Impact of Central Bank Interest Rates on Market Interest Rates

Radim Gottwald

Abstract: Changes to interest rates in an economy are affected by a variety of factors. Through changes to their internal rates, central banks indicate changes in the economy. The focus of the paper is the qualification of the impact of central bank interest rates on market interest rates. The empirical analysis works with data related to the USA, European Union and the Czech Republic. The investigation period is 2001-2012 and is split up into three four-year periods: 2001-2004, 2005-2008 and 2009-2012. Interbank interest rates, mortgage interest rates and interest rates for loans to non-financial businesses were adopted as market interest rates. Certain implementation delay is taken into account. Statistical indicators such as the Pearson correlation index and standard deviations are used and substantial, shared features and differences within selected territories are identified based on the indicators. The paper therefore classifies the impact of decisions by central banks on the economy. Results show that in the given regions we can see the biggest impact in central bank interest rates on interbank interest rates, interest rates to non-financial businesses and mortgage interest rates over the whole period.

Key words: Market interest rate · Interbank interest rate · Mortgage interest rate · Central bank interest rate · Central bank

JEL Classification: G20 · C10

1 Introduction

In addition to central bank interest rates, market interest rates exist in many countries as well. These market interest rates are the result of a variety of economic factors. These rates often respond to signals of certain changes in the economy that are presented on the market through changes in central bank interest rates and by frequent instruments of the monetary policy of the respective country. In practice, it is often enough for the central bank to announce a change it foresees for interest rates, which causes the market interest rates to change without any change to the actual rates. It may be useful for many economists and investors to forecast the probable development of market interest rates in future based on the results of the empirical analysis focused on these rates.

A wide range of authors investigate the monetary policy targets of central banks. Neyer (2007) says that the monetary policy target of the European Central Bank since 1 January 1999 has been price stability. Some developed market economies use the inflation targeting regime which, through interest rates, directly impacts inflation expectations and, as Revenda (1999) say, supports transparency, success and accountability of central bank’s monetary policy. Hetzel (2008) notes that inflation is a purely monetary phenomenon according to Milton Friedman, a well-known economist. The theory that inflation can be most efficiently affected by the amount of money in an economy and/or by the price of such money rests upon this assumption. According to Jílek (2004), central banks were taking this theory into account in their efforts to control price stability through the money supply targeting regime or exchange rates. Despite decision-making of central banks – independent to a degree – different economies have greater impact on each other nowadays due to globalization of banking markets. In the 1980s US banks saw a huge growth in trading with financial derivates. Trading non-transparent financial derivates however caused the financial recession in 2007. Thanks to globalization of banking markets, these highly risky mortgage "packages" penetrated the portfolio of many European banks and financial institutions and, as De Soto (2009) puts it, transferred the troubles of the US market to the European continent.

Besides the central bank interest rates, a number of economists are interested also in different types of interest rates. The correlation between different types of interest rates can be analyzed. Brada and Brůna (2004) analyze the sensitivity of reference interest rates PRIBOR to changes of the repo rate by the Czech National Bank and investigate whether the dependencies between interest instruments within the transmission mechanisms can be identified as pro-cyclic. Changes in market interest rates affect behavior, and so the ability of the central bank to influence anything at all depends, first, on the mutual interaction between official and market interest rates. Mariscal and Howells (2002) use a vector autoregressive error correction model to explore the response to changes in the central bank interest rate of three short-term mar-
ket rates. Short-term official rate of interest indicate the price at which it will make liquidity available to whole banking system. We can therefore ask what is the correlation between interest rates of the central bank and market interest interest rates. The author seeks the answer to this question by adopting the methodologies stated below.

2 Methods

The objective of the paper is to evaluate the impact of central bank interest rates on market interest rates. The empirical analysis works with data related to the USA, European Union and the Czech Republic. Data from investigation period 2001-2012 was used. To give a detailed picture of the changes, this current period covering the past 12 years is split up into three four-year periods: 1/2001-12/2004, 1/2005-12/2008 and 1/2009-12/2012. Besides interest rates set by central banks, i.e. interest rates of the major re-financing instrument of central banks, three-month interbank reference proposed interest rates, average mortgage interest rates and average interest rates on loans to non-financial businesses are selected from different types of market interest rates of commercial banks. From interbank rates with varying periodicity, the three-month interbank rates are usually the most common rates and hence most interesting. Since market interest rates do not respond to changes in central bank interest rates instantly, a certain implementation delay must be taken into account. Jílek (2004) says that deposit and loan instruments with variable interest rates respond to changes in the monetary policy with a delay of several months, while mortgage interest rates need even longer. Given the periodicity of setting other rates and their nature, a delay of one week is taken into account for interbank interest rates, a delay of six months is taken into account for mortgage interest rates and a delay of three months is taken into account for interest rates on loans to non-financial institutions.

