EURASIAN JOURNAL OF ECONOMICS AND FINANCE

http://www.eurasianpublications.com

AN EMPIRICAL STUDY OF THE CORRELATION BETWEEN THE MONETARY AGGREGATES AND THE PRICE LEVEL IN EURO AREA IN THE YEARS 2004 - 2013

Ludomir Slahor
Comenius University, Slovakia. Email: ludomir.slahor@fm.uniba.sk

Daniela Majercakova
Corresponding Author: Comenius University, Slovakia.
Email: daniela.majercakova@fm.uniba.sk

Alexandra Mittelman
Comenius University, Slovakia. Email: alexandra.mittelman@fm.uniba.sk

Abstract

The historical evidence suggests a high correlation between changes in the stock of money per unit of output and changes in prices in the same direction. The goal of this paper is to analyze the correlation between the monetary aggregates and the price stability before, during and after the financial and debt crisis in the European Monetary Union. For this purpose, firstly, the paper includes some basic theoretical aspects, secondly, practical analysis based on the Pearson product-moment correlation coefficient as a degree of the dependence between the monetary aggregate M3 and the harmonized index of consumer prices. The main task of the present paper is, accordingly, to consider, if there is any relationship between these variables, and whether there is any substantial reason for modifying the current mainstream mode of the policy analysis. The data were obtained from the data warehouses of the European Central Bank and the Statistical Office of the European Community (Eurostat). The obtained data were split up into 4 segments by the timetable of the period before the crisis, during the first and the second stage of the crisis and after the crisis. The base for the analysis was the quantitative theory of money, which states that money supply has the direct, proportional relationship with the price level. In general, we were able to identify the existence of very strong dependency between the content of monetary aggregate M3 and the price level measured by HICP, especially in the case when the data were not influenced by the seasonal aspects and within the delay of one month. It means that the transmission of monetary policy of ECB reacted relatively fast. On the other hand, the rapidity of transmission of monetary policy and its effectiveness is still not at the same level as it was in the period before the crisis and the influence of the crisis is still strongly visible.

Keywords: Monetary Aggregates, Money Supply, Inflation, Price Level, Correlation, Euro Area
JEL Classification: E31, E50

1. Introduction

Relationship between the money supply and overall price level has attracted a considerable amount of work in both economics and statistics for a very long time. Since the 1970s, central banks worldwide have affected the nominal quantities of money through their policy actions. These policy actions have included buying and selling government securities, changing reserve requirements and changing the interest rates at which central banks provide reserves to financial intermediaries, especially commercial banks.

M3 money supply is the European Central Bank′s broadest measure of money supply growth. It consists of M1 which is currency in circulation plus overnight deposits and M2 which includes deposits with an agreed maturity up to two years deposits redeemable at up to three months′ notice. To M3 belong also repurchase agreements, money market fund shares/units and debt securities up to two years. As a result of their inclusion, M3 is less affected by substitution between various liquid asset categories than narrower definitions of money, and is therefore more stable. Since January 1999, the ECB has used the year-over-year three-month moving average as its preferred measure of money supply growth.

M3 money supply was established as one of the "two pillars" of monetary policy used by the ECB, the other being the harmonized index of consumer prices (HICP) which has been constructed to allow cross EU member state comparisons. While the target for HICP is two percent, the seemingly largely ignored reference target for M3 growth is 4.5 percent as measured by a three month moving average which is compared with the same three months a year earlier. Of course, the ECB does not focus exclusively on M3, but analyzes a full set of monetary, financial and economic information. It employs a wide range of models, including money demand equations, time series indicator models and structural general equilibrium models. "The leading indicator properties of money regarding future prices have always been regarded as a centerpiece of the special role assigned to monetary analysis in the ECB´s monetary policy strategy." (Alves *et al.* 2007, p.18)

A central underpinning of the ECB two-pillar monetary policy strategy is a stable medium to long-run relationship between the growth rates of monetary aggregate M3 and HICP. As the Euro area has experienced a very turbulent period in recent years, it is interesting to see whether this relationship was and have been attained and how quickly monetary policy decisions have been transformed into the real economy. Is concerning also on the idea, that "The stability of monetary aggregates is verified by studying the stability of money velocity" (Ndjokou, 2011, p.2). Our paper is motivated by the recent literature on the importance of monetary aggregates for monetary policy as well as the discussion on the current strategy of the ECB. Few of the basic ideas should be summarized to the few sentences; the fact as Whelan (2014) said, that "ECB in period of last year's is failing in process to meet its own definition of price stability" is break off and "the apparent monetary overhang can be reconciled within standard models of money demand" (Dreger and Wolters, 2006, p.1). "According to the principles of structural change, the statistic characteristics would vary at the breakpoint between two segments of money stock which is a piecewise stationary series" (Chi, 2014, p.85).

The rest of the paper is organized as follows. In section 2, the data series between 2004 and 2013 used in the empirical analysis are discussed. This time interval was divided into four segments, namely 2004-2006 pre-financial crisis, the 2007-2009 global financial crisis, 2010-2012 sovereign debt crisis and post-financial crisis after 2012. Section 3 is devoted to show the relationship between M3 and HICP in different time segments. Section 4 concludes.

2. The ECB Statistical Data Warehouse as a Source of Data Series for M3 and HICP

In September 2006, the ECB released the first version of its online delivery service via the internet, the ECB Statistical Data Warehouse (SDW). The SDW is designed to address a wide range of Euro area statistics users. It features interfaces that provide access to many features and functions, designed to make data accessible to users regardless of their knowledge of IT systems or the intricacies of statistics. The SDW provides data on Euro area monetary policy, financial stability and the activities of the European System of Central Banks (ESCB).

Aggregate series are based on observations from national central banks, credit institutions and international data sources. Data is available in many different thematic categories, like for example, monetary operations, prices, monetary and financial statistics, Euro area accounts, etc.

