary policy generates significant joint movements in money and the interest rate, real and inflation impacts of policy are larger than when money's response is small. Greiber and Setzer (2007) found that liquidity plays a very important role in the transmission of monetary policy on house prices. Therefore the strength of the asset inflation channel could differ across the euro area. And, the role of monetary policy for house prices is less visible at the euro area aggregate level than at the level of individual member countries. Therefore we can expect heterogeneous or/and limited efficiency of monetary policy instruments across the euro area.

Setzer and Wolff (2009) contributed that differences in the monetary dynamics across euro area Member States are related to differences in the economic fundamentals determining money demand. The differences in money demand equation already identified Bosker (2003). He applied dynamic panel cointegration tests with VECM. Subsequently, Setzer, Van den Noord and Wolff (2010) focused on the factors which caused heterogeneity in money holdings in the euro area. They found that not only diversification in income but also higher house prices and higher user costs of housing are both associated with larger money holdings.

This topic becomes to be popular with increase of house price index in Germany during the year 2011. Ferrero, Nobili and Passiglia (2007) pointed out that the period 1992-2000 was characterized by a relatively stable M3 annual growth rate in the euro area, but in the period 2001-2006 the money M3 experienced a phase of strong and persistent acceleration (average annual growth rate of 7,6 per cent). They identified significant increase of deposits in Germany, France and Spain. At the same time, in Italy the decrease of total financial assets caused the decrease of total deposits. They also showed that money holdings liquidity excess conditions in the period 1992-2006 were related to acceleration of non-bank financial intermediaries' money demand and accumulation of marketable instruments. They conclude that the money holdings relate more to portfolio choices than to transaction motives. That implies smaller upside risks to price stability over the medium term than usually argued. The country specific monetary aggregates to highlight the instability of euro area money demand were applied by Nautz and Rondorf (2010) as well. They estimated long-run income elasticity of money demand above one. Their results strongly confirm our assumption of the declining income velocity of money demand in the euro area.

The money supply empirical literature is almost exclusively based on aggregate data for the whole euro area. It is the natural choice because the common monetary policy in the euro area should depend on euro area wide aggregates and not on country-specific developments. However, according to the money endogeneity assumption, the money supply is driven by money demand.

Money supply is defined, in broad terms, as currency plus deposit liabilities of domestic bank (Donnery, 2003). Most central banks compile and publish a money supply at the individual country level in the euro area, so-called national contribution to the euro-area aggregate M3. Mehrotra (2007) identified significant differences in the growth rates of national contributions to M3 across the Eurozone countries. He described co-movements of various national components with the euro area aggregate and discusses possible reasons for divergences in growth rates of national contributions in a panel data framework. Finally, he provides information content of national contributions to M3

using the standard Granger causality tests between monetary aggregates, consumer and equity prices.

In this paper, we assume money supply of the ECB is heterogeneously distributed across the euro area. We follow the money endogeneity hypothesis, especially the thesis that national banking systems create credit money and significantly contribute to the money stock. This contribution is determined by money demand which varies across the euro area.

It is widely agreed that money supply is good indicator of economic activity and leading indicator of future inflation. However, the period of nineties of the 20th century until the mid-2007 is characterized by stable environment of low inflation (measured by aggregate consumer price index or deflator) and sustainable economic growth in the most European countries. The recent problem is financial instability. Borio, Lowe (2002) and Kindleberger (2000) showed that financial instability is caused by increase in loans accompanied by growth in market prices of assets.

Our paper supports the renewed interest in the development of monetary aggregates stirred by the recent financial crisis. Despite the single monetary policy we focus on the heterogeneous distribution of money supply across the euro area. Our contribution is in identification of co-movements changes in time. We apply time-frequency domain analysis to identify different relationship across frequencies, i.e. separately for short term and long run.

1 Methodology

Analysis of time series cyclical movements and co-movement can be basically done in two ways, in the time and frequency domain. The most recent studies of monetary aggregates are dealing with the time domain. The frequency domain usage is wide and obtained results can give more information compared to time domain (Croux et al., 2001). In the last decade arises usage of the time-frequency domain techniques in economic area. It is paid attention to features of enlargement of European Union, as well as co-movement of economic activity and their aspects in optimum currency area (OCA) theory and the European integration process. Hallett and Richter (2007) examined the time-frequency framework in a way that allows accommodate structural breaks and non-stationary variables. Jagrič and Ovin (2004) used wavelets in case of week-stationary processes. Rua (2010) used time-frequency approach for measuring co-movement of economic activity among Germany, France, Italy and Spain via cross-wavelet spectrum. He applied the same methodological approach to identify co-movement between the money growth and inflation in the euro area (Rua, 2011).