Different statistical indicators are gradually calculated. By adopting the correlation coefficient, the correlation between rates, i.e. in fact the correlation intensity is investigated. Pearson correlation coefficient is calculated as follows:

$$r = \frac{\sum_{i=1}^{n}(x_i - E(x))(y_i - E(y))}{\sqrt{\sum_{i=1}^{n}(x_i - E(x))^2 \sum_{i=1}^{n}(y_i - E(y))^2}}$$

This coefficient applies to quantitative, random variables $x$ and $y$ with shared standard division and to specific values $(x_1,y_1), (x_2,y_2), \ldots (x_n,y_n)$. Median values of variables are identified as $E(x)$ and $E(y)$. A standard deviation is applied for statistical dispersion measurements of to what degree interest rates changed over a given period of time. This deviation is calculated based on this formula:

$$\sigma = \sqrt{\frac{1}{n} \sum_{i=1}^{n} x_i^2} - E(x^2)$$

The source of data is the official website of the central bank of the respective region, websites studying interbank interest rates, mortgage interest rates and rates on loans to non-financial businesses.

3 Research results

Applicable central bank interest rates and market interest rates – interbank interest rates, mortgage interest rates and rates on loans to non-financial businesses are studied one by one for the USA, the European Union and the Czech Republic. Furthermore, standard deviations for different types of interest rates related to different regions are compared.

3.1 Impact of central bank interest rates on interbank interest rates

Central bank interest rates represent an important instrument of banking market regulation and enforcement of monetary policy. For the USA the Federal Funds Rate (FFR) was chosen, i.e. an interest rate of the federal reserve funds of the US central bank FED. For the European Union the Main Refinancing Operation (MRO) rates was chosen, i.e. an interest rate of the main refinancing instrument of the European Central Bank. For the Czech Republic the 2T REPO rate was chosen, i.e. an interest rate for two-week repo operations announced by the Czech National Bank.

Interbank deposit market rates, i.e. rates against which banks in the respective regions borrow liquidity, were adopted as interbank interest rates. These rates are set through quotations supplied by reference banks in the respective regions. For the USA the 3M USD LIBOR rate was chosen. i.e. a US three-month interbank reference interest rate offered. For the European Union the 3M EUR EURIBOR rate was chosen, i.e. a European three-month interbank reference interest rate offered. For the Czech Republic the 3M CZK PRIBOR rate was chosen. i.e. a Czech three-month interbank
reference interest rate offered. Table 1 shows the correlation coefficients between central bank interest rates and interbank interest rates separately for the USA, the European Union and the Czech Republic.

**Table 1** Correlation coefficients between central bank interest rates and interbank interest rates

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<tbody>
<tr>
<td>USA</td>
<td>0.9831</td>
<td>0.9869</td>
<td>0.9624</td>
<td>0.1582</td>
</tr>
<tr>
<td>European Union</td>
<td>0.9730</td>
<td>0.9959</td>
<td>0.9101</td>
<td>0.9035</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>0.9608</td>
<td>0.9976</td>
<td>0.8154</td>
<td>0.9964</td>
</tr>
</tbody>
</table>


The values indicate that from 2001 to 2012 a relatively high degree of correlation over 0.96 can be observed for all regions, which can be attributed to the essence of interbank interest rates being the mediation criterion within a transmissive mechanism. The general rule says the higher the correlation coefficient values are calculated, the closer the correlation between interest rates will be. In all the regions, correlation is stronger from 2001 to 2004 than from 2005 to 2008 and even of the entire period of time. Almost direct correlation between interest rates is typical for 2001-2004. On the contrary, correlation between interest rates in the USA from 2009 to 2012 is weak.

### 3.2 Impact of central bank interest rates on mortgage interest rates

For the USA the 30-year 1/1 Adjustable Rate Mortgage (30 YEAR 1/1 ARM) was chosen, i.e. the average US interest rate on mortgages due in 30 years. The “2/1” sign for example would mean that the rate is fixed for two years until a new applicable interest rate will be calculated for the current period of one year. The German mean interest rate on mortgage loans was selected for the European Union. For the Czech Republic the Hypoindex indicator was used to select the average Czech interest rate on mortgages. Table 2 presents correlation coefficients between central bank interest rates and mortgage interest rates.