Data series for M3 and HICP in the time interval between 2004 and 2013 were downloaded from the corresponding part of the SDW. They are available both in seasonally adjusted (adj) and not seasonally adjusted (notadj) form. Seasonal adjustment is essential for the purpose of the short-term analysis, since it allows the removal of different variations in the time series that are repeated, more or less regularly, every year. The sources of seasonality in monetary aggregates are various. For currency in circulation and overnight deposits, the holiday period in summer, the 13th month salary and the payment of value added and income tax play an important role as well as interaction with marketable instruments at the end of the year. An important feature of the seasonality in monetary aggregates is its slowly moving character.

Figure 1. HICP_EU_notadj_ANR (2004-2013)
Source: SDW ECB

As said before, the HICP was developed for the purpose of measuring convergence on a comparable basis, as you should see at Figure 1. Since the start of the single monetary policy in the Euro area, the HICP has been a key indicator for the monetary policy strategy of the Eurosystem. The national HICPs which are available from 1995 have the common product coverage, but index baskets and weights reflect national consumption patterns. Before that date, series were extended using national CPIs adjusted to the coverage of HICPs. Seasonal price movements may be defined as intra-year changes occurring to a similar extent in successive years. In general, seasonal variations in prices are stronger in national series than in Euro area aggregates, as can be seen at Figure 2.

Figure 2. M3_EU_ajd_AGR (2004-2013)
Source: SDW ECB

The HICP and M3 data series can be accessed from the ECB Statistical Data Warehouse in many different forms. The annual rate of change (ANR) is the current month's index in respect to the same month's index a year previously. Instead, in the case of M3, we will use the annual growth rate (AGR).

$$(HICP_n - HICP_{n-1})/HICP_{n-1}$$

$$(M3_n - M3_{n-1})/M3_{n-1}$$

The monthly rate of change (MOR) is the current month's index in respect to the previous month's index. By M3 we will use growth rate to previous period (GR). The HICP base or comparison period is the year 2005 expressed by 100 index points (2005=100), as established by the Regulation (EC) no. 1708/2005 of the 20th October 2005.

The data which we analyzed in our paper were broken up into four segments: 2004-2006 pre-financial crisis, the 2007-2009 global financial crisis with Lehman Brothers collapse, 2010-2012 sovereign debt crisis and post-financial crisis after 2012. In the framework of these time periods, at first, we will describe the trends of the development of M3 and HICP individually and, as a second step, we will analyze their correlation. Our main objective was to find the accurate time lags between the actual changes of the money growth and delayed price changes.

3. The Analysis of the Relationships between HICP and M3

In the following section we are going to dedicate our attention to the relationships between the change of monetary aggregate M3 and the change of price level measured by HICP index. As we said before, the changes of price level result from the change of money supply and there must be a correlation between them. We could expect that if ECB supplies larger amount of money to the system, the inflation should increase.

Correlation is the measure of interdependence between two (or generally) more variables that can reach the values from the interval ≤-1,1≥ (Komornik and Komornikova, 2013). Value -1 represents the highest negative correlation, value 1, on the contrary, the highest positive correlation. The level 0 means no correlation. We used Pearson's correlation coefficient that is defined as follows:

$$r = \frac{\Sigma \, (x - \bar{x})(y - \bar{y})}{[\, \Sigma \, (x - \bar{x})^2 \, \Sigma \, (y - y)^2]^{1/2}}$$

where $\bar{x}$ and $\bar{y}$ are mean values of the sets.

Pearson's correlation coefficient is the most used type of correlation coefficient. It is used when variables are measured at least on the interval scale and does not depend on the coefficient scale where the variables were measured (in our case M3 is measured in millions of EUR and HICP in annual percentage rate change). This type of correlation represents the linear dependence among variables.

We have at our disposal 5 types of data series of monetary aggregate M3 from the statistical data warehouse of ECB: M3_EU_adj_AGR, M3_EU_adj_GR, M3_EU_adj, M3_EU_notadj, M3_EU_notadj_AGR. We have also 4 types of inflation measurement: HICP_EU_adj_INX, HICP_EU_adj_MOR, HICP_EU_notadj_ANR, HICP_EU_notadj_INX. For each of the variable of M3, we have done an analysis on the basis of the correlation between this variable and every variable from 4 variables describing the price level changes. The aim was to find which of the HICP values and the monetary aggregate M3 correlate together at the highest level and when. In other words, how long is the time delay between M3 change and its impact on HICP.

As far as this above mentioned process will not happen from day to day, it is important to determine the time delay correctly. In general, we have used 4 time periods from the years between 2004 and 2013 and the correlations with the time difference from 1 month up to 2 years for the particular time periods. For the last time period after 2012 ("post/financial crisis") we have used the time difference to 6 months only, as far as we did not have enough amount of data available.

In the following, we will provide information about the results of correlation analyses made in EXCEL program, by means of the function "Data Analysis", specifically the function "Correlation". At first, we will study the data as one unit and as the second step we will describe gradually the correlations within the predefined time segments.