1.1 Wavelet analysis

The time-frequency domain techniques allows to construct estimate of time series representation from both time and frequency domain perspectives. These approaches give possibility to capture the time and frequency varying features of money supply co-movements within a unified framework. In this way we are able to identify significant changes in national contribution to the aggregate stock of money in the euro area. For this aim we use wavelet analysis. The continuous Wavelet transform of a time series xt can be written as (Metrins, 1999):

$$W_x(a,\tau) = \int_{-\infty}^{\infty} x(t)\frac{1}{\sqrt{a}}\psi\left(\frac{t-\tau}{a}\right)dt, \quad a>0, \tau \in R, \tag{1}$$

where mother wavelet takes the form $\psi_{a,\tau}(t) = \psi\left(\frac{t-\tau}{a}\right)$, τ is the time position, a is the parameter of dilatation (scale), which is related to the Fourier frequency and numerator of the fraction $\sqrt{a}$ ensures the conservation of energy.

To be the invertible transform, basis (mother wavelets) functions must be mutually orthogonal, have zero mean value and limited to finite time interval. That is

$$\begin{aligned} &i) && \int_{-\infty}^{\infty}\psi_{a,\tau}(t)dt = 0, \\ &ii) && \int_{-\infty}^{\infty}\psi_{a,\tau}^2(t)dt = 1, \\ &iii) && 0 < C_\psi = \int_0^{\infty}\frac{|\Psi(\omega)|^2}{\omega}d\omega < \infty; \quad \Psi(\omega) = \int_{-\infty}^{\infty}\psi_{a,\tau}(t)e^{-i\omega t}dt, \end{aligned} \tag{2}$$

where $\Psi(\omega)$ is the Fourier transform of $\psi(t)$. There is an inverse wavelet transformation define as

$$x(t) = \frac{1}{C_\psi}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\psi_{a,\tau}(t)W_x(a,\tau)\frac{dad\tau}{a^2} \tag{3}$$

To satisfy assumptions for the time-frequency analysis, waves must be compact in time as well as in the frequency representation. There are a number of wavelets used, such as Daubeschie, Morlet, Haar or Gaussian wavelet (Grençay, Selçuk and Whitcher, 2002).

In order to analyze the relation between two time series in the frequency domain, cross-spectral analysis is often performed. Similar analysis could be also done in time-frequency (scale) domain. The wavelet cross spectrum can be defined as

$$W_{xy} = SO\left(W_x^*(a,\tau)W_y(a,\tau)\right), \quad (4)$$

where *SO* is the smoothing operator and W_x, W_y are the wavelet transform of time series *x* and *y*, respectively (Jiang and Mahadevan, 2011).

1.2 Data

As we mentioned in introduction, the most empirical studies use aggregate money stock in the whole euro area. In this paper we use national contributions to euro area M3 aggregate. We follow euro area definition of money supply. Datasets are calculated from the national bank's balance sheets of euro area monetary and financial institutions, excluding currency in circulation. The datasets are provided by public available database Eurostat in the period 1997M09-2012M04.

However, the national contributions to euro area monetary aggregate M3 are not equivalent to the national monetary aggregates that existed prior to the start of the monetary union. There are two problems. The calculated data include monetary liabilities to the whole euro area money holding sector, whereas national monetary aggregates included only the domestic money holding sector. Manna (2004) showed that amount of deposits from and loans to the euro area residents excluding residents of the home country is not significant for the most of member states in the period 1997-2002.

Subsequently, Sinn and Wollmershaeuser (2011) showed that capital flows significantly raised between the Eurozone countries. These capital transfers are allowed by European transfer system through which payments by both public and private market participants are recorded, cleared and settled in the euro Area (TARGET2). The accumulated payment imbalances between Germany and the rest of the euro area hit level of 450 billion euros in September 2011.

We assume that these capital flows do not increase imbalances and biases of the analysis in this paper, as Sinn and Wollmershaeuser (2011) presented, but accelerate credit money creation by national banking systems. Similarly argumentation we can find in papers of Buiter, Rahbari, and Michels (2011), Jobst (2011) or Collignon (2012).

Excluding the national contribution to euro area monetary aggregate we use amounts of ECB´s tender operations (Main Refinancing Operations, Long Term Refinancing Operations and other type of operations) in the period 1999/M01-2012/M06. The monthly sums are calculated from open market operations statistics provided by ECB.