**Table 2** Correlation coefficients between central bank interest rates and mortgage interest rates

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<tbody>
<tr>
<td>USA</td>
<td>0.7397</td>
<td>0.9292</td>
<td>0.4051</td>
<td>0.2940</td>
</tr>
<tr>
<td>European Union</td>
<td>0.7108</td>
<td>0.4116</td>
<td>0.5120</td>
<td>0.4033</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>0.4151</td>
<td>0.6473</td>
<td>0.8278</td>
<td>0.9603</td>
</tr>
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It is clear that the correlation we can observe over the whole period is less pronounced than that observed between central bank interest rates and interbank interest rates. We can also find substantial differences between the regions, which can be attributed to the local specifics of the mortgage markets. Also the mortgage crisis could have had an impact on the gradual decrease of correlation coefficients for the USA during the three subsequent periods. The strongest correlation for the USA was calculated for 2001-2004, for the European Union over the whole period and for the Czech Republic for 2009-2012.

### 3.3 Impact of central bank interest rates on loans to non-financial businesses

The Prime Loan Rate was chosen for the USA, i.e. the average US interest rate on loans. For the European Union the average European interest rate on loans to non-financial businesses and for the Czech Republic the average interest rate on loans to non-financial businesses were chosen. The correlation coefficients between the central bank interest rates and interest rates on loans to non-financial businesses are shown in Table 3.

**Table 3** Correlation coefficients between central bank interest rates and interest rates on loans to non-financial businesses

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<tbody>
<tr>
<td>USA</td>
<td>0.9576</td>
<td>0.9115</td>
<td>0.9113</td>
<td>-</td>
</tr>
<tr>
<td>European Union</td>
<td>0.8449</td>
<td>0.3919</td>
<td>0.5890</td>
<td>0.8286</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>0.7713</td>
<td>0.8725</td>
<td>0.9471</td>
<td>0.8058</td>
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The values calculated imply that over the whole period we could observe weaker correlation than correlation between central bank interest rates and interbank interest rates, but stronger correlation between central bank interest rates and mortgage interest rates. In the USA the correlation coefficient always represents 0.91 and it does not make sense to set this correlation coefficient for 2009-2012 due to the constant amount of interest rates on loans to non-financial businesses reported. Also here, we can see major differences between the different theories. The gradual increase in correlation coefficients for the European Union during the three subsequent periods can be more the result of the monetary policy of the central bank which shows for entities on the financial market when we determine the parameters for loans to non-financial businesses.

3.4 Comparing standard deviations in different regions

Standard deviations calculated differ depending on the region, interest rate type and time period. Table 4 shows standard deviations summarized in a transparent manner.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Standard deviations of various interest rate types</th>
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<tbody>
<tr>
<td>USA (1)</td>
<td>1.8603</td>
</tr>
<tr>
<td>European Union (1)</td>
<td>1.1110</td>
</tr>
<tr>
<td>Czech Republic (1)</td>
<td>1.2800</td>
</tr>
<tr>
<td>USA (2)</td>
<td>1.8506</td>
</tr>
<tr>
<td>European Union (2)</td>
<td>1.2178</td>
</tr>
<tr>
<td>Czech Republic (2)</td>
<td>1.2019</td>
</tr>
<tr>
<td>USA (3)</td>
<td>0.9761</td>
</tr>
<tr>
<td>European Union (3)</td>
<td>0.7130</td>
</tr>
<tr>
<td>Czech Republic (3)</td>
<td>0.7146</td>
</tr>
<tr>
<td>USA (4)</td>
<td>1.7987</td>
</tr>
<tr>
<td>European Union (4)</td>
<td>0.7801</td>
</tr>
<tr>
<td>Czech Republic (4)</td>
<td>0.7902</td>
</tr>
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The figure in the parentheses relates to the interest rate type applied to the calculation of the standard deviation, specifically: (1) to central bank interest rates, (2) to interbank interest rates, (3) to mortgage interest rates and (4) to interest rates on loans to non-financial businesses.

The biggest standard deviations could be calculated for the USA for central bank interest rates (1.8603) and interbank interest rates (1.8506), both during the whole period. The general rule says that interest rates become more unstable in time with growing standard deviation values. From this perspective, it is therefore interesting that despite this variability Table 1 shows very strong correlation between these interest rates (0.9831). Pronounced is also the instability of interest rates on loans to non-financial businesses over the whole period of time (1.7987). In all regions we can observe a high degree of correlation over 0.96 between central bank interest rates and interbank interest rates and also high values of standard deviation over 1.10 for each of the interest rates mentioned. This means that the relatively strong correlation is accompanied by a relatively high instability.