3.1. Overall Data (2004 – 2013)

The most important relationship between the variables within the time difference from 1 to 24 months in the period observed was seen between the monetary aggregate M3 measured as the volume in millions of EUR in the month given (from the 3rd month's difference not only for the data adjusted seasonally, but also for the data not adjusted) and HICP measured as the monthly index with the base year 2005 for the data adjusted seasonally and not adjusted at all. As we can see from the Figure 3 and Figure 4, the correlation was here higher than 0.9, The strongest relationship is specifically between monetary aggregate M3 measured by the means of volume in the months given in the seasonally adjusted data and HICP with the base year 2005 for seasonally adjusted data; the correlation from the total time difference was the highest, namely +0,9359. The difference between the data seasonally adjusted and not adjusted regarding the correlation was not significant.
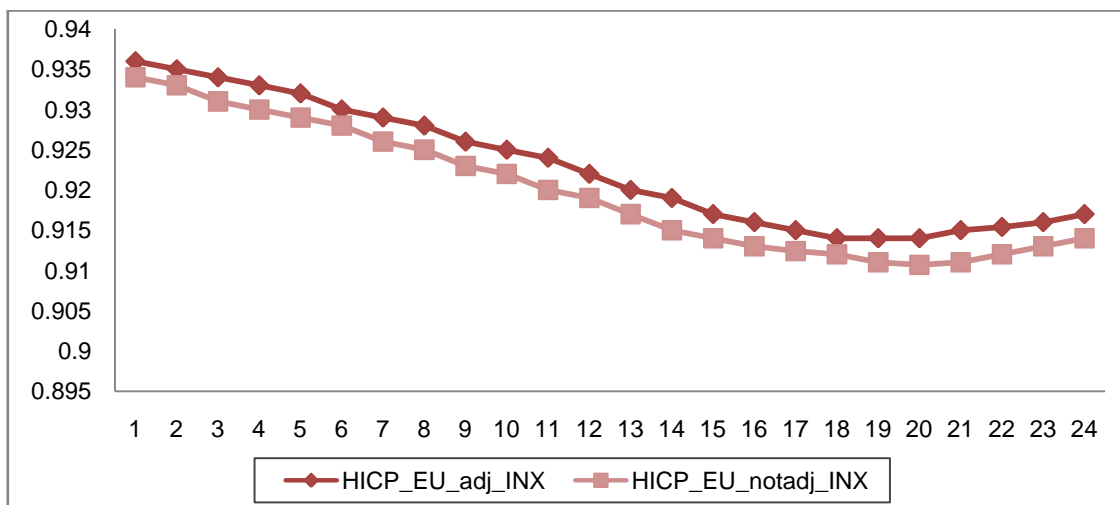
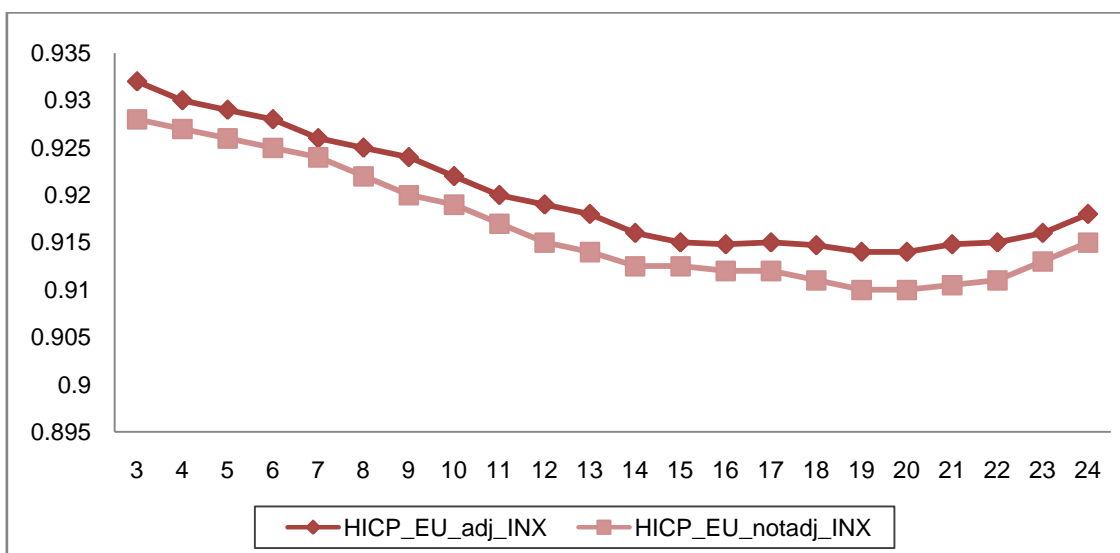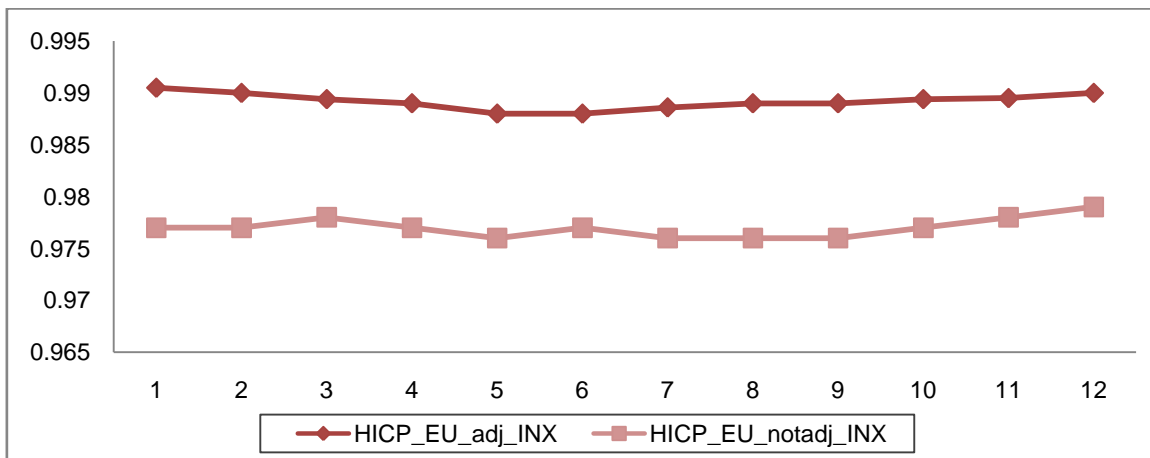**Figure 3. Correlation of M3_EU_adj_volume with HICP (delay in number of months)**