2 Results

Fig. 1 shows total amounts of ECB's open market operations, monthly changes of the monetary aggregate M3 and national banking system's contribution to the money stock in the euro area. Obviously, there is a clear link between official monetary aggregate M3 and banking system contribution to this monetary aggregate in the whole euro area. Discusable relation is between open market operations and monetary aggregate. Providing and reducing liquidity directly implies money stock increasing and decreasing until the end of the year 2008. Since the intensification of the financial crisis in September 2008 and throughout 2009, the European Central Bank (ECB) continued to reduce official interest rates to 1.0 per cent, which corresponds to the lowest level observed among Eurozone countries in recent history. In October 2008 the banks in the euro area were gripped by a full-scale liquidity crisis. The Eurosystem stepped in with massive liquidity injections, using both open market operations and marginal lending facilities. However, the additional liquidity held by banks has not been transmitted to the real economy through credits. The excess of liquidity leaves at the balance sheets of commercial banks. It is important to point out that money supply increasing is coniditioned by willingness of banks to lend money. If banks are reluctant to loan because of lack of creditworthy borrowers or their desire to wait for better opportunities, the size of bank reserves has no effect on the money supply.

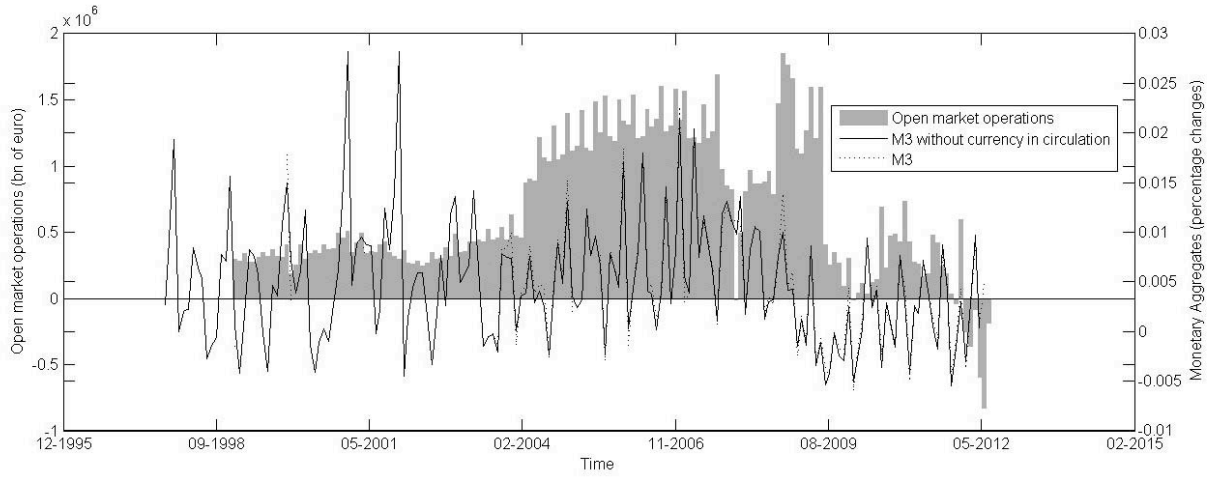

Fig. 1: Aggregate money supply in the euro area (Data source: ECB, Eurostat)

During the years 2010 and 2011 the ECB reduced liquidity providing and withdrawed excess liquidity by reversed operations in the year 2012. The monetary aggregate M3 significantly decreased during the last years. We assume that the decrease is caused no only by the ECB's open market operations but also by reduced amount of loans provided by banking systems in the whole euro area. If we expect money demand heterogeneity across the euro area, we assume that money distribution is hererogeneous as well.

To identify national contribution to the monetary aggregate M3 in the whole euro area we calculate moving correlation with the 18 values moving window (Fig. 2). In the all cases we can identify higher variability of correlation after the year 2009. The first subsample includes Belgium (BE), Germany (DE), France (FR), Luxembourg (LU), Austria (AT) and Finland (FI) - core Eurozone countries. The second part of the Fig. 2 presents moving correlation of the euro area periphery – Ireland (IE), Greece (GR), Spain (SP), Italy (IT) and Portugal (PT).

