The Fisher Hypothesis in the short-run

ERASMUS UNIVERSITY ROTTERDAM

Erasmus School of Economics

Department of Economics

Supervisor: Dr. V. Karamychev

Name: Bojidar H. Ignatov

Exam number: xxx

E-mail address: bojidar.ignatov@gmail.com

The Fisher Hypothesis in the Short–run

Analysis based on Eastern European countries

In this paper we analyze the Fisher Hypothesis in the framework of five Eastern European countries and the United Kingdom as comparison. We base our analysis on inter-bank interest rates, and the Consumer Price Indexes. We use the general inflation forecast equation of the Fisher Hypothesis. Our results show that the term structure of the nominal interest rates contains predictive power for all durations in Czech Republic, and in the longer durations of 6 and 12 months of maturity for Bulgaria. We observe that the longer the maturity period the greater the predictive power is.

Introduction

The Fisher Hypothesis is one of the key insights and building pieces of Economics as a science. Although not proposed by Irving Fisher, he is the first to mathematically derive and stipulate the relationship between nominal interest rates, real interest rates and inflation. Published in 1930, the book “The theory of Interest” is the foundation of the hypothesis, which later was named after the author.

The standard view over the Fisher Hypothesis states that there is a positive one-to-one relationship between the expected inflation and the nominal interest rate, assuming the real interest rate is constant over time. (Fisher, 1930) However, in recent years this is considered to be a strong form of the Fisher Effect which is not well supported in practice. Therefore, many researchers consider the hypothesis as defining that there is a relationship between the nominal interest rates and the expected inflation which is not constant over time because of the fluctuating real interest rate.

Since the hypothesis was published and theoretically explained, it has been a hot topic for research. Many different countries have been subject to analysis, while considering various sample periods of time as a testing frame. Further, several different statistical models have been developed and are currently considered as standard models for testing the Fisher Effect. In addition, due to the nature of the hypothesis researchers face real challenges while conducting their analysis. Several key issues are always subject to questionable decisions such as serial correlation, sample bias, errors-in-variables effects and last but not least – conducting analysis based on historical data, while the original definition of the hypothesis is based on expectations.

It can be easily seen that by making decisions about the aforementioned issues will lead to a different path in the results obtained. While there are academic papers which support the hypothesis in both the short and the long term, there are others which reject the fisher effect in any duration. Many different observations have been made about the variability of the results obtained. The most common issues at hand state that different countries and different time periods ultimately provide controversial results. In addition, improper econometric adjustments can even prove the conclusions to be inaccurate or even invalid.

However, the majority of researchers tend to reject the Fisher Hypothesis in the short run, while the longer maturity periods provide evidence in support of the fisher effect. Even more, it is a general trend that the longer the maturity period the stronger the relationship between inflation and nominal interest rates is. On the other hand, in general researchers find that the real interest rate is not constant over time, thus rejecting the strong form of the hypothesis.

Our research supports the latter observed pattern. We find evidence for a relationship between the nominal interest rates and the inflation only for two countries, namely Bulgaria and Czech Republic. Despite the fact that we reject the Fisher Hypothesis for all other countries, we still observe higher p-values in the short run, compared to the long run. We also reach to the conclusion that the term spread of the real interest rates is not constant over time for all countries, thus rejecting the strong form of the hypothesis.

It can be easily seen why the Fisher hypothesis is a well-examined field in economics and a hot topic for researchers. The importance of the described effect can be seen in many areas of the Economics as a science. For example, in Macroeconomics, the Fisher Hypothesis is used in modeling fiscal policies, thus predicting their effect and result. In Finance, the asset pricing models are based on assumptions about the real interest rate. In addition, the Fisher Hypothesis can even be used to calculate perfect currency hedging on the money markets.

The Fisher Effect can be found in many areas of the Economics and the adjacent fields. Thus, the hypothesis and its validity are of crucial importance. This research will explore the short-term relationship between the inflation rates and the nominal interest rates, hence adding to a part that is not well explored in previous researches. In addition, we will base our research on relatively small and developing economies of the new members of the European Union such as Bulgaria and Romania. Furthermore, we will include data for the United Kingdom so that there is a well-developed financial market for comparison purposes.

The rest of the paper is organized in six parts, namely: Theory where we will elaborate on the definition of the Fisher Hypothesis and derive the general equation mathematically, Literature Overview where we will examine several key research papers which we will be using as a benchmark for our results, Data section where we discuss the gathered raw data and the necessary processing, Methodology where we discuss the econometrics behind this research, Results where we show our findings, Discussion section where we criticize the statistical methods used and suggest further development, and finally Conclusion section where we summarize our results and try to draw more general conclusions.

Theory

In this section we will provide the theoretical overview of the Fisher hypothesis. We will also provide an overview of the different statistical methods to test the relationship in question. Further, we will elaborate on the implications and conclusions that we may derive from the theory.

The Fisher Hypothesis or also known as the Fisher Effect is an important economic concept which links the expected inflation rates to the nominal interest rates. Before we continue with the derivation of the equation in question we have to define the components, namely:

- Nominal Interest Rate (i) – the nominal cost of borrowing– the interest rate that a borrower has to pay for borrowing money. For borrowing the amount of N, the borrower has to pay X + X*I = X* (1+i).
- Real Interest Rate (r) – the real cost of borrowing – the rate of return a lender will get, considering the inflation after the specific period of time. This is the variable to be explained by the Fisher Equation.
- Inflation rate (π) – the rate of price level change between two periods. Mathematically, the inflation rate in period *t* equals the aggregate price level of time *t* minus the aggregate price level in time *t-1*, divided by the aggregate price level of time *t-1*, i.e.:

  $$\pi^t = \frac{P^t - P^{t-1}}{P^{t-1}}$$

  The most common indexes used for inflation are the Consumer Price Index (CPI) or the GDP Deflator.

- Expected Inflation (π^e) – the expected rate of price level change between two periods. Mathematically it is computed the same way as the actual inflation rate, but instead of observed values we use the expected aggregate price levels for the future period, i.e.:

$$\pi_{t+1}^{e} = \frac{P_{t+1}^{e} - P_t}{P_t}$$

The Fisher Equation can be easily derived in an intuitive manner as follows:

An institution lends X amount of money to Person A. Thus, as seen from above, Person A will have to return (1+i)*X amount of money after the specified period of time. However, the amount in the end of the period will be composed of gains from Inflation, and gains from the real rate of return, hence (1+π)*(1+r)*X. This means that:

$$(1 + i) * X = (1 + \pi) * (1 + r) * X$$

Canceling out X and removing the brackets:

$$1 + i = 1 + r + \pi + (r * \pi)$$

However, in reality $r*\pi$ is negligible and it can easily be removed so that we derive to the main Fisher Equality:

$$i = r + \pi$$

From this equation we can easily infer and understand the Fisher Effect which proposes a 1-1 relationship between the nominal interest rate and the expected inflation, written as $\Delta i = \Delta \pi$. (all else being equal).

From a statistical point of view, there are several tests which can be implemented to investigate the validity of the Fisher Hypothesis. Every test has its set of assumptions, hence different results and interpretations. However, all of the tests listed below assume the Rational Expectations Hypothesis. This is a key assumption because empirical work is mostly based on historical (observed) data, and not on expected information. Thus analysts accept the actual data to be the best proxy for the expected data.

Theory	Empirical Test
Inflation Forecast Test: $i_t = E_t(rr_{t+1}) + E_t(\pi_{t+1})$	$\pi_{t+1} = c + i_t + \varepsilon_{t+1}$ **(1)** $\pi_{t+m} - \pi_{t+n} = c + (i_{t,m} - i_{t,n}) + \varepsilon_{t+m}$ **(2)**
Cointegration Test: $i_t = E_t(rr_{t+1}) + E_t(\pi_{t+1})$	$i_t = c + \pi_t + \varepsilon_t$
Constant Real Interest Rate Test: Corr($E_t(rr_{t+1}), E_t(\pi_{t+1})$)= 0	$i_t = c + \pi_{t+1} + \varepsilon_{t+1}$
Real Rate Correlation Test: Corr($E_t(rr_{t+1}), E(\pi_{t+1})$)	$\pi = a + b * rr + \varepsilon$

Table 1: Empirical Tests of the Fisher Hypothesis. The table is built on the work of a previous research paper by Ignatov et all (2011).

However, those empirical tests are subject to several limitations.

1. The Fisher Effect does not necessarily imply a 1 to 1 relationship between the inflation rates and the nominal interest rates.(Crowder/Hoffman, 1996) The correct coefficient values has to account for taxation as well thus taking a value greater than 1. We can show this with the following calculations where *r>0* is the real interest rate, *i* is the nominal interest rate, π^e is the expected inflation and *T>0* is the effective tax rate:

The Net return on investment is:

$$(1 + r) = \frac{[1 + i(1 - T)]}{(1 + \pi^e)}$$

Hence, in order to keep the after-tax return constant:

$$i = \frac{r(1 + \pi^e) + \pi^e}{(1 - T)} = \frac{r}{(1 - T)} + \frac{(1 + r)}{(1 - T)}\pi^e$$

2. Shome, Smith and Pinkerton (1988) suggest that the real interest rates change according to the business cycle model, thus making the Fisher Hypothesis more complex in an uncertain environment.
3. Barsky (1987) suggests that the errors-in-variable and missing-variables biases will be severe in the statistical tests of the Fisher Hypothesis.
4. The calculation of the actual inflation rate is not addressed at all in the original definition of the Fisher Hypothesis.

5. Monetary policies can influence the short run interest rates and inflation rates. Hence, the short run testing of the Fisher Hypothesis can be influenced by the introduction of new monetary policies, thus making the calculations inaccurate or even invalid. However, several authors suggest that the Fisher Hypothesis can hold in the short term. (Mishkin, 1992)

In this research paper we will focus on the Inflation Forecast Test. From a statistical point of view equation (1) in the table above might suffer from non-stationarity, thus empiricists derived equation (2) as an equivalent in testing.

In this model we will focus on the slope coefficient of the term spread of the nominal interest rates. As it is suggested by Mishkin (1990) we will be expect to find significantly different from zero coefficients, thus confirming that the nominal interest rates contain information about the future path of the inflation rates. In addition, values not significantly different from 1 will suggest that the term spread of the real interest rates is constant over time, hence proving the strong form of the Fisher Hypothesis.

The Fisher effect is one of the most important principles of economics. Its influence is easily seen in three different aspects of the theory: macroeconomic stabilization policy, asset pricing models and risk management. Firstly in macroeconomics if the Fisher hypothesis was true then monetary policy would have an effect on the real economy only in the case of shocks that have affected the financial system in the short term. In that case any long term continuation of expansionary monetary policies would have no effect. (Mishkin and Simon 2007) Secondly, the Fisher hypothesis is also important for various asset pricing models because it allows constant (in the case of the strong form) or at least relatively stable real interest rates. If that was not the case then even basic models like the CAPM will be hard to estimate empirically because such models usually assume the risk free real interest rate to be constant (Berk and DeMarzo 2007). Finally the Fisher hypothesis is also important in the fields of risk measurement and management. This is due to the fact that if the Fisher hypothesis was true then no inflation risk premium should be added to corporate cost of capital (Buraschi and Jiltsov 2005). Because of those three effects I have to conclude that the extent to which the Fisher hypothesis holds true has a wide importance for the theory and practice of economics.

Literature Review

In this section we will provide a short description of previous academic researches touching the same topic as ours. We will discuss four papers more closely with their methodology and dataset differences, which consequently lead to slightly different conclusions.

First of all, we provide a table, summarizing the most important characteristics of the researches in question.