Figure 4. Correlation of M3_EU_notadj_volume with HICP (delay in number of months)

3.2. Pre-financial Crisis Period (2004 – 2007)

As we can see from the Figure 5 and Figure 6, in this time period the monetary aggregate M3 (as the volume of millions of EUR) was strongly correlated with HICP measured as the monthly index with the base year 2005 (similar result as in the overall time period 2004-2013). There are substantially stronger correlated HICP that are seasonally adjusted. These correlations are stronger than with those M3 without seasonal adjustment, whereby there is moderately decreasing trend till the half-year time delay, after there is the increasing correlation again. M3 for seasonally not adjusted data and HICP for seasonally adjusted data are correlated little bit stronger than with HICP for not seasonally adjusted data.
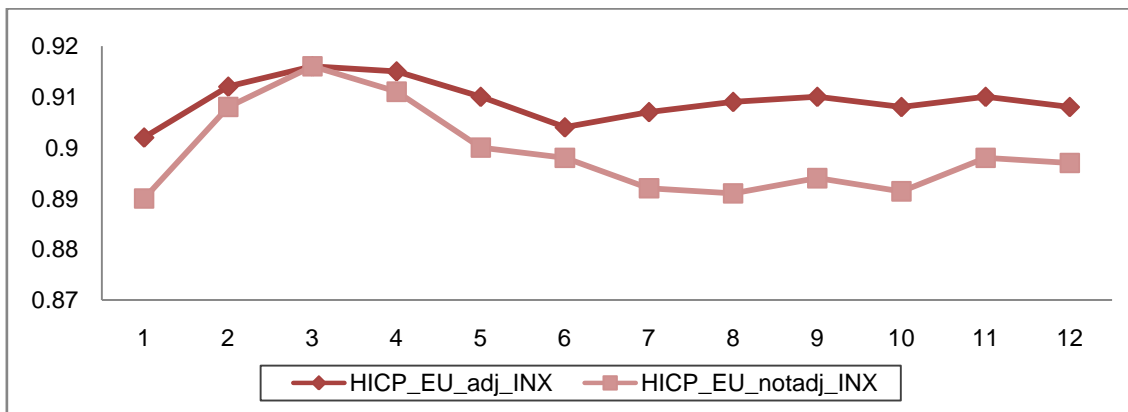
Figure 5. Correlation of M3_EU_adj_volume with HICP (delay in number of months)
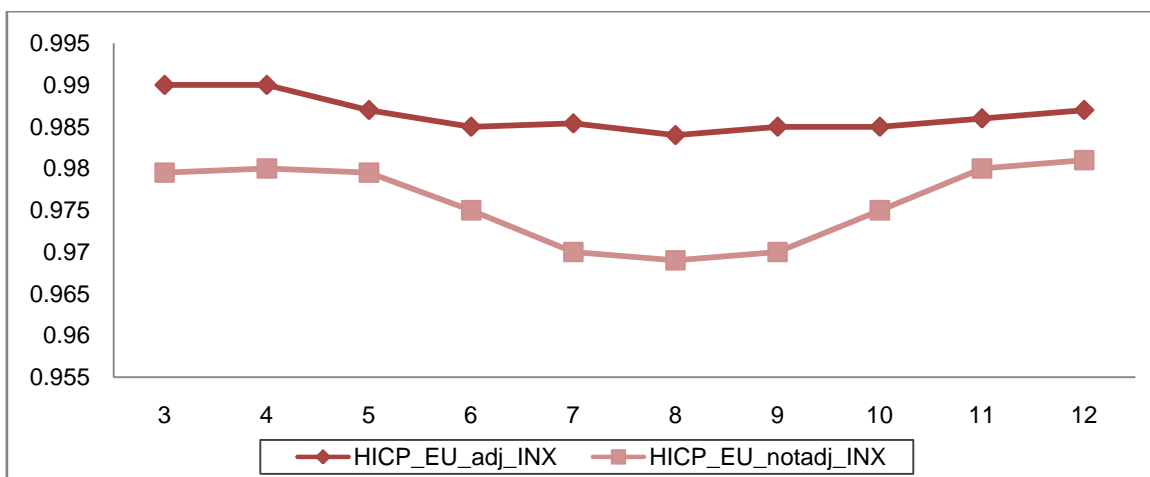
Figure 6. Correlation of M3_EU_notadj_volume with HICP (delay in number of months)

Also, as we can see from the Figure 7 and Figure 8, the combination of M3_EU_adj_AGR and HICP (given according to the base year 2005) has been shown as strongly correlated. We can see here the more expressive difference in the correlation between HICP with seasonally data adjustment and not seasonally data adjustment. The highest correlation is for the time delay of three months, namely +0.916, for both, seasonally adjusted and seasonally not adjusted HICP. For the seasonally not adjusted levels of monetary aggregate M3 (M3_EU_notadj_AGR) the highest levels are visible after three months of the time delay.

Figure 7. Correlation of M3_EU_adj_AGR with HICP (delay in number of months)
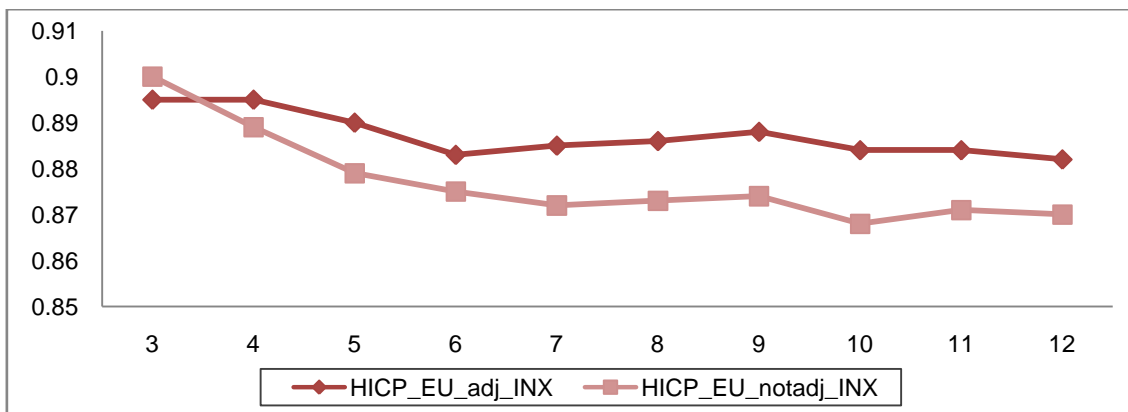
Figure 8. Correlation of M3_EU_notadj_AGR with HICP (delay in number of months)