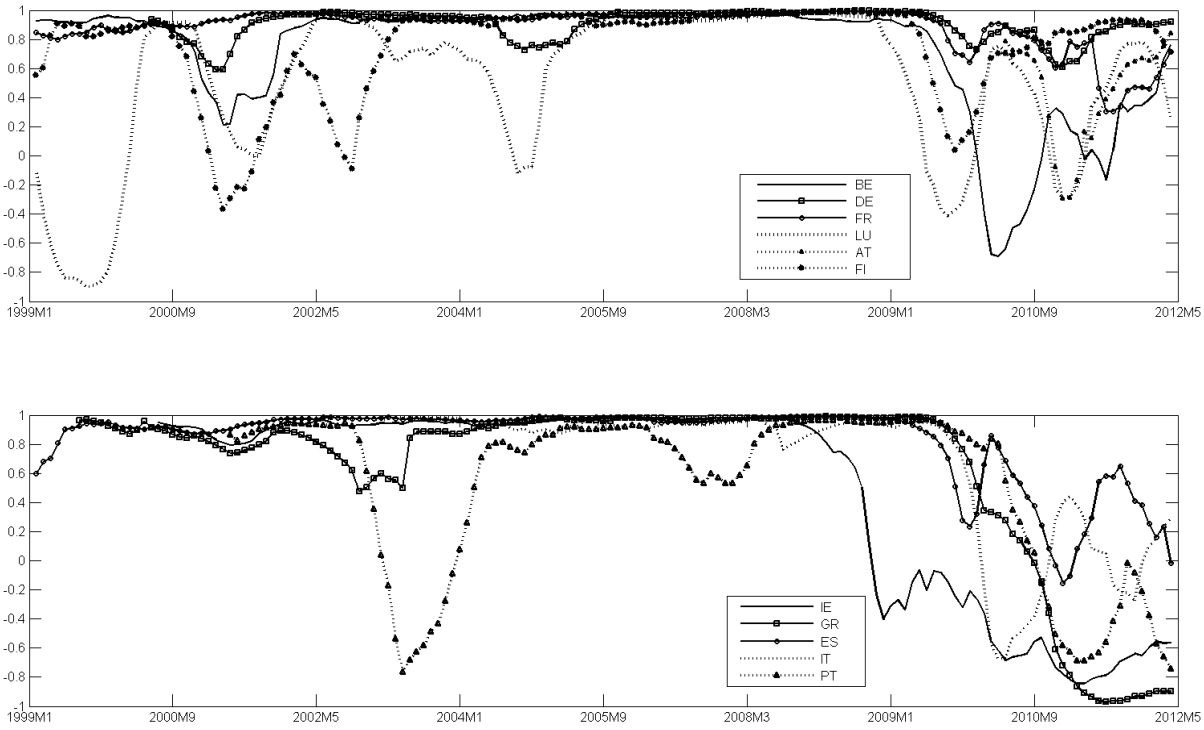

Fig. 2 Moving correlation (Data source: Eurostat)

More detailed view on the money supply distribution across the euro area provides Tab. 1. We can see that national contributions to the monetary aggregate M3 in the Euro area are positively correlated (excluding Slovakia) before the year 2009. After 2009 we identified high differences and direction of dependence as well.

These results do not provide information about the causality. The datasets used in this analysis are not stacionarized. Therefore, the results probably provide spurious correlation. However, we can identify significant structural change after the year 2009. There is difference between the core Eurozone countries (Belgium, Germany, France, Luxembourg, Austria and Finland) and periphery countries (Ireland, Greece, Spain, Italy and Portugal). The national contribution of the core Eurozone countries to the aggregate money supply (M3 excluding currency in circulation) is positive. In the case of periphery countries we identified negative correlations.

Obviously, after the year 1999 Germany significantly contributes to the money aggregate M3 in the whole euro area. On the contrary, the monetary aggregate M3 (excluding currency in circulation) in the whole euro area is negatively correlated with banking system contribution in Greece and Ireland. We cannot conclude that the money supply shock affected negatively periphery countries or there are direct capital flows between Germany and Greece. However, we can interpret the results as the heterogeneous distribution of the money supply across the euro area after the year 2009.

Tab. 1 Money supply correlation within the euro area

	1999M1-2009M12		2010M1-2012M4	
	Correlation coeff.	Sample size	Correlation coeff.	Sample size
Belgium	0,9934 ***	148	0,5409 ***	28
Germany	0,9919 ***	132	0,9151 ***	28
Estonia	0,9824 ***	22	NA	
Ireland	0,9849 ***	130	-0,8627 ***	28
Greece	0,9846 ***	142	-0,9598 ***	28
Spain	0,9974 ***	148	0,4301 **	28
France	0,9986 ***	148	0,7617 ***	28
Italy	0,9758 ***	109	0,2640	28
Cyprus	NA		NA	
Luxembourg	0,9737 ***	148	0,5235 ***	28
Malta	NA		NA	
Netherlands	NA		NA	
Austria	0,7114 ***	13	0,7654 ***	28
Portugal	0,9681 ***	121	-0,7458 ***	28
Slovenia	0,7105 **	10	NA	
Slovakia	-0,4175	11	NA	
Finland	0,9859 ***	148	0,8893 ***	28

Source: own calculation
Note: Statistically significant at a 1% (***), 5% (**), 10% (*), NA – not available observations

This result is at least surprising in the context of OCA theory and common monetary policy efficiency. The financial crisis is mostly described as the global negative symmetric shock affected all member countries in the euro area. The OCA theory assumes that a common monetary policy is efficient if business cycles are co-moved in the all member countries within a currency area. Especially, its stabilization effect is maximized. Thus, the decline in economic activity during the financial crises should be effectively stabilized by common monetary policy of the ECB. Therefore, we expected co-movement in money distribution across the euro area after the year 2008. As we mentioned in the introduction, the key problem is in money demand heterogeneity.

