Stability of money demand in the Czech Republic

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Abstract

This paper is going to show empirical research of demand for money in the Czech Republic. It will describe variables influencing money demand and estimate them. There will also be discussion about the own rate and it’s estimation by the method of weighted averages. Observed period is from the second quarter of 2005 to the second quarter of 2013. The financial crisis is a big part of this period and it definitely influences the results. The stability of demand for money will be tested by CUMSUM test and Chow test and the results will be interpreted.

Key Words

Demand for money, structural break, CUMSUM test, own rate, stability

1 Introduction

Money demand is an important macroeconomic variable. It is an important component of the macroeconomic stability. According to monetarists and M. Friedman it is even the internal source of stability of economy. The period between mid-nineties and 2007 can be characterized as a period of stable macroeconomic environment. In the current crisis the investments significantly lowered. The broader money aggregates lowered with investments. All banks were trying to motivate people to invest by decreasing interest rates to their minimum. But even with low interest rates the broad money did not increase. This indicates a problem with the demand for money and almost its unresponsiveness to interest rates. Crisis started in 2008 and therefore there is enough statistical evidence to empirically describe its influence on money markets.

This paper will focus on the stability of demand for money in the Czech Republic especially after the hit of the crisis. The main goal is to find out if the money demand was stable in examined period. The secondary goal is to describe macroeconomic indicators that influence the demand for money and if they do so with an agreement to theory. To reach these goals it will be necessary to find out the own rate.

2 Literature review

The first part of this work is an estimation of money demand and factors influencing it. According to CGL(2001) the money demand depends on real output and the opportunity cost of holding money. He defines an opportunity cost as a difference between interest rates and the
own rates. Other authors generally use only one opportunity cost (generally the difference between short term interest rates and own rates) – Beyer(2009), Green(2002) or Santis(2008). CGL(2001) on the grounds of research Baba et al. (1992) says that if there are imperfections on capital markets then the money is demanded for both portfolio and transaction reasons and therefore the long term returns should be included in the model.

The Brand and Cassola (2000) argued that the opportunity cost does not have to be included in the case of long term demand for money because long term government bonds represent dynamics of difference of long term interest rate and own rate.

The authors are in an agreement that the model should focus on broad money M3. The different story is an inflation. Some works uses GDP deflator (CGL, 2001) but others CPI (Green, 2002).

This give us the equation of demand for money described in following section. Econometric analysis is then performed according to Green(2002). The own rate is calculated the same way as in CGL(2001). The method is also described in methodology. For the seasonal adjustment was used method TRAMO/SEATS developed by Victor Gómez and Agustín Maravall at the Bank of Spain.

### 3 Objectives and methodology

The sources of data are online databases of OECD, Eurostat and the Czech National Bank. At first we will do multiple regression in form

\[
\frac{M_t}{P_t} = \alpha + \beta y_t + \gamma (STi_t - OWN_t) + \delta (LTi_t - OWN_t) + \epsilon_t
\]

Where \(M_t\) is monetary aggregate M3, \(P_t\) is a price level. \(y_t\) is real GDP in time \(t\) and \(STi_t\) are short term interest rates (day to day rates form Eurostat). \(LTi_t\) are government bonds with maturity of 10 years. \(OWN_t\) is an own rate that is going to be explained below. All of these variables are in the log form. By including long term interest rates the estimation is going to be more exact. On the other hand it is very likely that there is going to be problem with collinearity (characterized by low significance of parameters) between short term and long term rates that is going to lead to exclusion of one of these rates.

The expression \(M_t/P_t\) is generally described as a supply of money. At the equilibrium of money market the demand and supply of money are equal. Assuming that the market is in equilibrium then approves usage of term \(M_t/P_t\) in the regression.

Own rate is computed by using method of weighted average. All rates of returns of components of M3 are averaged. The weights are as large as large is the part of its component in M3. In calculated own rate there are included currency in circulation (interest rate is 0), overnight deposits, deposits with agreed maturity up to 24 months and deposits redeemable at notice up to 3 months. The Repurchase agreements, Money market fund shares/units and Debt
securities up to 2 years are not included because of complications with determining of these rates of return. This should not change the own rate too much because in 2013 together they were approximately 1% of whole M3.

The real GDP and M3 were seasonally adjusted at first. Then the logs of all variables were taken. In some literature can be found the equation starting with $M_t - P_t$. The reason is that a log of division is the same as difference of logs of each number. In other words the difference is only in notation. The inflation is computed from CPI. Generally there is very slight difference between GDP deflator and CPI and the trends are the same.

According to theory, the money demand should depend positively on GDP and negatively on difference of interest rates. To this regression can be applied CUMSUM test to test the stability of money demand and possible structural break. This test is used when the point of structural break is unknown.

CUMSUM test has two variants – CUMSUM test and CUMSUMSQ test. It is calculated like a series of one-step ahead forecast errors that is obtained by running a series of regressions: the first regression uses the first $k$ observations and is used to generate a prediction of the dependent variable at observation $k + 1$; the second uses the first $k + 1$ observations and generates a prediction for observation $k + 2$, and so on (where $k$ is the number of parameters in the original model). CUMSUM test has the Harvey–Collier $t$-statistic for testing the null hypothesis of parameter stability. The CUMSUMSQ test has the 95 percent confidence band is calculated using the algorithm given in Edgerton and Wells (1994). (Gretl Command Reference)

Chow test is used when we know where the structural break occurred. There is one obvious point where this could happen – 3rd quarter of 2008 when Lehman Brothers fell and asked for protection from creditors.