3.3. Global Financial Crisis Period (2007 – 2009)

For this time period, statistically significant correlation between M3 (measured as the volume in millions of EUR) and HICP as monthly rate of change is identifiable for both, seasonally adjusted and seasonally not adjusted data.
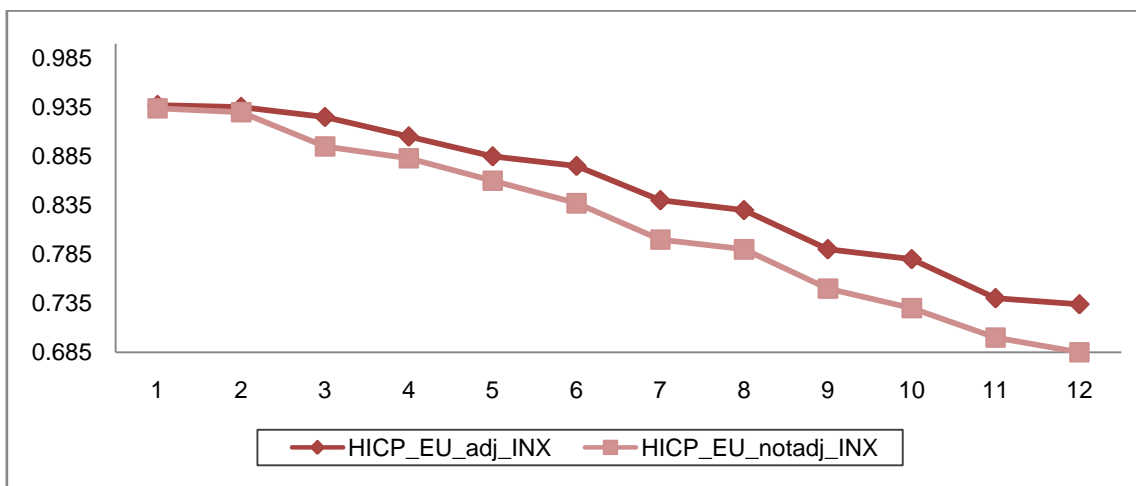

Figure 9. Correlation of M3_EU_adj_volume with HICP (delay in number of months)

Similar to the foregoing cases, seasonally adjusted HICP does have the highest correlation as well, even though only by decimal numbers, as it can be seen at Figure 9 together with Figure 10 for comparison. The correlation trend has decreasing character in time. The highest level of correlation (+0.9465) between M3 and HICP is after one month delay.
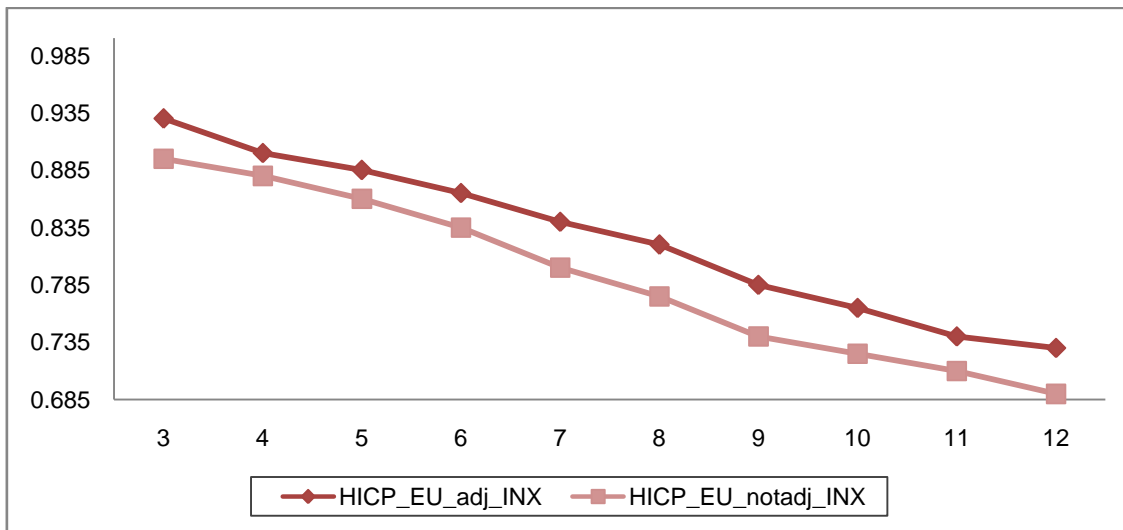

Figure 10. Correlation of M3_EU_notadj_volume with HICP (delay in number of months)