In the next part of the empirical analysis we try to identify co-movements in money supply at different range of frequencies. It means that we try to distinguish between short and long-term co-movements or temporary and permanent shocks in money distribution across the auro area. In the

empirical analysis we have to consider changes in time as well. We focus on time-frequency representation of time series and their time-frequency cross-spectrum representation calculated between Euro area and the selected country. The country selection was done according to the result of correlation coefficient in the two periods (Tab. 1). We distinguish three basic cases. (1) Countries where the correlations were not significantly changed in time (Germany, France), (2) countries where the correlations were statistically significant, but the relation changed (Greece) and (3) countries where the correlations were statistically significant but insignificant after the year 2009 (Italy).

To analyze selected time series in time-frequency domain we used Daubeschie wavelet. Before the application of Wavelet transform we applied Hodric-Prescott filter (Hodrick and Prescott, 1980) to remove long-term trend.

Each figure (Fig. 3-6) consists of six basic charts. The first row shows two charts in time domain representation of euro area and selected country, the second row illustrates their time-frequency domain representations. In the third row we can find the results of the wavelet analysis. These two charts of time-frequency dependence measurement called a cross-spectrum, more precisely its absolute value (the left chart is 3 dimensional, the right 2 dimensional).

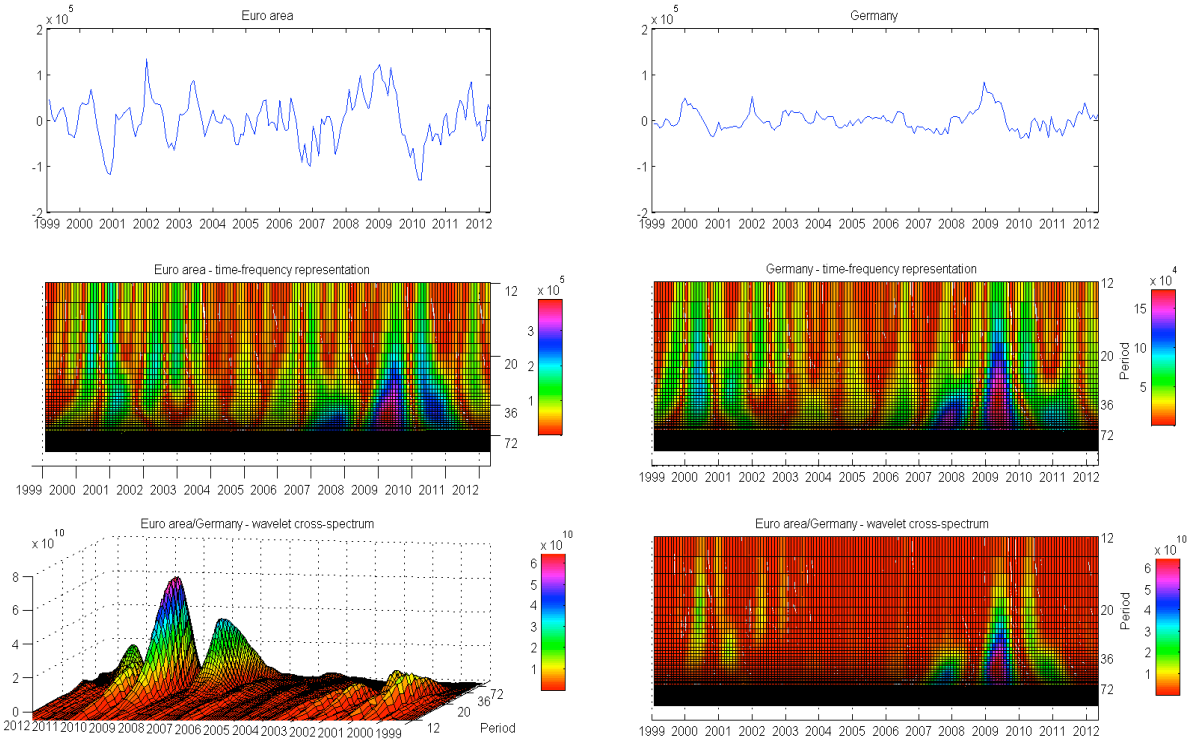

Fig. 3 Euro area and Germany, time-frequency domain representation (Source: own calculation)

Looking at the time representation of euro area and Germany (Fig. 3) we see lower variability in Germany. We can see different drift in 2007-2008 (increase in the euro area, stagnancy in Germany). The time-frequency cross-spectrum identified co-movement in the 2nd half of the year 2008 and in the years 2009-2010. The both co-movements are significant at low frequency range, from 36 to 72 months (3 to 6 years). We can conclude that there are cyclical co-movements of money supply between the euro area and Germany at a cycle length more than 3 years. Thus, to money supply contribution of the German banking system is correlated at the specific cycles during in the year 2009 and 2010. We assume that German banking system played crucial role in money supply in the euro area during the global financial and subsequent European debt crisis.