Reference	*Methods used*	*Data*	*Results*
Jorion and Mishkin (1990)	Standard inflation forecast model. Small sample bias corrected by Monte Carlo simulation, serial correlation corrected with method proposed by Hansen and Hodrick	1973 to 1989, for the US, Germany, Britain, and Switzerland. Maturities from 1 to 5 years.	Predictive power of the term structure of the nominal inflation rates rises with the increase of maturity period. Long horizons support the fisher hypothesis. Real interest rate term structure not constant over time.
Stefan Gerlach (1997)	Standard inflation forecast model. Serial correlation corrected with Newey-West methodology and bootstrapping procedure.	1968 to 1985, for Germany. Maturities from 1 to 10 years.	6-7 year maturities carry the most information. Nominal interest rates carry predictive power about future inflation rates, but the real interest rate term structure is not constant over time.
Koedijk and Kool (1995)	Standard inflation forecast model Standard errors serial correlation corrected with Newey-West procedure.	1982 to 1991. Seven countries included. 1 to 5 year bond rates.	Relationship between nominal interest rates and future inflation is weak. The difference could be explained by the smaller sample used, compared to other researches.
Mishkin (1992)	Based on cointegration tests. Newey-West correction for standard errors.	1953 to 1990. 1 and 3 month maturities for the US. Period spit into 3 parts to take into account economy changes.	Evidence for a long run Fisher effect only. Longer sample period leads to a stronger effect. Finds a common stochastic trend in both inflation and nominal interest rates.

Table 2: Summary of relevant academic papers discussing their key aspects. The table is built on the work of a previous research paper by Ignatov et all (2011).

In order to provide a solid overview of the academic section where our research will fit, we will focus on four previously published papers which touch on almost the same issue we are building on. The academic works in question are listed in the above table, with their key aspects.

The main article that we will be using as our benchmark was published by Jorion and Mishkin in 1990. They investigate the Fisher Hypothesis with the standard inflation forecast test discussed previously in the theory section. The authors investigate if the nominal interest rates contain any predictive information about the interest rates and reach a general conclusion about the structure of the real interest rates. They base their analysis on maturities of 1 to 5 years long for four different well-developed economies and further compare their findings to previous researches about the United States. Further, Stephan Gerlach investigates even longer maturities for Germany, aiming to provide insights on which part of the yield curve will prove to contain the most predictive power about the future path of the inflation rates. He also links his work to the academic research of Jorion and Mishkin, but he suggests that 6-7 year maturities would be the best fit for the purposes of the analysis. Similarly, Koedijk and Kool extend the previously published papers while trying to provide valuable insights about the importance of the sample period chosen for the analysis, as well as the country chosen. Finally, Mishkin conducts a co-integration test trying to find if there are any stochastic trends in the variables which would therefore explain the fact that the Fisher effect is observed to be strong for some countries, and relatively week or even rejected for other.

Methodology Differences

The methodologies used by most of the published papers in the field refer back to the basic inflation forecast equation which was discussed in the Theory section. The formula uses the difference between the future inflation rate and current inflation rate as a dependant variable, and the term spread of the nominal interest rate as an independent variable. Using this model also means that the authors assumed the rational expectations hypothesis, since most of the academic work in the field is based on historical data, and not on expected values.

Jorion and Mishkin discuss two important values of the slope of the beta coefficient in this model – the term structure of the nominal interest rates. They suggest that a significantly different from zero value is evidence that the independent variable contains predictive information about the term structure of the future inflation rates. Further, they consider that a value not significantly different from one indicates a 1-1 relationship between the inflation rates and the nominal interest rates, meaning that the term structure of the real interest rates is constant over time. In that manner the methodology used by Stefan Gerlach and Koedijk and Kool is fairly similar. In addition, Mishkin also conducts a co-integration analysis in order to formalize the differences in long run and short run forecasting.

The first major difference between the aforementioned academic papers is the way the different authors estimate the relevant p-values for the test statistics. On one side, Jorion and Mishkin rely on the Monte Carlo simulation procedure in order to correct for a possible small sample bias. On the other hand, most of the other authors assume the standard asymptotic distributions to be valid.

The second major issue in most of the researches is the serial correlation of the error terms. Since the analysis is based on overlapping observations, i.e. Gerlach uses 10-year maturity period, the error terms will inevitably suffer from serial correlation. Jorion and Mishkin use a previously proposed method by Hansen and Hodrick (1980) while modifying it slightly for their purposes. On the other hand, Koedijk and Kool use the generalized method of moments estimator adjusted by the Newey-West procedure. Mishkin also relies on the same procedure in the co-integration based research. However, as Newey&West (1994) suggest, improper lag selection may lead to biased and inaccurate results. Lastly, Stefan Gerlach corrects for serial correlation in the error terms by using Newey-West method but also a bootstrapping procedure which makes the results more reliable.

Results Differences

The results stipulated by the four papers differ quite significantly. On one side, Jorion and Mishkin and Stefan Gerlach find that there is some predicting power in the term structure of the nominal interest rates and the relationship can be used for forecasting purposes. Similarly, Mishkin adds that there is a common stochastic trend in both the nominal interest rates and the inflation rates, which implies a relationship between the two variables.

However, he finds that these trends can explain only the long run Fisher effect and have no significance in the short run. On the other hand, Koedijk and Kool find enough evidence for a relationship between the test variables only for Germany, while for the other six countries he clearly rejects the Fisher Effect.

While it has not been established what is the cause of the aforementioned differences, Koedijk and Kool argue that the choice of sample period, and country to be examined, is crucial to the results. They also suggest that the introduction of monetary policies would result into long run changes in the relationship between the observed inflation and nominal interest rates, thus affecting the long run trends of both variables and making the correlation even weaker. However, Mishkin argues that the common relationship between the nominal interest rates and the future inflation rates is based on the common trends that they share. This explains that in periods where the two variables do not share the same trend the Fisher Hypothesis will be rejected.

From another point of view, the contradicting results add up together in a broader picture. All of the papers agree that the predictive power of the nominal interest rates grows stronger as the maturity period increases. Gerlach states that the strongest relationship can be found at the maturities from 6 to 7 years. He also adds that the effect reaches its optimum if the term spread is measured with respect to the 2 or 3 year rates. Further, the papers by Jorion and Mishkin and Stefan Gerlach conclude that the term structure of the real interest rates is not constant over time and cannot be reliably predicted.

Overall, the conclusions reached in this well-explored academic area differ significantly. It is very likely that the specific choice of sample period, as well as the country examined play crucial role to the ultimate conclusions. However, the general pattern is that the term structure of the real interest rates is not constant over time, thus cannot be reliably predicted by the term structure of the nominal interest rates. Contrary, the latter is found to contain predictive information for the future path of the inflation rates. It is also worth mentioning that in most cases, the longer the maturity period is, the stronger the relationship between the two variables becomes.

Data

This academic research is based on data for six countries, namely Bulgaria, Czech Republic, Greece, Romania, Slovakia and the UK. For all of them we use the CPI absolute value index for all goods as a proxy for the relevant inflation rates. Further, we use the interbank interest rates as the best available approximation of the nominal interest rates.

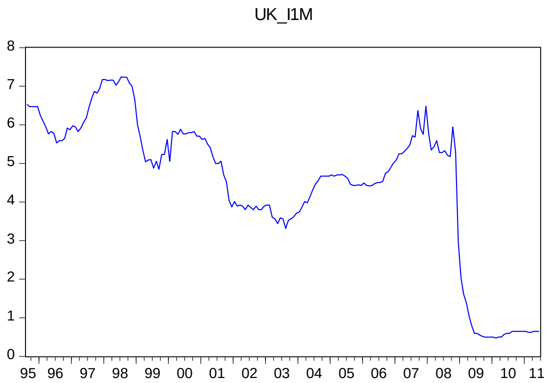
All interbank interest rates are calculated and published by the authorized national banks and statistical agencies. Each working day ask/bid quotes are gathered from a representative panel of banks in the respective country. Then the top 20% and the bottom 20% of those quotes are removed in order to avoid unnecessary outliers, and the remaining are averaged arithmetically to result in a single daily value for the specific interbank interest rate. The respective monthly value that is included in our research is the spot value for the middle of the month. It is worth mentioning that all quoted rates are with respect to the domestic currency of the specific country.

Furthermore, the nominal interest rates are converted into continuously compounded rates as the general Fisher equation is formulated by using this format of data. For that purpose we use the following equation:

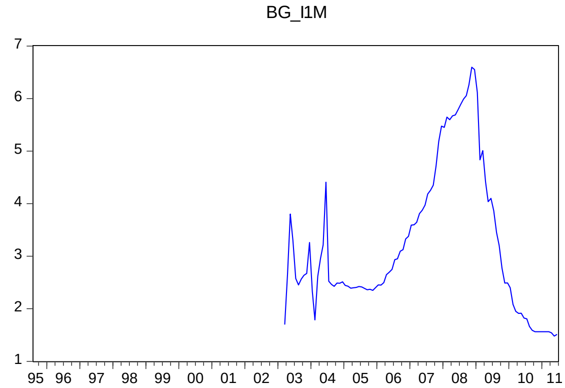
$$cc\_i^t = 100 * Ln(1 + \frac{i^t}{100})$$

Where cc_i^t is the continuously compounded rate in time t measured in percent and i^t is the input interest rate in percent.

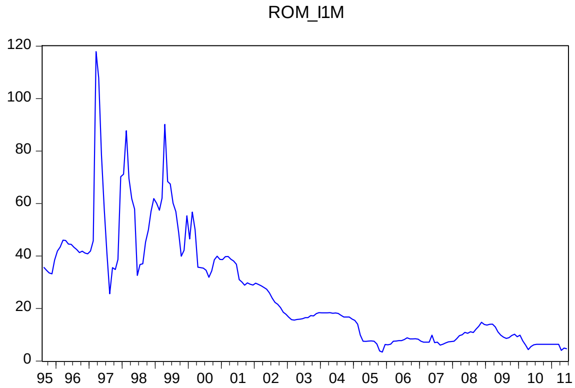
Several facts and observations are important to be noticed for the pattern of the interest rates. First of all, in the most recent years, all the countries in question have been victims to the world financial crisis. The interest rates have dropped drastically. This effect can be easily seen in the below graphs for the United Kingdom and Bulgaria. It is worth mentioning that Bulgaria retained a Currency Board Agreement, implemented sound financial policies, accelerated privatization and pursued structural reforms leading to a rapid economic growth between 2003 and 2008. (Library of Congress, 2011)



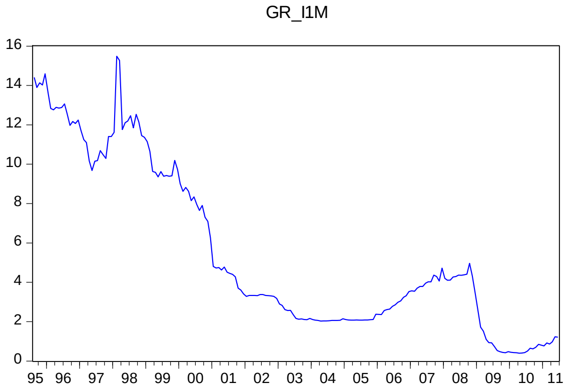
Graph 1: 1-month Interest Rate for UK



Graph 2: 1-month Interest Rate for Bulgaria



Graph 3: 1-month Interest Rate for Romania



Graph 4: 1-month Interest Rate for Greece

The graphs corresponding to the other countries are listed in the appendix since the changes from 2008 till 2011 are not that drastic.

Further descriptive statistics are provided below. As it is to be expected, the short term interest rates have the highest standard deviations, while the long term interest rates have the highest mean value. It is worth mentioning that the 1996-1999 privatization schemes in the post-communist countries have driven the interest rates to drastic levels (Soos, 2010), i.e. Romania in 1997 has recorded a value of almost 120% for a 1-month interbank interest rate. However, those fluctuations in the late 90s have their effect in the inflation rates diagrams as well; hence we suggest that they contain information useful to the fisher hypothesis testing.