## 4 Results

At first, the own rate will be calculated. The values are between 0.4 and 3.

### 4.1 Stationarity of TS

Before the analysis the stationarity tests have to be done. This work uses Dickey-Fuller Augmented stationarity test, the variant with constant. This stationarity test has null hypothesis non-stationarity so therefore we want to reject the null. The results are in the table below (Table 1).

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1 For more information about Chow test see Wooldridge, chapter 7
2 For more information about ADF see Journal of the American Statistical Association (1979), article published by Dickey and Fuller
<table>
<thead>
<tr>
<th>Variable</th>
<th>Test-statistics</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln(M/P)</td>
<td>-3.60</td>
<td>0.01**</td>
</tr>
<tr>
<td>Ln(y)</td>
<td>-3.16</td>
<td>0.02**</td>
</tr>
<tr>
<td>STi - OWN</td>
<td>-0.98</td>
<td>0.76</td>
</tr>
<tr>
<td>LTi - OWN</td>
<td>-2.21</td>
<td>0.21</td>
</tr>
<tr>
<td>STi – OWN FD(1)</td>
<td>-3.32</td>
<td>0.02**</td>
</tr>
<tr>
<td>LTi – OWN FD(1)</td>
<td>-5.21</td>
<td>&lt;0.01*</td>
</tr>
</tbody>
</table>

Source: Author’s work

Both opportunity costs have to be taken as a first differences otherwise the series would not be stationary. Non-stationarity causes spurious regression, autocorrelation and high values of $R^2$.

4.2 Regression

The regression has following form (in parenthesis are the standard errors):

$$\text{est.} \frac{M_t}{P_t} = -20.83(3.91) + 2.25(0.29)y_t - 0.57(0.15)(STi_t - OWN_t) - 0.03(0.03)(LTi_t - OWN_t)$$

This equation may be described as demand function for monetary aggregate M3. What stands for notice is low significance on opportunity cost on government bond yields. This value is very close to zero. Even though removing it from an equation causes slightly decrease value of $R^2$ adjusted it would be beneficial to take it out. It influences regression very slightly and within its standard error is value 0 that shows that the size of parameter can be actually zero. If this is true the parameter can cause no effect on logs of real M3 at all.

The regression excluding opportunity cost of long term government bonds is below.

$$\text{est.} \frac{M_t}{P_t} = -21.48(3.89) + 2.30(0.28)y_t - 0.48(0.13)(STi_t - OWN_t)$$

The value of $R^2$adj. is high: 0.70. The F-test shows that the model as a whole is significant (p-value = 9.2*10^-9).

4.3 Stability

CUMSUM test is graphically shown in Figures 1 and 2. This test has issues with power. (Andrews, 1993). But in this case, it shows clearly that there is a structural break. The CUMSUM SQ shows it less clearly but still the cross out of bounce is visible. On top of this the Chow test indicates strongly that the structural break in third quarter in 2008 does exist. See results at Table 2. The null hypothesis is that there is no structural break in data.
Table 2: Tests for Structural Break

<table>
<thead>
<tr>
<th>Test</th>
<th>Test statistics</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUMSUM test</td>
<td>5.37</td>
<td>&lt;0.01**</td>
</tr>
<tr>
<td>Chow test</td>
<td>103.56</td>
<td>&lt;0.01**</td>
</tr>
</tbody>
</table>

Source: Author's work

Figure 1: CUMSUM test

Source: Author's work, Gretl
These results indicate that the demand for M3 was unstable in the Czech Republic in period 2005-2013.

5 Discussion and Conclusion

The conclusion of this research is that in years 2005 – 2013 in the Czech Republic the demand for real M3 is dependent negatively on opportunity cost of short term interest rates and positively on GDP. It does not depend on long term spread. The CUMSUM tests and Chow’s test showed that there is a structural break in the regression. This means that the demand for money in this period of time was not stable.

The first part of our findings is expected. Positive relationship between real M3 and GDP is logical as well as negative relationship with interest rate. The insignificance of long term spread is caused by collinearity and similar trend of short and long term interest rates. Issues with non stationarity were solved. The non stationarity in economic time series is a common thing. The surprising is a very strong evidence of instability. Especially Chow’s test showed very low p-value and therefore high statistical evidence of structural break. But even CUMSUM test had statistically significant results. There is no doubt that the demand for M3 was unstable. This is not something new and revolutionary. Kapounek (2011) also found that during the crisis there was instability (but in Eurozone). The question is – what does it mean? These findings go against the monetarist’s point of view that the stability of money demand is the source of stability in the whole economy. On the other hand, Friedman’s equation of money demand looked differently and included adaptive expectations about interest rates and inflation.
We cannot say that the structural break would be in this form too, but on the other side it is likely.

The stability is important. A stable demand function for money is perceived as a prerequisite for the use of monetary aggregates in the monetary of policy (Goldfeld and Sichel, 1990). There can be several reasons for instability. Decrease of velocity of money during the crisis or change of sensitivity (elasticity) to interest rates are mentioned the most often (Kapounek, 2011 and Reynard, 2004).

The research can be extended. The CUMSUM test is not the strongest test for structural break, it would be beneficial to support it by method using GMM. The result should not be changed – the statistical evidence is very strong. This topic is close to endogeneity/exogeneity of money. Using Granger causality can prove both one of them. An interesting would be also to compare with other countries in Europe (but not Eurozone) and across the world. If some countries do have stable money demand even after 2008 it can be beneficial to look at monetary policy differences.

6 References