In the European Union the majority of standard deviations for three subsequent sub-periods drop in time. The highest values of standard deviations are calculated, similarly as for the USA, for central bank interest rates and interbank interest rates, both during the whole period. These findings applying for the European Union also apply for the Czech Republic.

The lowest values of standard deviations were found in the already mentioned constant interest rates reported for loans to non-financial businesses in the USA in 2009-2012 and for the almost constant, but expansionary monetary policy with interest rates close to zero during the same period and in the same region. After calculating the standard deviations for a certain interest rate, we can assume similar instability for other interest rates based on the correlation calculated between this interest rate and some other rate.

Given the objective of this paper, i.e. evaluation of the impact of central bank interest rates on market interest rates, correlation coefficients show that in the given regions we can see the biggest impact in central bank interest rates on
interbank interest rates, interest rates to non-financial businesses and mortgage interest rates over the whole period. This impact is most pronounced in the USA, followed by the European Union and the Czech Republic. By analyzing not the whole period, but the sub-periods, we can come to results that cannot be regarded as too clear. In all the regions, the majority of standard deviations of the three subsequent periods decrease in time and biggest values of the standard deviation are calculated for central bank interest rates and for interbank interest rates, both over the whole period.

4 Discussion
The contribution of the paper consists in the evaluation of the impact of central bank interest rates on market interest rates based on an empirical analysis. The author presents the degree of correlation between different types of interest rates in the USA, the European Union and the Czech Republic over the past 12 years. By benchmarking the correlation coefficients against standard deviations for the given regions, the author identifies common features and differences, and investigates the general implications of the decisions by central banks for the economy – impacts of the monetary policy of central banks on selected interest rates set by the market. Based on results of the empirical analysis focused on these rates, development of market interest rates in the future could be forecasted.

Further research can go in several directions. To find to what extent central bank interest rates act as basic rates for selected market rates, we can choose, in addition to different regions, also different types of interest rates, a total period, sub-periods and/or adopt some other methodology. To be able to get results with a higher telling value, we can integrate more complex formulas into the calculations, reflecting more exactly the real correlation between interest rates. In general, the intensity and response time of market interest rates is affected by a number of macroeconomic indicators and the economic cycle - to be more precise, the particular phase of the cycle in which the economy is currently situated. When assessing the intensity and response time, we can consider the telling value of the indicators we have adopted. Brada and Brůna (2004) assume that different types of interest rates are dependent on the economic cycle within the transmission mechanism. They realize that with growing maturity of the interest rate, the response time of the interest rate drops relatively fast. Jilek (2004) says this may be because of the uncertainty regarding future development of long-term interest rates or because of certain assumptions of market entities which, based on certain expectations, respond naturally to the current change in the monetary instruments of the central bank. The longer the maturity of a specific interest rate, the bigger the intensity of the response. Brada and Brůna (2004) also explain the decreased sensitivity of the reference interest rate on the interest instruments of the central bank by the anticipation of expected settings and changes to reference interest rates before this actually happens. The intensity and response time also depends on the type of market interest rates and on whether these are short-term, middle-term or long-term rates.

Besides the assessment of historical data, this data can be predicted for the future as well. It is therefore possible to evaluate to what extent market interest rates have changed following historical changes in central bank interest rates – specifically regarding the direction in which they go, their proportion parameters and the extent to which market interest rates changed as a result of changes to the current interest rates. In summary, we can evaluate which business policy financial institutions providing interbank loans and deposits, mortgages and loans to non-financial businesses will choose.

5 Conclusions
The aim of the paper is to evaluate the impact of central bank interest rates on market interest rates. To find out the role of central bank interest rates in setting market interest rates, data from the USA, the European Union and the Czech Republic from 2001 to 2012 were applied. The respective correlation coefficients and standard deviations are calculated not only for this total period, but also the sub-periods of 2001-2004, 2005-2008 and 2009-2012. "Market rates" shall mean interbank interest rates, mortgage interest rates and interest rates on loans to non-financial institutions. The results show that over the whole period and in all regions the central bank interest rates have the biggest impact on interbank interest rates, followed by interest rates to non-financial institutions and finally mortgage interest rates. This impact is always most pronounced in the USA, followed by the European Union and the Czech Republic. After comparing the standard deviations, it was found that in all the regions interest rates usually decrease over the three subsequent periods and highest values are reached for central bank interest rates and for interbank interest rates, both during the whole period.

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References