3.4. Sovereign Debt Crisis Period (2010 – 2012)

Correlation between M3_EU_adj_volume and HICP for seasonally adjusted (HICP_EU_adj_INX) and seasonally not adjusted data (HICP_EU_notadj_INX) is strongly decreasing with time and the most important relationship is after the first month when the correlation is equal to +0.9106 (see Figure 11 and Figure 12).
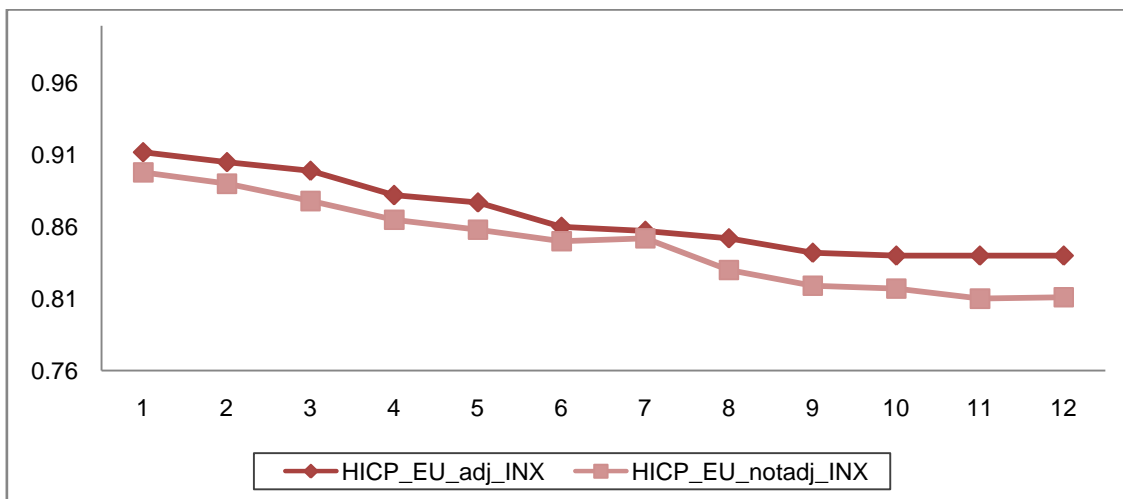

Figure 11. Correlation of M3_EU_adj_volume with HICP (delay in number of months)
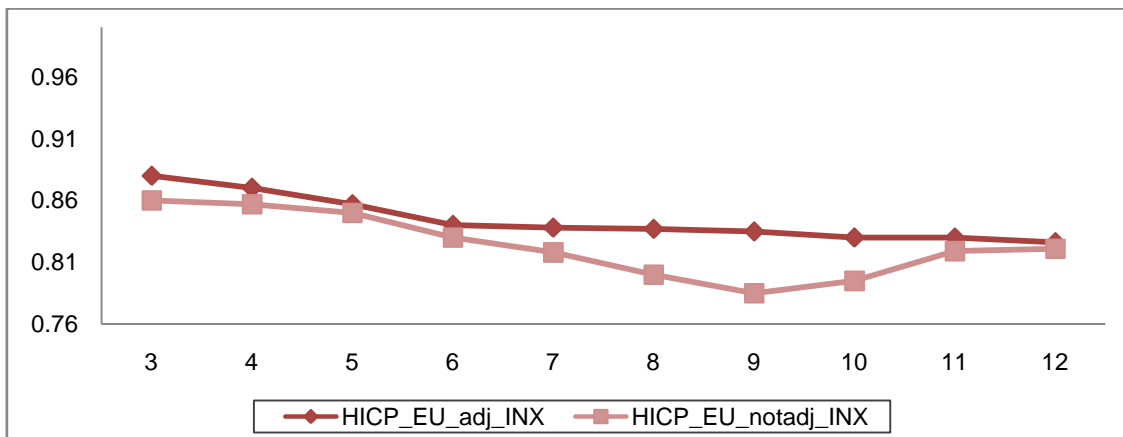
Figure 12. Correlation of M3_EU_notadj_volume with HICP (delay in number of months)

Correlation between M3_EU_adj_AGR and HICP with seasonally adjusted and seasonally not adjusted data is decreasing relatively slowly. HICP_EU_notadj_INX basically copy HICP_EU_adj_INX, although with the lower correlation. As we can see from the Figure 13, seasonally adjusted data of annual change of monetary aggregate M3 (M3_EU_adj_AGR) correlate with HICP at the highest level after two months; +0.9429 for seasonally adjusted data and +0.9249 for seasonally not adjusted data.

On the other side (Figure 14), correlation of M3_EU_notadj_AGR with HICP is at the highest level after 7 months; +0.9066 for HICP seasonally adjusted and +0.8981 for HICP not seasonally adjusted.
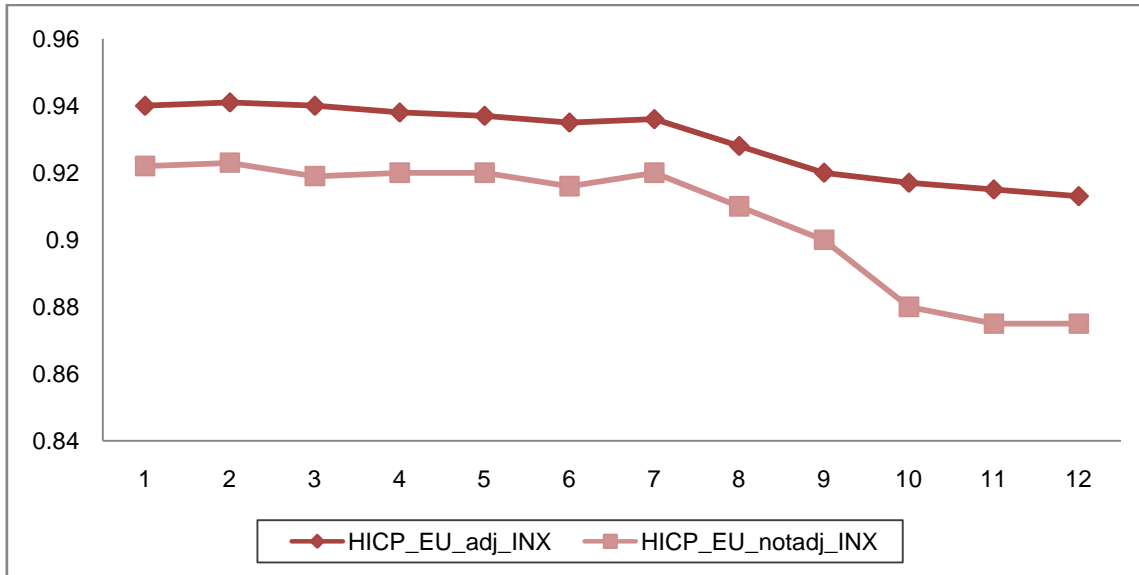