Last but not least, we base our investigation on data for the period between 1995 and 2011 for all countries with two exceptions. Firstly, we analyze data for Slovakia up to December 2008 due to acceptance of the Euro as the only domestic currency in the early 2009. Secondly, our analysis for Bulgaria is based on values after 2003, since the data for the interest rates that we were able to obtain was limited.

Table 1: Descriptive statistics of the Interbank Interest rates converted to continuous compounded rates.

Country	Bulgaria				Czech Republic				Greece			
Duration	1m	3m	6m	12m	1m	3m	6m	12m	1m	3m	6m	12m
Mean	3.226352	3.911958	5.511866	7.162861	5.180646	5.192834	5.224714	5.3087	5.463825	5.663265	5.607694	5.461479
Median	2.648613	3.231229	5.611535	7.379859	3.580141	3.642836	3.662118	3.729578	3.700673	3.748844	3.845119	4.152575
Maximum	6.595627	6.990845	7.309246	8.133111	33.46849	22.15423	17.88154	15.8541	15.48647	33.63294	24.88893	14.25407
Minimum	1.480979	2.752761	4.154493	6.059639	0.811697	1.004934	1.301494	1.547957	0.399202	0.637961	0.945516	0.905884
Std. Dev.	1.385004	1.185479	1.037518	0.712655	4.630869	4.287539	4.117363	3.978125	4.302786	4.7244	4.393111	3.572139

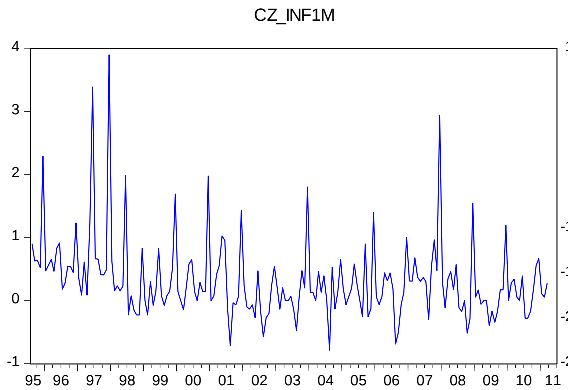
Country	Slovakia				Romania				United Kingdom			
Duration	1m	3m	6m	12m	1m	3m	6m	12m	1m	3m	6m	12m
Mean	8.382933	7.449229	8.49141	8.652788	26.24856	26.00446	25.35427	24.70157	4.498825	4.625645	4.703482	4.871664
Median	7.315752	5.845757	7.329693	7.329693	18.11542	17.98184	17.20187	16.33935	4.893872	5.027763	5.057429	5.116829
Maximum	30.56448	27.76317	25.30906	28.14125	117.9239	107.449	98.20036	85.19015	7.246577	7.522342	7.580296	7.652669
Minimum	1.965556	0	2.156578	2.185933	3.382155	4.430393	4.640637	4.859967	0.473875	0.568382	0.796817	1.242252
Std. Dev.	5.517951	6.079477	5.46568	5.563174	21.21235	20.2483	18.96199	17.79519	1.895135	1.860926	1.792922	1.684524

The Fisher model also incorporates domestic inflation rates. Since we could not obtain inflation itself for the aforementioned countries, we use the CPI index as the best available proxy. All price indexes are taken from the Thomson database, with a reference year of 1995=100. It is worth mentioning that the CPI indexes for all countries are issued by the domestic central bank. The data is recorded on a monthly basis as an absolute index value. For the purposes of our analysis the CPI index had to be converted into inflation rate percentages in monthly values. The following formula was used for the transformation:

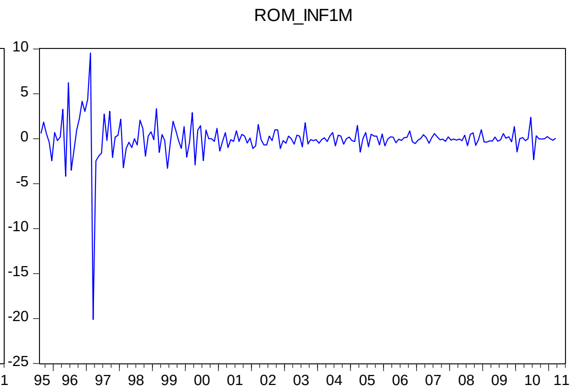
$$inf^t = \frac{100}{t} * Ln(\frac{cpi(t+i)}{cpi(i)})$$

Where inf^t is the inflation rate in percent for month t, cpi is the index data provided in the dataset.

There are several important notes to be made for the inflation rates in the countries in question. The appropriate graphs are shown below, and further discussed.



Graph 5: Czech Rep. 1-month inflation rate



Graph 6: Romanian 1-month inflation rate

In the left graph we see the inflation rate pattern for Czech Republic in the period between 1995 and 2011. During 1997 several Eastern European countries were affected by a wave of hyperinflation. That was due to weak and unstable decentralized banking system and slow reforms. However, since 2000 and the introduction of a steady economic policy package, the economy is in its steady progress state. Usually when we are facing strong outlier certain measures have to be taken in order to reduce their effect on the results later. However, if we examine Graphs 3 and 6, we will see that the peaks of the inflation rates and interest rates for Romania coincide in time. This means that they still contain viable information about the relationship between interest rates and inflation rates, thus we will include them in our calculations.

The graphs of all other inflation rates are included in the Appendix. We can see that for Czech Republic and Romania the peak values in 1997 persist for every maturity which is considered to be normal. All other countries show persistent values and stable changes in their inflation rates and should not bias our testing results in any way.

General descriptive statistics for all countries are provided below. As it is to be expected short term inflation rates in the 1 month horizon are the most volatile, with highest mean values and standard deviations. It is worth mentioning that different sources provide different values for the inflation rates or in our case CPI indexes, depending on the method used for the construction of the variable, and more specifically the reference basket of goods. We are using domestic data for every country, issued by the authorized national institute, thus matching it to the data collected for the nominal interest rates.

Table 2: Descriptive Statistics of the inflation rates for the sample periods used for further analysis.

Country	Bulgaria				Czech Republic				Greece			
Duration	1m	3m	6m	12m	1m	3m	6m	12m	1m	3m	6m	12m
Mean	0.49121	0.49808	0.511182	0.503606	0.314088	0.31201	0.307991	0.301921	0.324082	0.309876	0.305938	0.298868
Median	0.535482	0.558366	0.499894	0.458878	0.172019	0.247493	0.240922	0.229642	0.248319	0.325489	0.282616	0.281281
Maximum	3.040298	2.180906	1.626159	1.184861	3.901458	1.75688	1.125033	1.051554	3.207306	1.688341	0.960952	0.640352
Minimum	-2.19087	-0.83851	-0.26435	-0.021	-0.78741	-0.41824	-0.18049	-0.03095	-1.96597	-0.79245	-0.08684	0.041157
Std. Dev.	0.840644	0.612093	0.448092	0.295617	0.628798	0.406032	0.300542	0.24915	1.089294	0.550861	0.185397	0.108074

Country	Slovakia				Romania				United Kingdom			
Duration	1m	3m	6m	12m	1m	3m	6m	12m	1m	3m	6m	12m
Mean	0.498288	0.492496	0.488174	0.482232	-0.00179	-0.00717	-0.01005	-0.01209	0.237798	0.235795	0.233886	0.230654
Median	0.290698	0.342385	0.341733	0.47632	-0.01987	-0.02791	-0.00499	-0.0132	0.301191	0.234288	0.258265	0.242201
Maximum	5.493372	2.200268	1.343135	1.276081	9.546321	5.65669	4.066965	2.090644	1.113184	0.776902	0.62299	0.447758
Minimum	-0.36765	-0.16856	-0.01121	0.033557	-20.1011	-8.1665	-3.92112	-1.92032	-1.44558	-1.18448	-0.55082	-0.13172
Std. Dev.	0.827878	0.513229	0.361712	0.262209	2.089354	1.019434	0.573491	0.285836	0.390166	0.252685	0.173488	0.115356

Methodology

In this section we discuss the methodology used and elaborate on the econometric issues which were encountered during the analysis.

We estimate one of the standard models used for testing of the Fisher Hypothesis, namely testing if the term spread of the nominal interest rates contains any predictive power of the future inflation rates. This issue leads us to equation (2), previously discussed in the Theory section:

$$\pi_t^m - \pi_t^1 = \alpha^m + \beta^m(i_t^m - i_t^1) + \varepsilon_t^m$$

Where the future inflation rate from period *t* to period *t+m* minus the one-period inflation rate is regressed on the term structure included as a slope variable. Similarly to the inflation rate, the term structure is taken as the difference between the *m*-period interest rate at time *t* and the one-period inflation rate at time *t*.

The theory states that the value of the beta coefficient shows if nominal interest rates contain any predictive information about the future path of the inflation rates. We test the beta coefficients with a standard t-test, using the significance level of 5%. In case we find enough evidence to reject the H_0=0 (p-value lower than 0.05), we can conclude that nominal interest rates can be used as a predictive instrument for the inflation rates. However, if we cannot reject the null, this means that there is no relationship between the two variables, and we reject the Fisher Hypothesis.

Furthermore, we will test if the beta coefficient is significantly different from one. Theory suggests that values which are not different from one, would mean that the term spread of the nominal interest rates is constant over time. Hence, we may conclude that inflation rates and nominal interest rates are moving at a 1-1 basis

In addition to this it will be important to look at the ranges of values of the beta coefficient whenever they are significantly different from 0 and 1 because they contain information about the relationship between real interest rates and inflation. This is due to the fact that the Fisher hypothesis implies that:

$$Nominal\ Interest\ Rate = Real\ Interest\ rate\ +\ Inflation\ Rate.^*$$

*Assuming continuous compounding of the rates.

Therefore there are two possible cases for those ranges in our analysis the one where beta is between 0 and 1 and a second range where beta is smaller than 0 or bigger than 1. In the former case an increase in the nominal interest spread will lead to a smaller increase in the inflation spread which according to the abovementioned statement of the Fisher hypothesis implies a positive correlation between the nominal and real interest rate spreads. That is true because if the beta is smaller than 1 but positive say 0.5 then an increase in the nominal interest by say 10 basis points implies a smaller increase in the inflation rate of 5 basis points. If we then look at the equation above then the other 5 basis point of the increase have to happen in the real interest rate. In the case where beta is outside the range 0-1 similar logic indicates that the correlation should be negative. If in either range the correlation is different that will imply a strong influence by missing variables which are not included in the above equation and are therefore not part of the Fisher hypothesis. Because the periods that I am studying in this paper are relatively short such variables can be things like market crises, (Stambaugh 1998) monetary policy (Evans and Marshall 1998) and others.

However, before we analyze the results and make any conclusions it is important that we address several important practical and econometric issues of the model in case.

First of all, the Fisher Hypothesis is defined using the expected values of the inflation rates. However, in practice expectations are usually unavailable or not observed at all. For this reason, the above model is based on the assumption of the rational expectations hypothesis. We take historical information about the inflation, and the nominal interest rates, thus testing the Fisher Hypothesis. This is one of the key issues of this model which can affect the results in an unpredictable way.

Secondly, the model construction itself suggests that the error terms of the regression output might exhibit serial correlation. The issue can easily addressed with an example: For the one year period, 12 months duration of the forecast, the first calculation is based on the values of the inflation rates and interest rates for months from 1 to 12. Afterwards, the model switches one position further, thus using the months from 2 to 13. This means that the first and the second calculations are both based on the months from 2 to 12, and one more. This could lead to a serious problem for a longer maturity period, violating key assumption of the OLS estimation method and making the regression output results inaccurate or even invalid. In order to correct for the aforementioned problem we will implement the Newey-West procedure in Eviews which will corrects for conditional heteroskedasticity and serial correlation. (Newey & West, 1994) It is worth mentioning that we are using the automatic lag selection from the software and not correct for it manually.