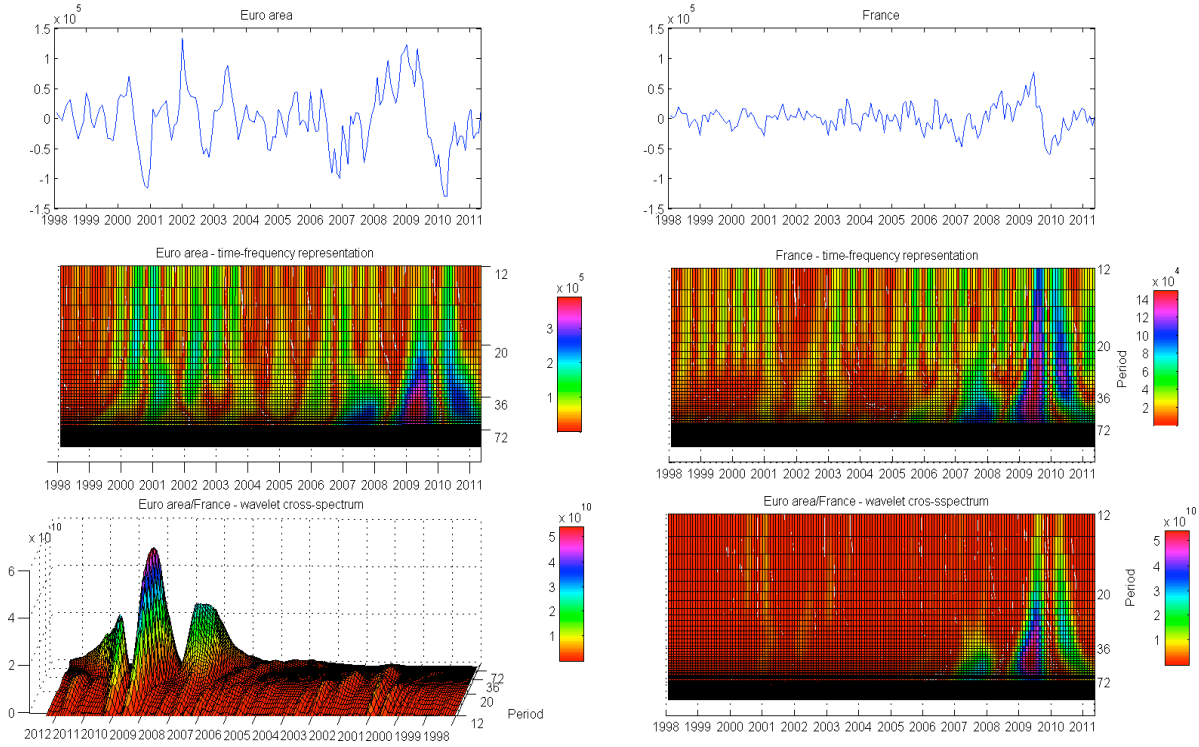

Fig. 4 Euro area and France, time-frequency domain representation (Source: own calculation)

The time representation of national contribution to the monetary aggregate M3 in France (Fig. 4) shows lower variability compare to the euro area as well. The wavelet analysis provided similar results as in Germany. We found co-movements in the years 2008, 2009 and 2010. The co-movements are significant at range from 36 to 72 months, but there are also co-movements in shorter cycles, shortest to one year during the crisis years.

Finally, we can conclude that national contribution of the core Eurozone countries (Germany and France) to the aggregate money supply were significantly correlated when negative symmetric shock

occurred. The analysis in time domain (Tab. 1) showed positive correlation and wavelet analysis identified cyclical co-movements in cycle length of 3 or more years.

Fig. 5 presents national contribution of the banking system in Greece. The time domain representation indicate stable money supply untill the year 2008 with the lowest variability among the all selected countries (y-axis is limited at 1.5 x 10^4). Similarly to other analyzed countries, after the year 2008 the variability increased. During the years of crisis we found co-movements at wider spectra of cycles. Unlike the core Eurozone countries the correlation is negative (Tab. 1).