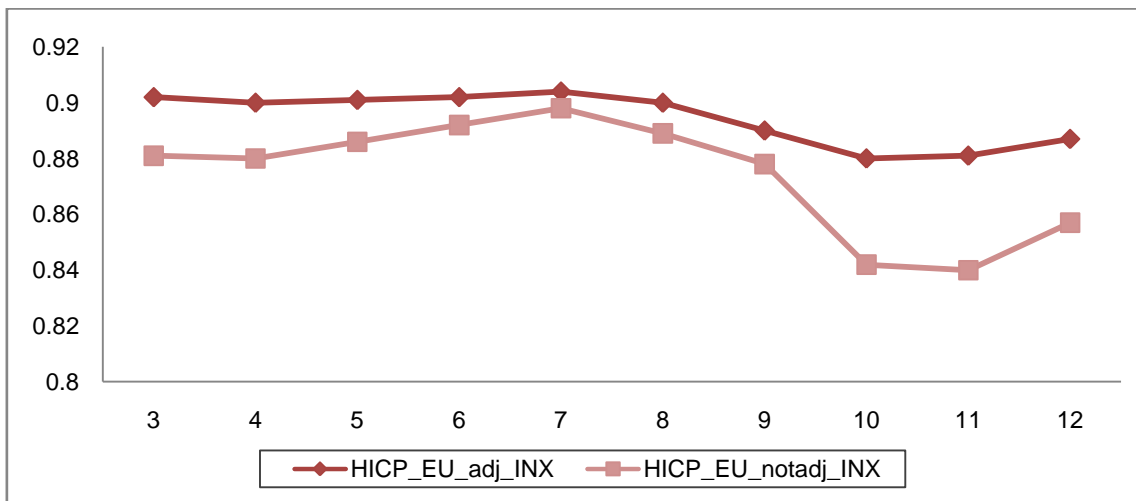**Figure 13. Correlation of M3_EU_adj_AGR with HICP (delay in number of months)**

Figure 14. Correlation of M3_EU_notadj_AGR with HICP (delay in number of months)

3.5. Post - Financial Crisis Period (2013)

This final period of only six months is too short for doing the full correlation analysis. However, we can try at least outline an approximate picture of the situation after observing the first couple of months of time delay.

From the available data, we can see the following pairs of data highly correlated: firstly, M3_EU_adj_volume and HICP_EU_adj_INX (Figure 15), secondly, M3_EU_notadj_volume and HICP_EU_adj_INX (Figure 16) and finally, M3_EU_notadj_volume and HICP_EU_notadj_ANR (Figure 17).

In the first case (Figure 15) the correlation between M3 and HICP was after first month of time delay at the level +0.7911 and was decreasing gradually. In the second case (Figure 16) it was at the level +0.9097 after the fourth month of time delay and in the third case (Figure 17) the correlation was +0.8452 after the first month of time delay.
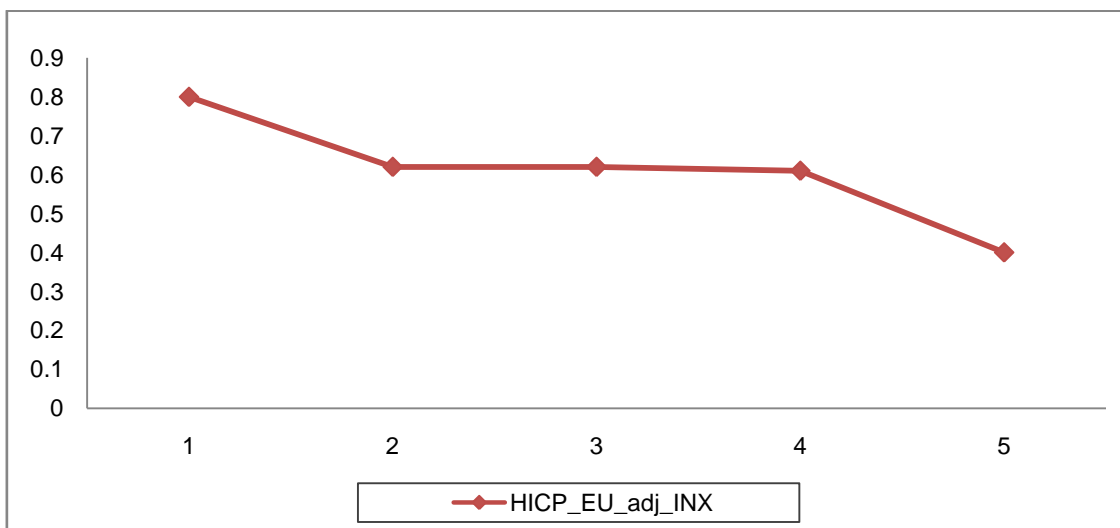