Thirdly, we have to consider the possibility of small sample bias in our results. For most of the countries our calculations are based on almost 15 years of monthly data which should be sufficient for viable and accurate results. However, the calculations for Bulgaria, especially at the longer maturity periods, are based on 3 years of monthly observations. However, calculating the relevant p-values using any procedure like the Monte Carlo simulation could create a bias itself. Hence, for the purposes of the present research we will assume that the effect of a possible bias is minimal.

Last but not least, we have to consider the possibility for errors in variables. All our data is taken from the authorized national statistics institutes of the respective country. Hence, we consider that having the same institution building up both variables for the research in question should lead to consistent results and reduce the possibility of errors in variables to its minimum.

Results

In this section we discuss our empirical results. First we start with a table to summarize our regression estimations. Then we continue with an overview of the results for every country separately. Afterwards, we evaluate two special cases in our analysis and elaborate by constructing two more models. Finally, we compare our results to previous research and draw conclusions about the validity of the Fisher Hypothesis.

The empirical results following our analysis are listed below in Table 3. We summarize the regression estimates of the inflation change model for all 6 countries with the 3 different maturity periods. The table contains the values of the alpha and beta coefficients with their respective standard errors which give us information about the general relationship between the nominal interest rate and the inflation rates. Further, the relevant t-statistics for the coefficient tests and the p-values corresponding to them are listed, which provide us with the insight if the aforementioned economic connection is statistically significant, and lead towards conclusions about the validity of the Fisher Hypothesis. Last but not least, the table contains the values for R-squared which provides us a general perspective of the explanatory power of the model. It is worth mentioning that the listed p-values are the normal asymptotic values provided by Eviews and are not calculated through a Monte-Carlo simulation procedure.

Table 3A. Regression estimates of the inflation-change model.

Country	Period	Sample	alpha	beta	a=0	b=0	b=1	R^2
Bulgaria			(s.e.)	(s.e.)	(p-value)	(p-value)	(p-value)	
	3 to 1	Sample (adjusted): 2003M03 2011M01	0.01531	-0.01608	0.123943	-0.1145	-7.23466	0.00011
			0.123524	0.140446	0.9016	0.9091	0.00*	
	6 to 1	Sample (adjusted): 2007M11 2010M10	-0.2871	0.149516	-2.52031	2.048918	-11.6548	0.091427
			0.113916	0.072973	0.0166*	0.0483*	0.00*	
	12 to 1	Sample (adjusted): 2007M11 2010M04	-0.44679	0.114501	-3.61274	2.488447	-19.2445	0.179069
			0.123671	0.046013	0.0012*	0.019*	0.00*	
CZ								
	3 to 1	Sample (adjusted): 1995M08 2011M01	-0.00478	0.153078	-0.21383	18.18978	-100.637	0.068291
			0.022353	0.008416	0.8309	0.00*	0.00*	
	6 to 1	Sample (adjusted): 1995M08 2010M10	-0.00881	0.14225	-0.24691	16.58978	-100.034	0.089558
			0.035696	0.008575	0.8053	0.00*	0.00*	
	12 to 1	Sample (adjusted): 1995M08 2010M04	-0.03275	0.121134	-0.75603	9.236851	-67.0161	0.081357
			0.043316	0.013114	0.4506	0.00*	0.00*	
Greece								
	3 to 1	Sample (adjusted): 1995M08 2011M01	0.010035	-0.03583	0.270291	-4.7467	-137.21	0.00365
			0.037128	0.007549	0.7872	0.00*	0.00*	
	6 to 1	Sample (adjusted): 1995M08 2010M10	-0.01454	-0.00286	-0.33842	-0.15167	-53.2683	0.000009
			0.042955	0.018827	0.7354	0.8796	0.00*	
	12 to 1	Sample (adjusted): 1995M08 2010M04	-0.03175	-0.01162	-0.53269	-0.10173	-8.8552	0.000091
			0.059596	0.11424	0.5949	0.9191	0.00*	

Significant values at 5% significance level are marked with an asterisk (*).

Table 3B. Regression estimates of the inflation-change model.

Country	Period	Sample	alpha	beta	a=0	b=0	b=1	R^2
Romania			(s.e.)	(s.e.)	(p-value)	(p-value)	(p-value)	
	3 to 1	Sample (adjusted): 1995M08 2011M01	-0.03162	-0.1023	-0.36765	-0.72288	-7.78919	0.017879
			0.085991	0.141517	0.7136	0.4707	0.00*	
	6 to 1	Sample (adjusted): 1995M08 2010M10	-0.12408	-0.1225	-0.84805	-1.13824	-10.4298	0.06504
			0.146307	0.107625	0.3975	0.2565	0.00*	
	12 to 1	Sample (adjusted): 1995M08 2010M04	-0.22211	-0.12597	-1.30895	-1.45561	-13.0108	0.130541
			0.169682	0.086541	0.1923	0.1473	0.00*	
Slo								
	3 to 1	Sample (adjusted): 1995M08 2008M12	-0.00707	0.005095	-0.218	0.493099	-96.2954	0.000223
			0.032448	0.010332	0.8277	0.6226	0.00*	
	6 to 1	Sample (adjusted): 1995M08 2008M12	-0.01184	0.01587	-0.21614	0.484655	-30.0536	0.001294
			0.054758	0.032746	0.8292	0.6286	0.00*	
	12 to 1	Sample (adjusted): 1995M08 2008M12	-0.02374	0.02847	-0.38554	1.047557	-35.7478	0.005363
			0.061571	0.027177	0.7004	0.2964	0.00*	
UK								
	3 to 1	Sample (adjusted): 1995M08 2011M01	0.001164	0.011428	0.057349	0.069544	-6.01595	0.000041
			0.020297	0.164325	0.9543	0.9446	0.00*	
	6 to 1	Sample (adjusted): 1995M08 2010M10	0.01385	-0.03224	0.520415	-0.2529	-8.09844	0.000525
			0.026613	0.127461	0.6034	0.8006	0.00*	
	12 to 1	Sample (adjusted): 1995M08 2010M04	0.005974	-0.00375	0.159124	-0.05806	-15.5384	0.000016
			0.037546	0.064598	0.8738	0.9538	0.00*	

Significant values at 5% significance level are marked with an asterisk (*).

Firstly, we examined the correlation matrixes which are listed in the Appendix as Tables A1 to A6. We observe that in all cases the correlation between the nominal interest spread and the real interest spread is positive and significant. This means that we would expect the significantly different from zero betas to take values between 0 and 1. We observe only one case where the beta is lower than zero, in the short-run for Greece, which we will discuss later in this section.

Our analysis for Bulgaria is based on two different time periods in accordance with the availability of data. That issue was previously discussed in the Data section. The results for Bulgaria show that in the very short run of 3-month maturity period, the beta coefficient is not significantly different from 0. This means that the nominal interest rates do not contain predictive information about the future path of the inflation rates in the 3-month maturity period. However, for 6-month and 12-month maturity periods the regression results provide enough evidence in support of the hypothesis that nominal inflation rates can be used to predict the future inflation rates. At all maturity periods the estimation results conclude a beta value significantly different from 1, thus we may conclude that the real interest rates term spread is not constant over time, and the nominal and real interest rates do not move on to a 1 to 1 basis. Last but not least we observe that the predictive power of our model increases with the increase of the maturity period.

The results for the Czech Republic show significant values of the beta coefficient for every maturity period. However, the values are significantly different from 1 as well. This means that our analysis confirms that nominal interest rates are related to the future inflation rates, but the slope of the real interest rates is not constant over time. It is worth mentioning that this is the only country where the regression estimates confirm the weak form of the Fisher Hypothesis in all maturity periods. All three models for this country show almost the same explanatory power with a slight increase from the shortest to the longest maturity periods.

The analysis for Greece is a mirror of what we found previously for Bulgaria. In this case the shortest maturity period proves a relationship between the nominal interest rates and the future inflation rate. However, for 6-month and 12-month durations the beta coefficient is not significantly different from zero, thus we are unable to reject the zero hypotheses. As in all previous cases beta is significantly different from one hence the conclusions stay the same. It is worth mentioning that the predictive power of the models is decreasing from the short to the long run. Furthermore, this is one special case that we discuss in more detail later on in this section.

Romania and Slovakia share the same conclusions in all cases. The beta coefficients are always not significantly different from zero, suggesting that there is no relationship between the nominal interest rates and the future path of the inflation rate. Further, in all cases betas are significantly different from zero, suggesting that the term spread of the real interest rates is not constant over time. The explanatory power of the models increases with the increase of the maturity period for both countries.

The United Kingdom is a special case in our analysis. At first we observe that in none of the maturity periods the beta coefficient is significantly different from zero. This would lead to the conclusion that nominal interest rates do not contain any information about the future inflation rates. However, the UK is the most advanced and the biggest economy system in our research project. This suggests that exposing this economy to the conditions of crisis would lead to controversial results. For that reason we repeated our analysis, excluding the observations from the period of the latest economic crisis, from 2008 to 2011.

In Table 4 we can see the results for the UK, for the period before the latest financial crisis. The results are reported in the exact same manner as in the previous two tables.

UK	Period	Sample	alpha	beta	a=0	b=0	b=1	R^2
			(s.e.)	(s.e.)	(p-value)	(p-value)	(p-value)	
	3 to 1	Sample: 1995M08 2007M06	0.0101	-0.089	0.590	-0.786	-9.615	0.002
			0.0171	0.113	0.556	0.433	0.000*	
	6 to 1	Sample: 1995M08 2007M06	0.0136	-0.052	0.506	-0.459	-9.315	0.001
			0.0269	0.113	0.614	0.647	0.000*	
	12 to 1	Sample: 1995M08 2007M06	0.0281	-0.070	0.872	-0.982	-14.998	0.005
			0.0322	0.071	0.385	0.328	0.000*	

Table 4: Adjusted UK regression estimates.

In this case, we observe the same conclusions, but the results are closer to what we may expect. As before, in all cases beta coefficients are not significantly different from zero, and they are significantly different from 1. We can conclude that for the UK the nominal interest rates do not contain information about the future inflation rates for the maturity periods of 3, 6 and 12 months duration.

However, the latter analysis was made in order to provide a valuable insight about most of our results. As the results for Bulgaria have suggested, the significance of the beta coefficient, thus the relationship in question, is stronger with the increase of the maturity periods. We observe the same behavior for Romania, Slovakia and the UK if we exclude the data in the crisis period. This means that in case we would conduct an analysis over a broader period, and more importantly including longer durations for the nominal interest rates and the future inflation rates, we are very likely to find that the beta coefficient values prove significantly different from zero, thus confirming the fisher effect.

The second special case in our analysis is Greece. Here we observe a significant negative value of the beta coefficient. As it was discussed in the methodology section, in this case we would either expect a negative correlation between the term-spreads of the real interest rates and the nominal interest rates, or the model suffers from missing variables which make our analysis inaccurate. However, the correlation matrix shows a positive and significant correlation between the variables which means that we exhibit the influence of missing variables or an econometric problem. Hence, we analyzed the input data and we constructed a new model, which eliminates the currency crisis of 1996-1997, thus getting slightly different results, as shown below:

Country	Period	Sample	alpha	beta	a=0	b=0	b=1	R^2
Greece			(s.e.)	(s.e.)	(p-value)	(p-value)	(p-value)	
	3 to 1	2000M06 2011M01	0.057838	-0.33508	0.997132	-1.1534	-4.59561	0.004792
			0.058005	0.290512	0.3206	0.2509	0.000*	
	6 to 1	2000M06 2010M10	0.02053	-0.14767	0.35536	-0.89947	-6.99067	0.002629
			0.057772	0.164171	0.7229	0.3702	0.000*	
	12 to 1	2000M06 2010M04	-0.000486	-0.13495	-0.00817	-0.85669	-7.20512	0.007435
			0.05947	0.157519	0.9935	0.3934	0. 000*	

Table 5: Adjusted regression estimates for Greece.