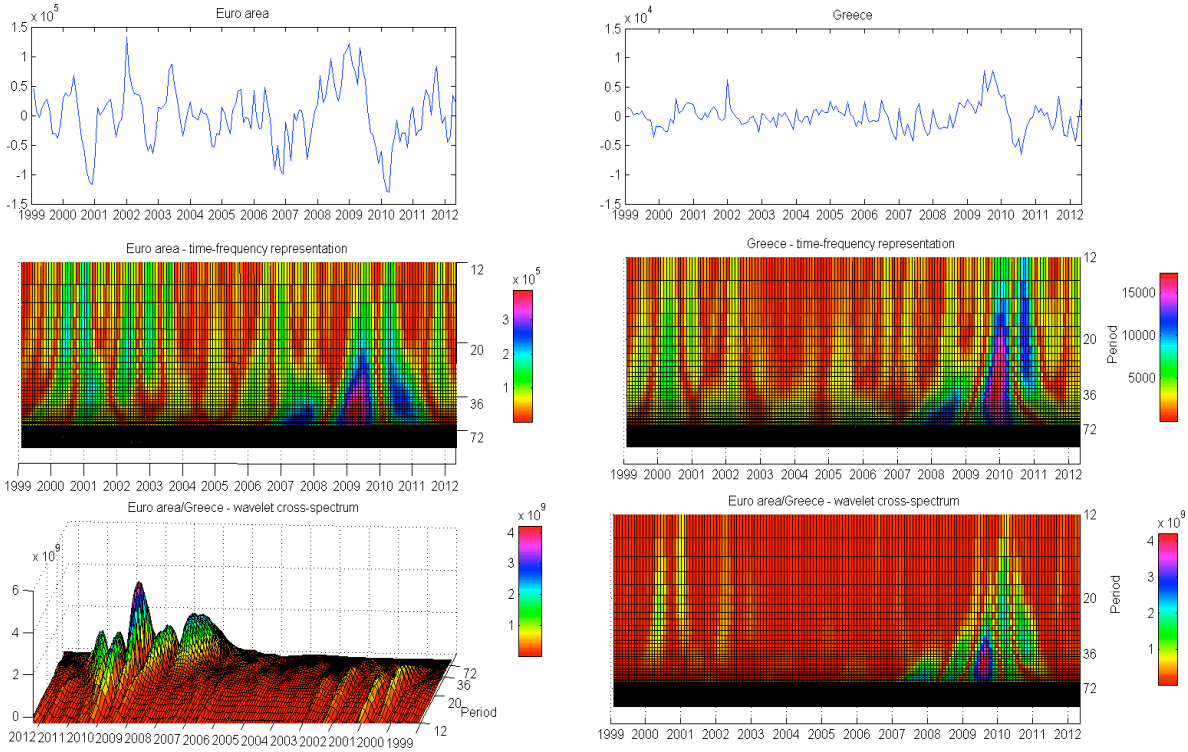

Fig. 5 Euro area and Greece, time-frequency domain representation (Source: own calculation)

The last case is Italy (Fig. 6). The evolution of the national contribution to the monetary aggregate M3 in the whole euro area indicates different behavior compare to others selected countries. The wavelet analysis identified co-movements in different time periods. We found significant co-movements in late 2007. The indication of co-movement at range from 36 to 72 months (3 to 6 years) we can identify in the year 2009. The co-movements at specific cycles are not so significant in comparison with other findings. The banking system in Italy has very specific characteristics which differentiate it from other European countries. It is specialized in traditional activities. Therefore the recent financial crisis mainly affected non-banking financial intermediaries. The reduction in investments and consumption has had a deep impact on specialized credit (leasing, factoring or retail credits).