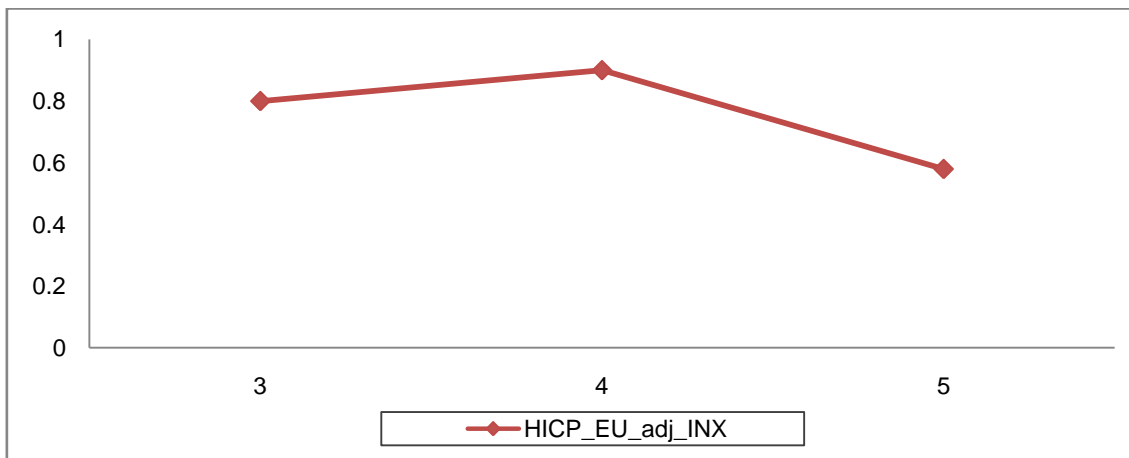**Figure 15. Correlation of M3_EU_adj_volume with HICP (delay in number of months)**

Figure 16. Correlation of M3_EU_notadj_volume with HICP (delay in number of months)
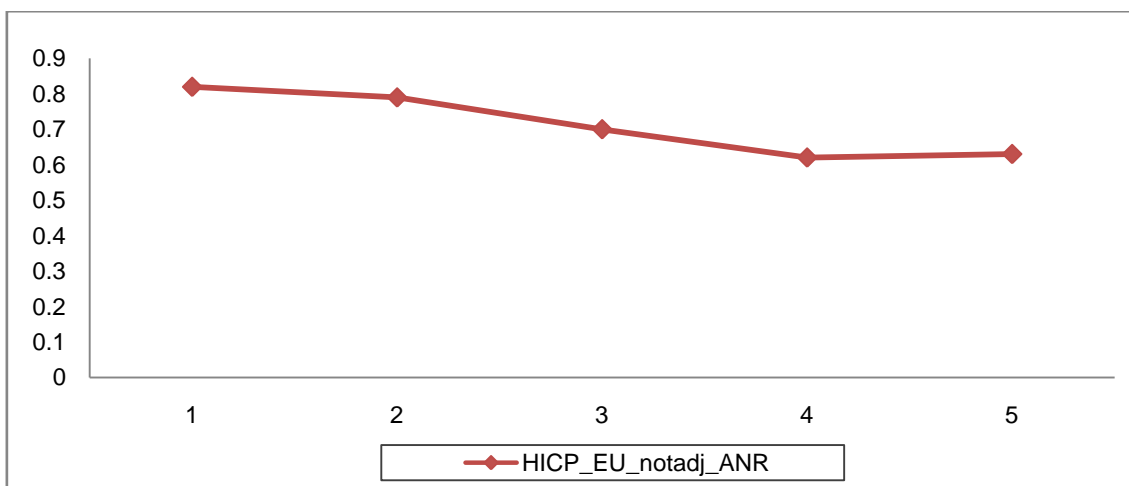

Figure 17. Correlation of M3_EU_notajd_volume with HICP (delay in number of months)

4. Conclusions

Globally, we can say that there is a strong dependence (positive correlation) between the monetary aggregate M3 and price level measured by the means of HICP. This applies mainly with the seasonally adjusted data, data that were cleaned from the seasonal effects and especially with the time delay of one month. It seems that the transmission of the monetary policy of ECB works rather fast.

       This transmission speed was specifically important in the crisis periods, where we can see that the correlation between M3 and HICP is smaller (+0.9450) as it was in the pre-financial crisis period (0.9900). We can conclude that the effectiveness of the monetary policy during the pre-financial crisis period was higher than during the crisis, so that it was not able to react to the threats of endangering the price stability of ECB so dynamically as during the "ordinary" years (what is understandable).

       In the sovereign debt crisis period, it took even more than one month for the decisions about money supply were transferred into the price level change (Figure 13 and Figure 14), where the correlation between M3 and HICP was the highest after two or up to seven months. In post-financial crisis period, it seems that the trend of crisis has not gone yet, because the correlation among the variables reaches only +0.9100 (this can be caused by the following of the too short time period).

When comparing the development in pre-financial crisis period and post-financial crisis period, we can state that the transmission speed of the monetary policy and its effectiveness is still not on the pre-financial crisis level and that the influence of crises was in the year 2013 still strongly visible. However, the principle of the dependence of price level from money supply was always kept.

References

Alves, N., Marques, C.R., and Sousa, J., 2007. Is the Euro Area M3 abandoning us? *Banco de Portugal Economics and Research Department Working Papers*, 20.

Chi, Q., 2014. The impact of money supply on the price: Evidence from China. *Research in World Economy*, 5(1), pp.75-87. http://dx.doi.org/10.5430/rwe.v5n1p75

Dreger, C. and Wolters, J., 2006. Investigating M3 money demand in the Euro Area – New evidence based on standard models. *German Institute for Economic Research Discussion Paper*, 561.

Komornik, J. and Komornikova, M., 2013. Modelling financial time series using reflections on copulas. Kybernetika, 49(3), pp.487-497.

Ndjokou, M.M., 2011. Monetary aggregates and price stability in the BEAC zone. *International Journal of Economics and Finance*, 3(1), pp.116-123.

Whelan, K., 2014. The ECB and Non-Standard Policies: Too Little Too Late? *European Parliament's Committee on Economic and Monetary Affairs* [online] Available at: <http://www.europarl.europa.eu/studies> [Accessed 07 July 2014]