In the latter table we can observe that the beta coefficient is no longer significant, thus implying that the nominal interest spread does not contain predictive information about the future inflation spread.

The evidence for Bulgaria, Czech Republic and Greece suggest that we can assess inflationary pressure. In the cases of a negative beta, negative slope, we would expect that the inflation rate will decrease in the upcoming periods. On the other hand, positive slope coefficient suggests that the inflation pressure will be positive in the next periods. However, we have to be conservative towards this conclusion because future government interventions and central bank policies cannot be predicted by our model.

As a conclusion of this section we will compare our results to previously published paper on a similar topic, regarding different time period and different countries. Jorion and Mishkin (1990) base their analysis on the US, UK, Germany and Switzerland. They analyze the Fisher Hypothesis in the long run, by taking maturities of 2 to 5 years. Their results are comparable to ours in the sense that we find the same patterns across all the countries in question. They observe the increase in predicting power, and the increase of significance of the beta coefficient in their regression estimations. Similarly, they find strong evidence in support of the Fisher effect in the long run models they are using, and tend to reject it in the short run. However, we find that the beta coefficient is significantly different from zero in all cases, while they conclude the opposite. This comparison is surprising because our analysis is based on maturity periods for less than 1 year, while they examine the relationship in the long run. In addition, we include recent members of the European Union like Bulgaria and Romania where the financial systems are not as well developed yet, while they base their research on developed economies only. Last but not least, they include observations for the period between 1973 and 1989 which is the period directly after the economic crisis in the US. In that sense, the period they include is similar to the period that we examine because all of the countries we analyze, except the UK and Greece, have been in their recovery periods after the fall of the iron curtain.

Discussion

In this section we will elaborate on the methodology used, and more specifically on the limitations it imposes and the biases they can create.

First of all, we assume the Rational Expectations Hypothesis. This means that we create the future inflation rate by using historical data. By the original definition of the Fisher Hypothesis the data for the inflation rate has to be based on expected values, most likely collected by surveys. However, this kind of research is still unlikely to be conducted for the countries in question because this type of data is still abundant. Unfortunately, the effect of this assumption on our results cannot be predicted, since we cannot compare the historical data that we used to the expected inflation data that the hypothesis suggests to be used.

Secondly, we have based our analysis on data gathered by different sources. As it was discussed previously, we have collected the data for every country from the respective official authority, in order to make the single-country analysis the most accurate. This was made because the EU centralized statistics institution (EURO Stat) could not provide all the necessary data for all the countries together. However, different institutions can have slightly different methodology of gathering the data, and converting it afterwards. This may result into inaccurate comparison between the countries.

Thirdly, we would consider the hazard of small sample bias. Our dataset consists of observations from Aug-1995 to June-2011 on a monthly basis. This means that for the better part of our analysis small sample bias should not be present. However, the data for Bulgaria, in the long run of 12 months, is based on the period between Nov-2007 to Apr-2011, which leaves only 30 observations for the purposes of our regression analysis. We suggest that in this case there will be severe small sample bias, which may lead to inaccurate p-values and improper conclusions. However, in our case the results and conclusions suggest that sample bias is not severe because the results proved to our expectations. As a further development we would suggest either including more observations for the specified country, or calculating the relevant p-values through the Monte-Carlo simulation procedure.

Lastly, we consider that the Newey-West automatic lag selection may select an inappropriate lag length, thus not resolving the issues of heteroskedasticity and autocorrelation in the residuals. As it is discussed by Newey&West (1994), our standard p-values might tend to over-reject the null hypotheses in the longer run scenarios. Thus, we suggest that using manually calculated lags in the Newey-West can improve and provide more clear results.

Furthermore, the conditions of the recent crisis would suggest that short-term relationships will be biased by the government intervention policies. However, we tried adjusting the sample periods by limiting them to the middle of 2007, when the crisis does not have such a strong effect on the interest rates and inflation rates. It is worth mentioning that for Bulgaria this was not possible due to the abundance of data. As we saw previously, the results for the United Kingdom changed drastically when we excluded the period of the financial crisis. On the other hand, the results for the other regression models were not different from the ones including the full data. We believe that this effect is due to the difference in progress and economic situations in the countries in question. The United Kingdom is the biggest, and most advanced financial system of all the countries included in our analysis. We can also observe, that the UK has had a relatively stable economy in comparison to the other countries which suffered drastic policy changes, privatization and inflation booms.

Conclusion

In this academic research we focused on the relationship between the nominal interest rates and the future path of the inflation rates, thus testing the Fisher Hypothesis. Our analysis was based on six countries, five of which eastern European and the UK for comparison purposes. Our dataset covered the period from 1995 to 2011, consisting of inter-bank interest rates recorded on a monthly basis, and the CPI indexes for every country in question.

We discussed the formulation of the Fisher Hypothesis, along with several standard econometric models, used for the purposes of testing the effect. Furthermore, we elaborated on previously published work, thus providing a general overview of the topic and discussion of the different methodologies used and results obtained.

Our analysis provided support for the weak form of the Fisher Hypothesis, namely that there is a relationship between inflation rates and nominal interest rates, for three of the countries in different maturity periods. On the other hand, we rejected the strong form of the Fisher Effect in all cases, thus concluding that the real interest rates are not constant over time. We also observed a general pattern in the results, namely the relationship between the variables in question grows stronger with the increase of the maturity period. This suggests further research for the same countries, using longer maturity periods. We believe that the hypothesis will be therefore confirmed, due to the pattern which was already discussed.

Overall, we find enough evidence in support of the Fisher Hypothesis for Bulgaria and the Czech Republic. Although not at 1 to 1 basis, this suggests that the term structure of the nominal interest rates can be used to assess the short term inflationary pressure in the mentioned economies. The implication is that a positive slope would indicate a rise in the inflation rates for the upcoming periods, while a negative slope suggests decline in the inflation rates. However, it is ascertained that monetary policies have a significant effect on the short term rates, thus altering the relationship between the two variables in question.

REFERENCES

1. A Country Study: Bulgaria, DR55 .B724 1993, Library of Congress, June 2011, Federal Research Division, The USA
2. Berk, Jonathan, Peter DeMarzo, 2007, Corporate Finance, The USA, Pearson Education
3. Buraschia, Andrea, Alexei Jiltsovc, 2005, Inflation risk premia and the expectations hypothesis, Journal of Financial Economics, Volume 75, Issue 2, Pages 429-490
4. Evans, Charles, David Marshall, 1998, Monetary policy and the term structure of nominal interest rates: Evidence and theory, Carnegie-Rochester Conference Series on Public Policy, Volume 49, Pages: 53-111
5. Fahmy, Yasser, Magda Kandil, 2003, The Fisher effect: new evidence and implications, International Review of Economics and finance 12 451-465
6. Fisher, Irving, 1930, The Theory of Interest, Clifton, Augustum M. Kelley
7. Gerlach, S., "The information content of the term structure: Evidence for Germany", Empirical Economics, vol 22 (2) June 1997:161-79
8. Hill, Carter, William Griffiths, Guay Lim, 2008, Principles of Econometrics, Third Edition, the USA, Wiley
9. Ignatov, Bojidar, Emile Schiff, Branimir Zelenkov, Yan Li, Testing the Fisher Hypothesis: Extension and Discussion, March 2011, Seminar Interest Rates and Stock Markets
10. Jorion, Philippe, Frederic Mishkin, 1991, A multicountry comparison of term-structure forecasts at long horizons, Journal of Financial Economics 29 59-80
11. Koedijk, K.G. and Kool, C.J.M., "Future inflation and the information in international term structure", Empirical Economics, vol.20 (2) June 1995: 217-42
12. Korkofingas, Con, Joseph Macri, 2007, An examination of the fisher hypothesis for New Zealand in a deregulated environment: a Cointegration approach, Journal of International Business and Economics, Volume 7
13. Mishkin, Frederic, 1992, Is the Fisher effect for real?: A reexamination of the relationship between inflation and interest rates, Journal of Monetary Economics, Volume 30, Issue 2, Pages 195-215
14. Mishkin, Frederic, John Simon, 1995, An Empirical Examination of the Fisher Effect in Australia, Economic Record, Volume 71, Issue 3, Pages: 217-229
15. Soos Karoly A. , Politics and Policies in Post-Communist Transition: Primary and Secondary Privatisation in Central Europe and the Former Soviet Union, Central European University Press November 2010, ISBN-10: 9639776858
16. Stambaugh, Robert, 1988, The information in forward rates: Implications for models of the term structure, Journal of Financial Economics, Volume 21, Issue 1, Pages 41-70
17. Whitney K. Newey and Kenneth D. West, "Automatic Lag Selection in Covariance Matrix Estimation", The Review of Economic Studies, Vol. 61, No. 4 (Oct., 1994), pp. 631-653, Oxford University Press

Appendix

Correlation Matrixes – Term Spread of Nominal Interest Rates to Term Spread of Real Interest Rates.

Bulgaria		Term Spread of Nominal Interest Rates			
			12 to 1	6 to 1	3 to 1
Term Spread of Real Interest Rates	12 to 1	Correlation	**0.96375**		
		Probability	**0**		
	6 to 1	Correlation		**0.8799**	
		Probability		**0**	
	3 to 1	Correlation			**0.71844**
		Probability			**0**

Table A1: Correlations for Bulgaria

Czech Republic		Term Spread of Nominal Interest Rates			
			12 to 1	6 to 1	3 to 1
Term Spread of Real Interest Rates	12 to 1	Correlation	**0.9074**		
		Probability	**0**		
	6 to 1	Correlation		**0.88482**	
		Probability		**0**	
	3 to 1	Correlation			**0.83315**
		Probability			**0**

Table A2: Correlations for the Czech Republic

Greece		Term Spread of Nominal Interest Rates			
			12 to 1	6 to 1	3 to 1
Term Spread of Real Interest Rates	12 to 1	Correlation	**0.63878**		
		Probability	**0**		
	6 to 1	Correlation		**0.72108**	
		Probability		**0**	
	3 to 1	Correlation			**0.87438**
		Probability			**0**

Table A3: Correlations for Greece

Romania		Term Spread of Nominal Interest Rates			
			12 to 1	6 to 1	3 to 1
Term Spread of Real Interest Rates	12 to 1	Correlation	**0.96076**		
		Probability	**0**		
	6 to 1	Correlation		**0.9248**	
		Probability		**0**	
	3 to 1	Correlation			**0.82574**
		Probability			**0**

Table A4: Correlations for Romania

Slovakia		Term Spread of Nominal Interest Rates			
			12 to 1	6 to 1	3 to 1
Term Spread of Real Interest Rates	12 to 1	Correlation	**0.92877**		
		Probability	**0**		
	6 to 1	Correlation		**0.91258**	
		Probability		**0**	
	3 to 1	Correlation			**0.94596**
		Probability			**0**

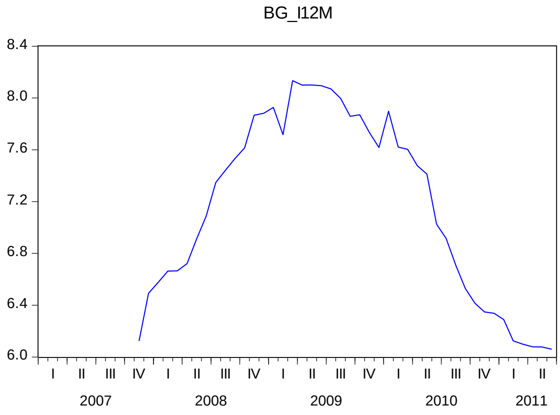
Table A5: Correlations for Slovakia

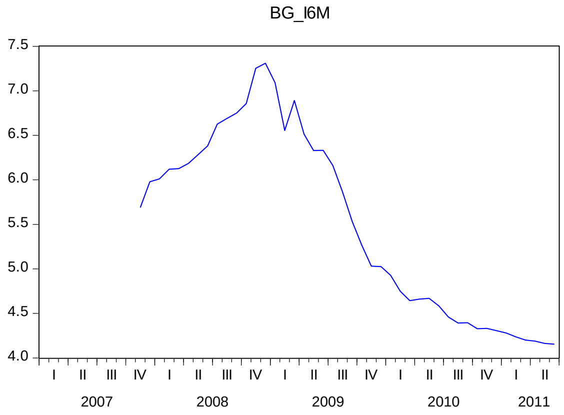
United Kingdom		Term Spread of Nominal Interest Rates			
			12 to 1	6 to 1	3 to 1
Term Spread of Real Interest Rates	12 to 1	Correlation	**0.73592**		
		Probability	**0**		
	6 to 1	Correlation		**0.59906**	
		Probability		**0**	
	3 to 1	Correlation			**0.48835**
		Probability			**0**

Table A6: Correlations for the United Kingdom

Continuously compounded nominal interest rate graphs, calculated as described in the "Data" section.