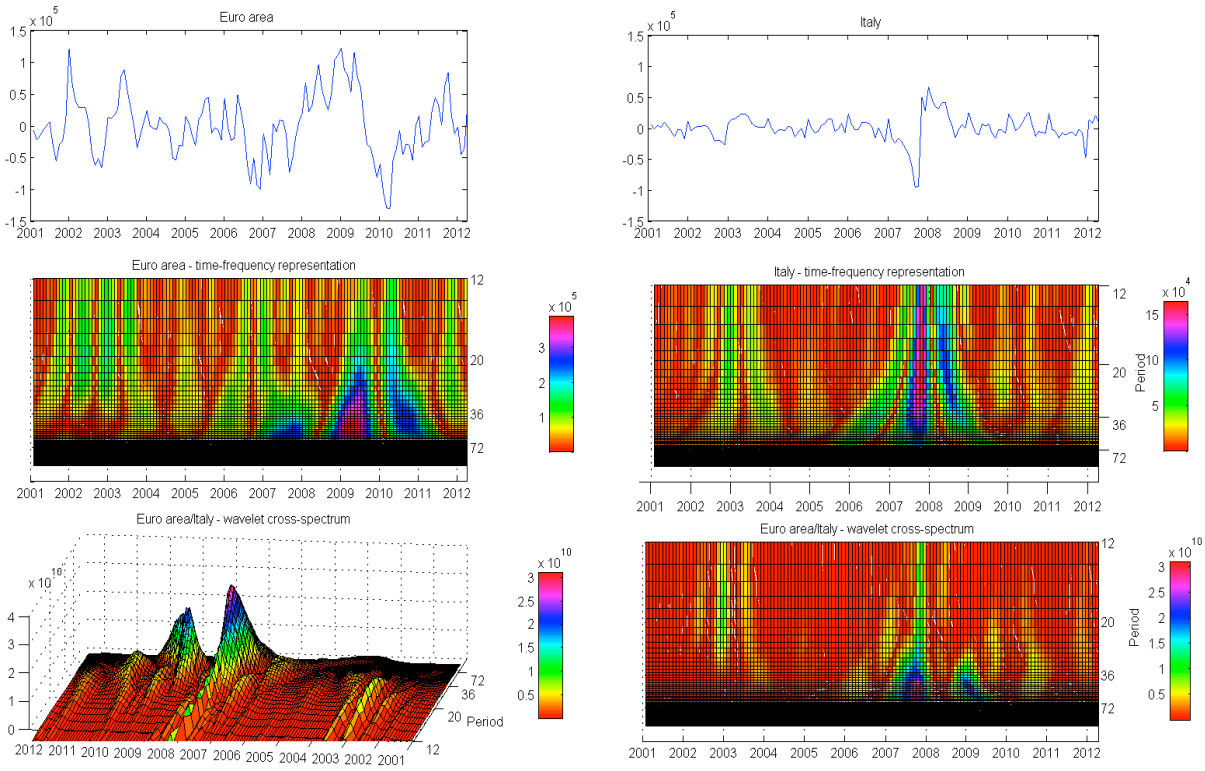

Fig. 6. Euro area and Italy, time-frequency domain representation (Source: own calculation)

Our results support the assumption of the long-term cyclical co-movements. Therefore we can discuss the relationship between the national contribution to the aggregate money supply in the euro area and aggregate monetary base. However, our findings identified positive relations in the case of the core Eurozone countries. On the contrary, the money supply in Greece is negatively correlated with the euro area.

Conclusions

In this paper we provided results of co-movements analysis in time and time-frequency domain. In time domain we identified significant changes of the national contribution in the individual Eurozone member states to the euro area monetary aggregate M3 in the year 2009. After this year the significant heterogeneity of the money supply distribution occurred across the Eurozone. According to our findings, banking systems in Germany and France (core Eurozone countries) played crucial role for the money supply of the whole euro area. In the period 2010-2012 banking system in Ireland and Greece negatively contributed to the money supply whereas the ECB provided liquidity and the core Eurozone member countries increased the money supply (especially Germany, France, Austria and Finland).

More detailed information provided wavelet analysis. We identified cyclical movements of money supply at length from 36 to 72 months (3 to 6 years) in the analyzed countries. Consequently, we found that these cycles were co-moved in specific periods. In Germany and France we identified two separate co-movement periods. The first became with the global financial crisis and the second in late 2009 when the European debt crisis began. The co-movements of the cycles at length from 36 to 72 months (3 to 6 years) were found in Greece as well. We conclude that the symmetric shock in economic activity within the currency union was accompanied by cyclical co-movement of money supply. However, the contribution of national banking systems is heterogeneous. The money supply increase in the core Eurozone countries was accompanied by decrease in the periphery countries, especially in Greece.

We conclude that changes in money supply in different countries within the currency union co-moved after the both negative symmetric shock occurred and ECB reduced massive liquidity injections. Note, that the co-movements were not identified in the period of financial crisis intensification when the banks in the euro area were gripped by a full-scale liquidity crisis. Concurrently, the national contribution to the aggregate money supply in the euro area differs. We found positive correlation in the core eurozone countries and negative at the periphery. According to the theoretical background, the heterogeneity should be caused by differences in money demand across the euro area. However, the heterogeneity was found while economic recession involved all analysed countries. Thus, the demand for money should be reduced in all these countries.

There are two important implications for macroeconomic policy. (1) We assume that national banking systems reciprocally balanced and redistributed money supply across the euro area. Lowering barriers to capital flows allow compensate liquidity providing by central monetary authority.

(2) Significant differences of national contribution to the money supply is less apparent at the aggregate level and yet could eventually have systemic and financial stability risks for the euro area as a whole. The process of credit money creation is arranged by the national banking systems, independently of the European central bank and common monetary policy. Therefore, the financial instability indicators (especially credit creation and changes in asset prices) should be monitored at the country level.

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