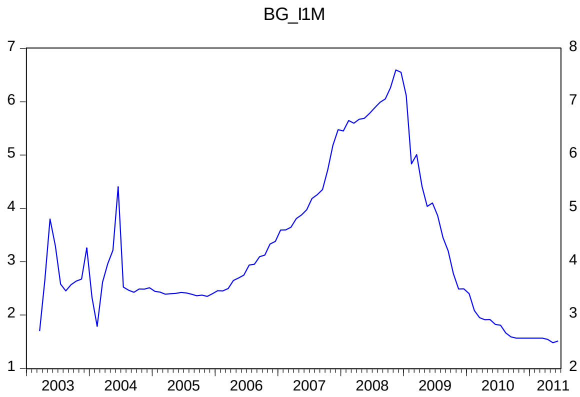
Bulgaria:

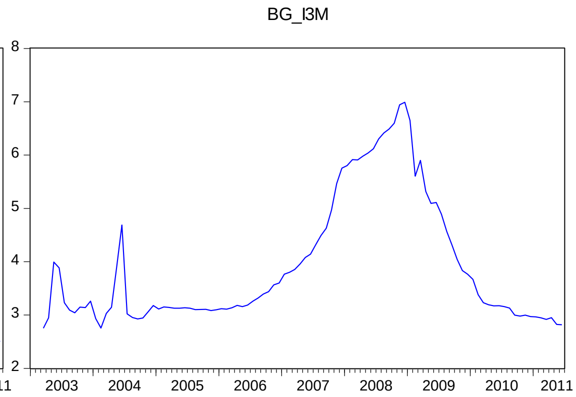




12-month maturity.

6-month maturity

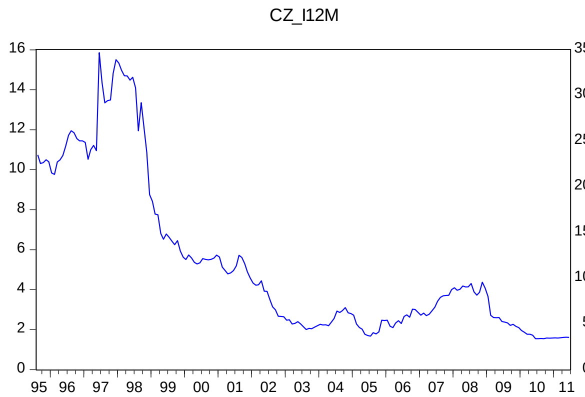


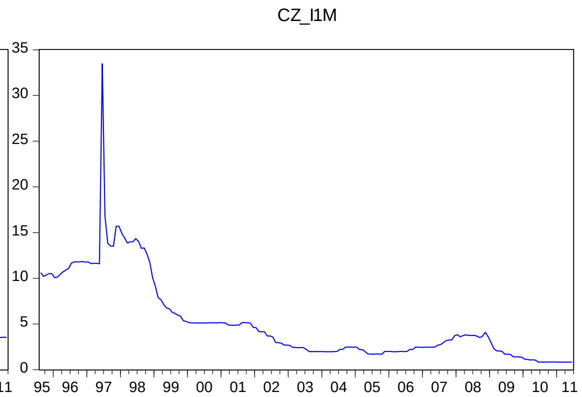


1-month maturity.

3-month maturity

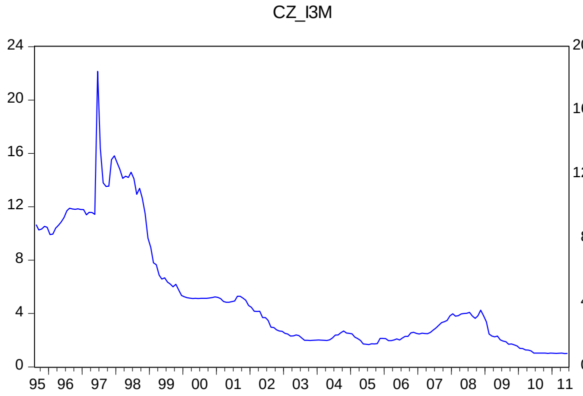
Czech Republic:

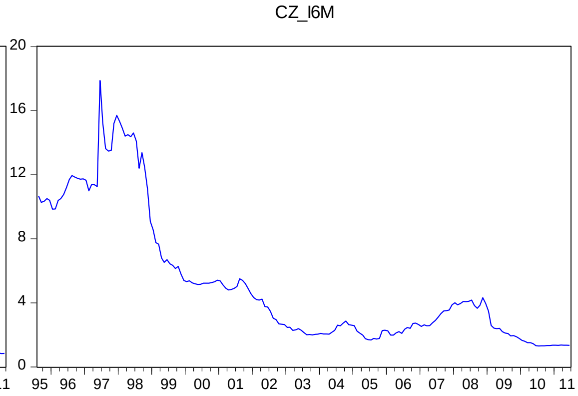




12-month maturity

1-month maturity

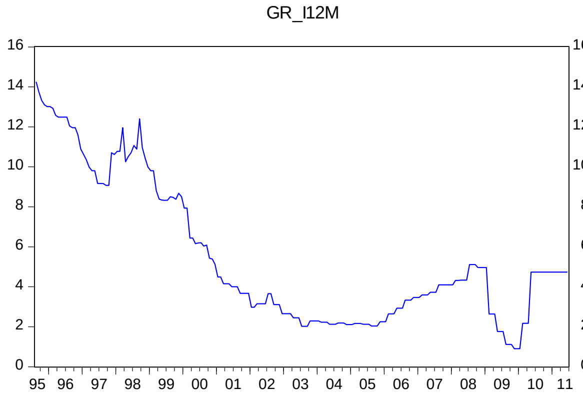


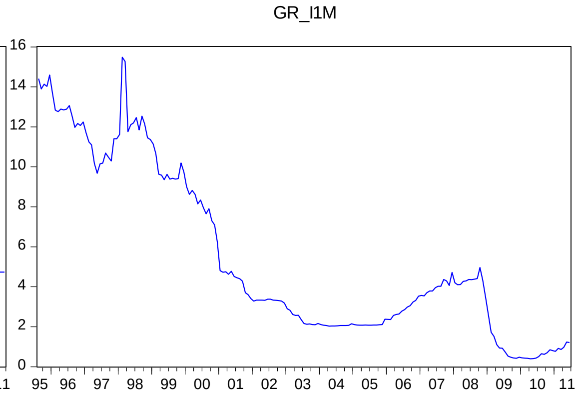


3-month maturity

6-month maturity

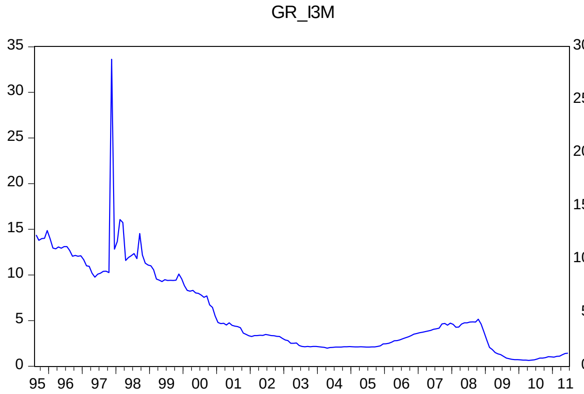
Greece:

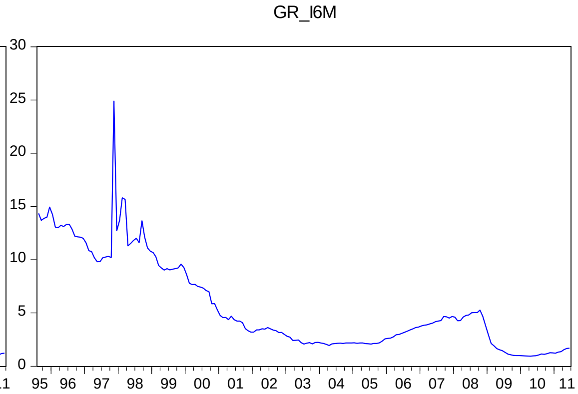




12-month maturity

1-month maturity

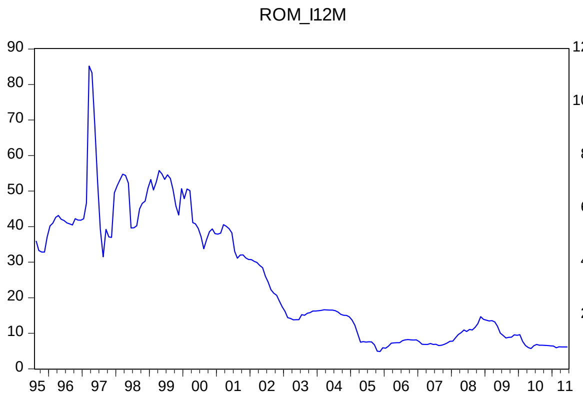


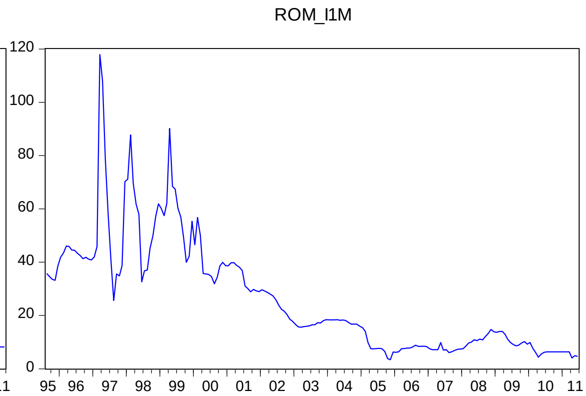


3-month maturity

6-month maturity

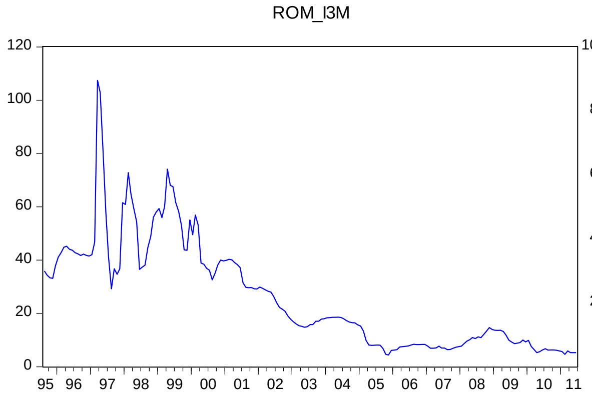
Romania:

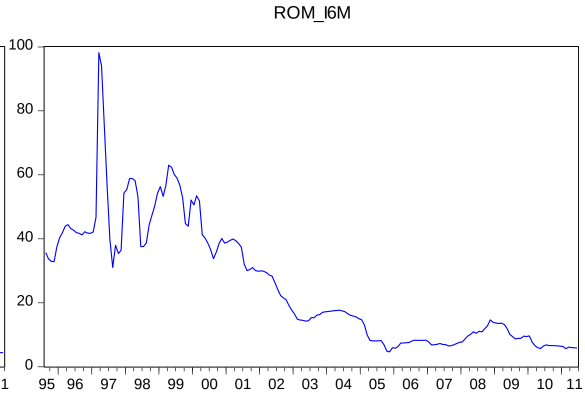




12-month maturity

1-month maturity

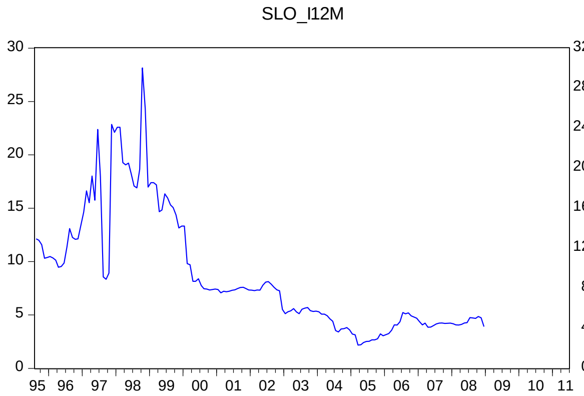


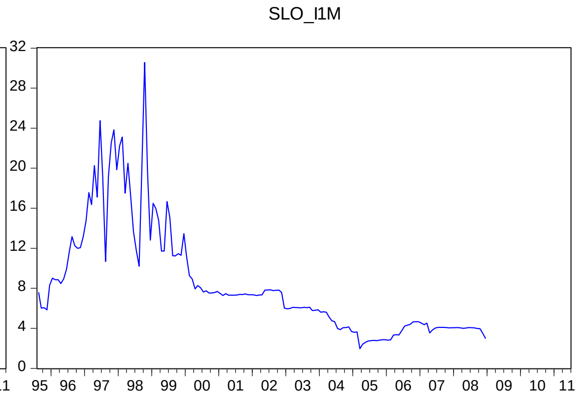


3-month maturity

6-month maturity

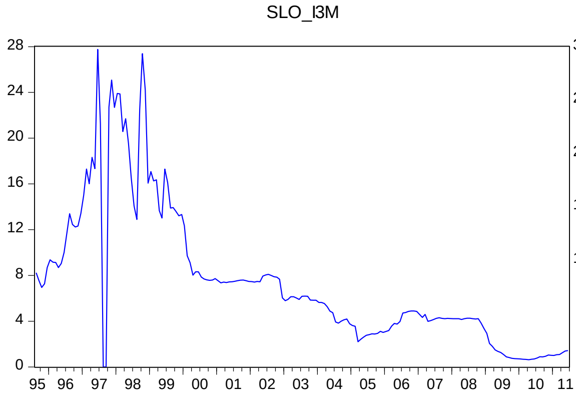
Slovakia:



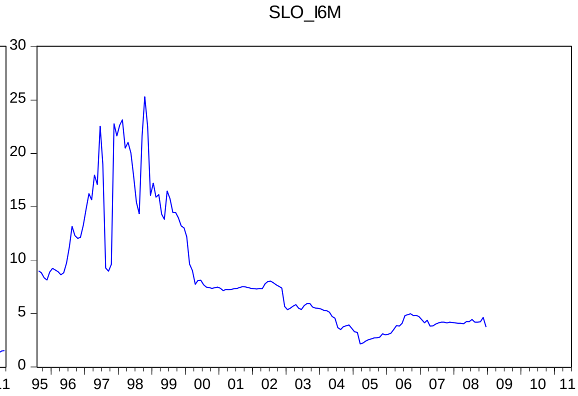


12-month maturity

1-month maturity

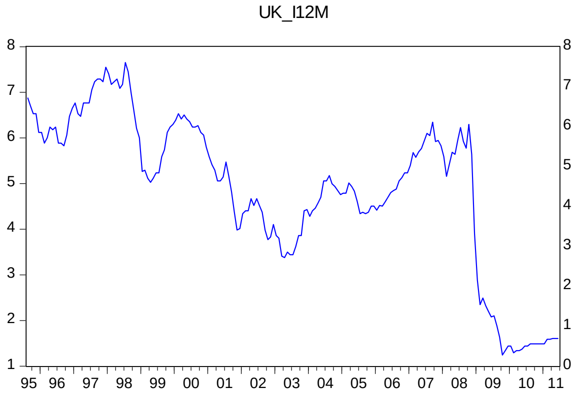


3-month maturity

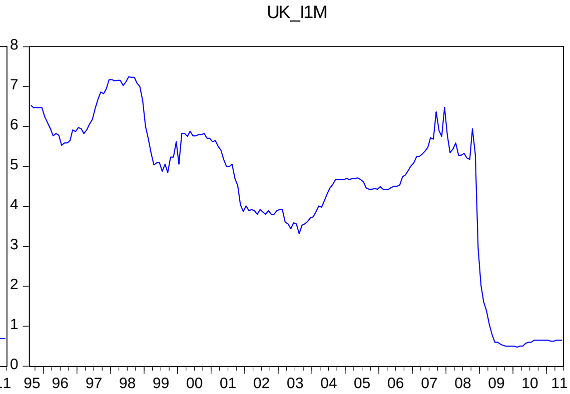


6-month maturity

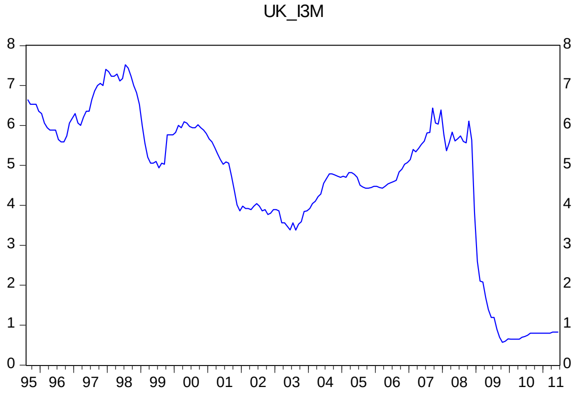
United Kingdom:



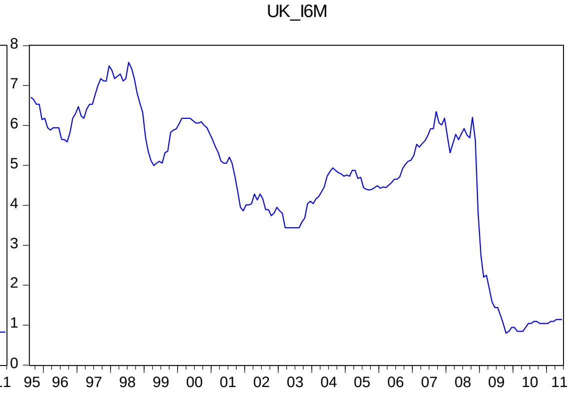
12-month maturity



1-month maturity



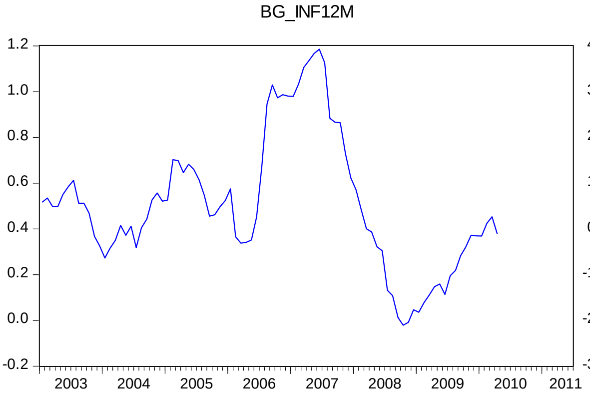
3-month maturity



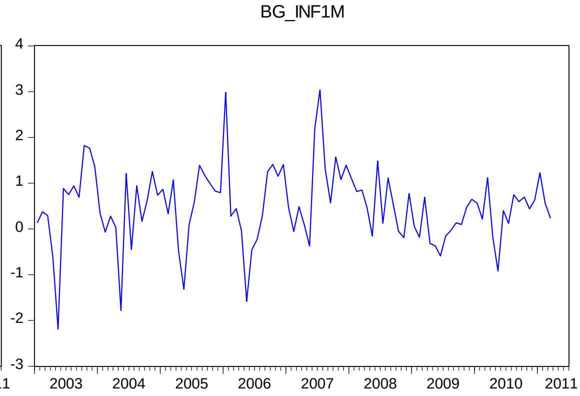
6-month maturity

Continuously compounded inflation rates, calculated as described in the "Data" Section.

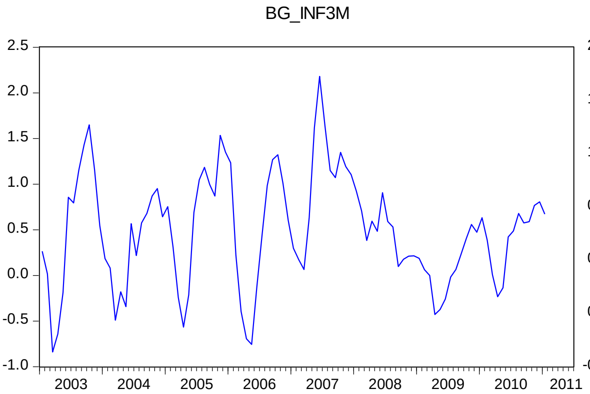
Bulgaria



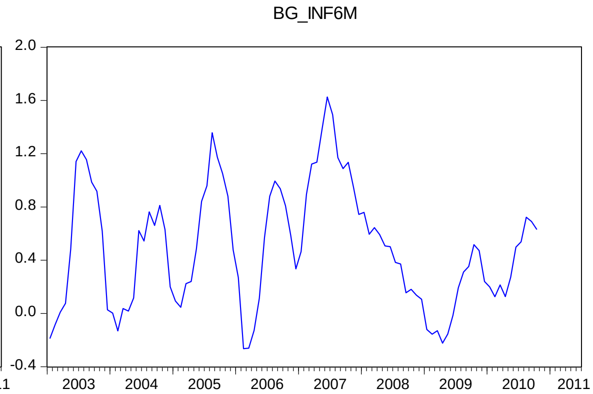
12-month maturity



1-month maturity

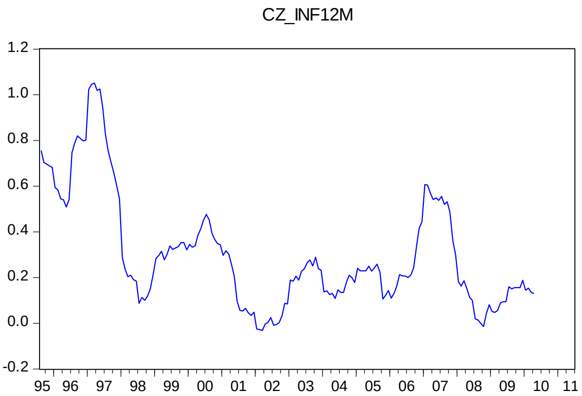


3-month maturity

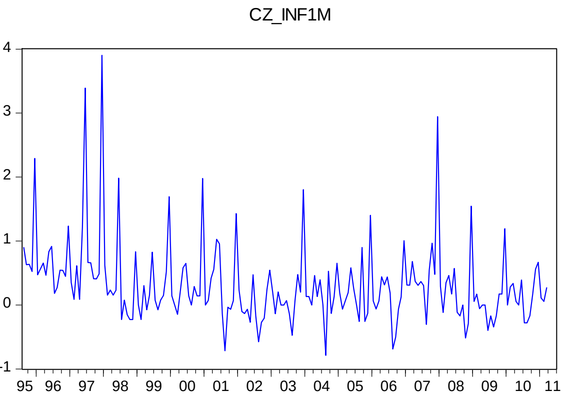


6-month maturity

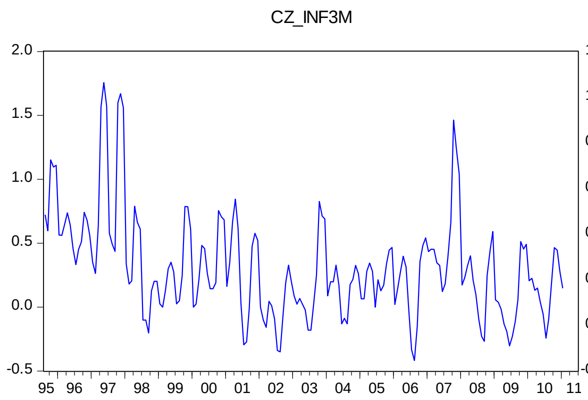
Czech Republic:

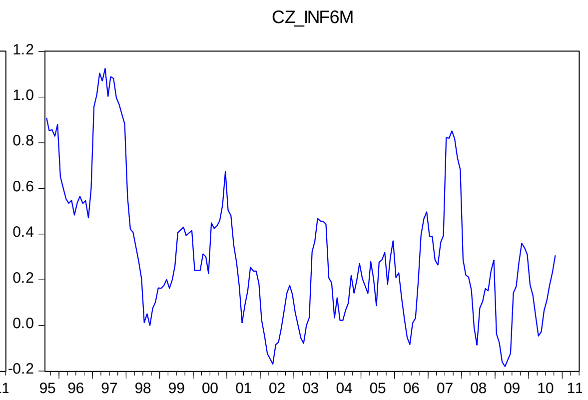


12-month maturity



1-month maturity

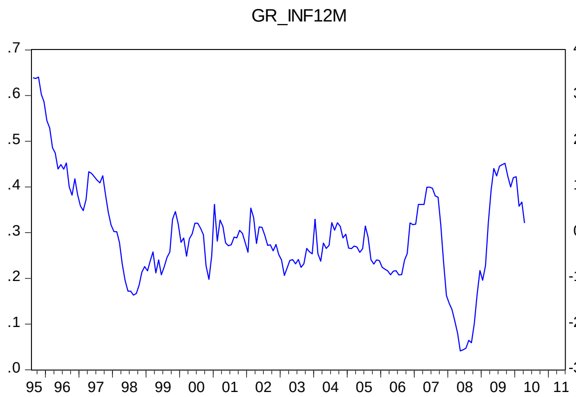


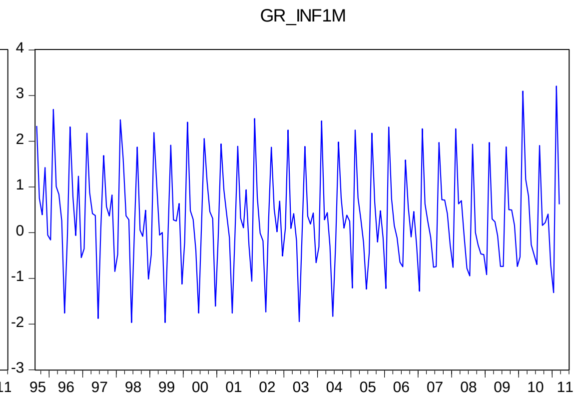


3-month maturity

6-month maturity

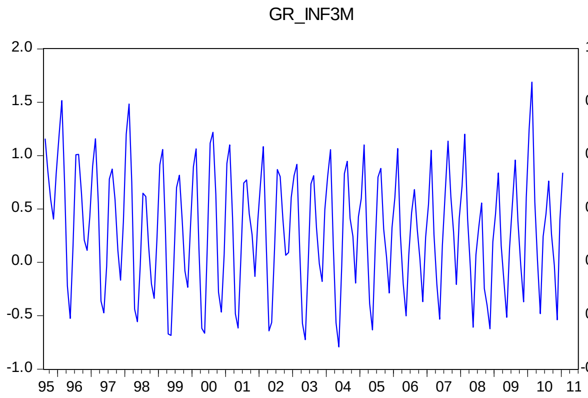
Greece:

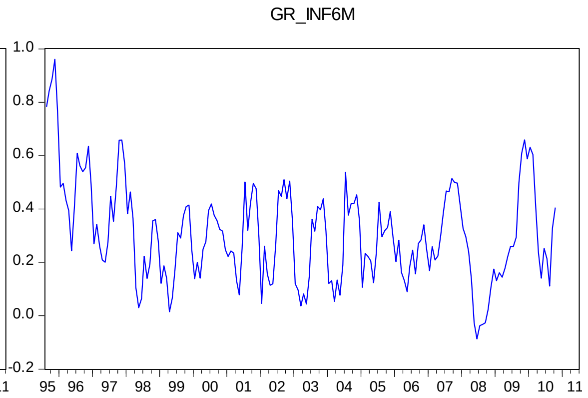




12-month maturity

1-month maturity

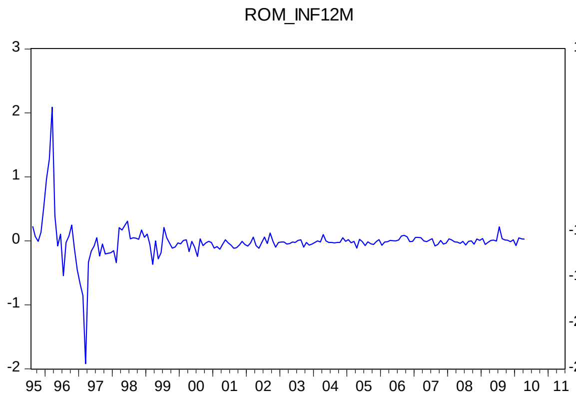




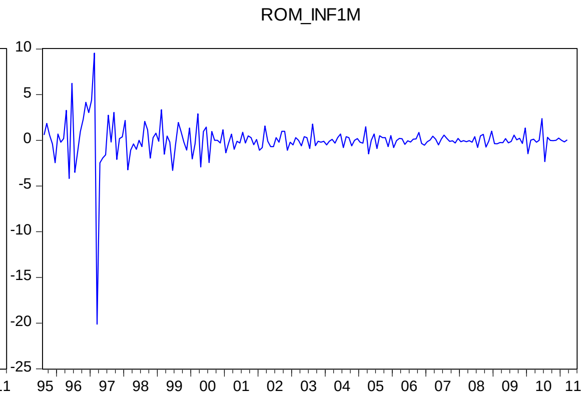
3-month maturity

6-month maturity

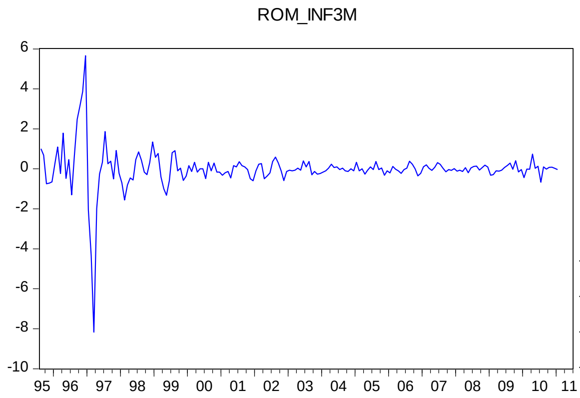
Romania:



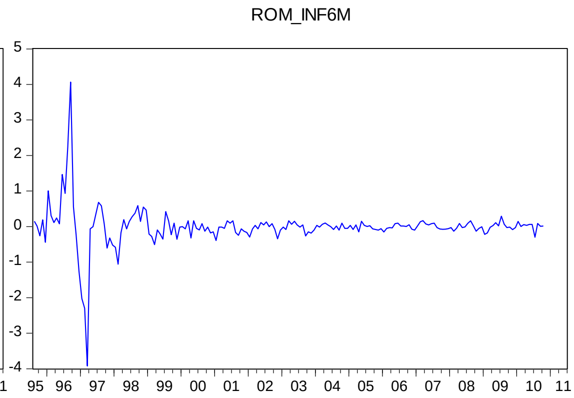
12-month maturity



1-month maturity

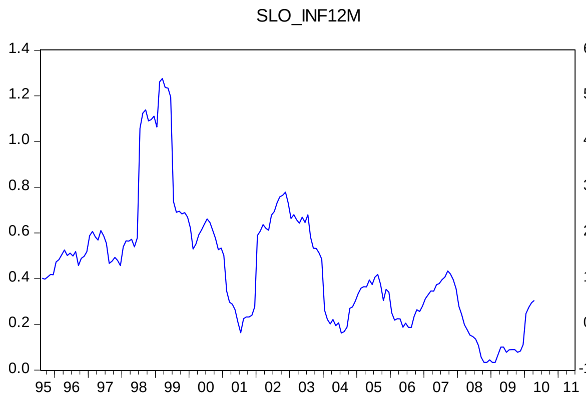


3-month maturity

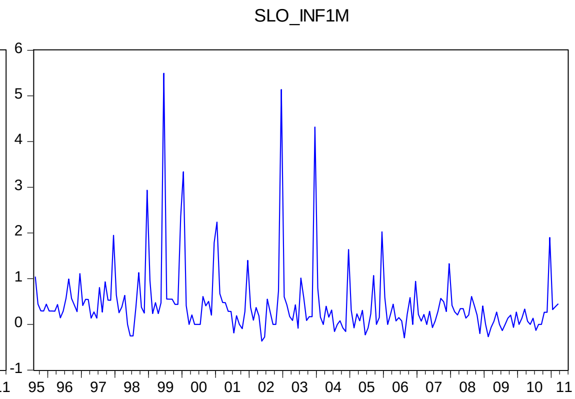


6-month maturity

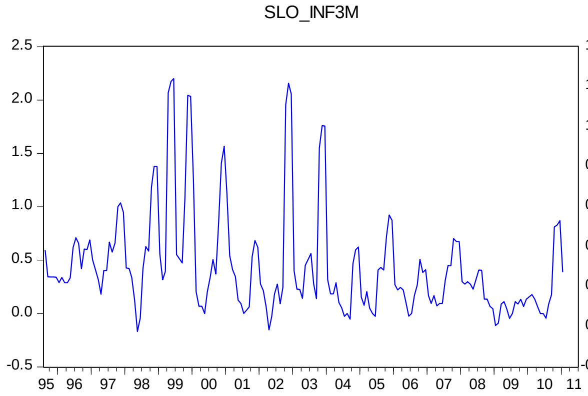
Slovakia:



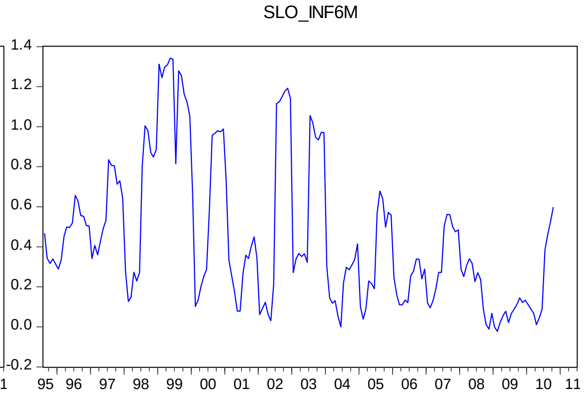
12-month maturity



1-month maturity

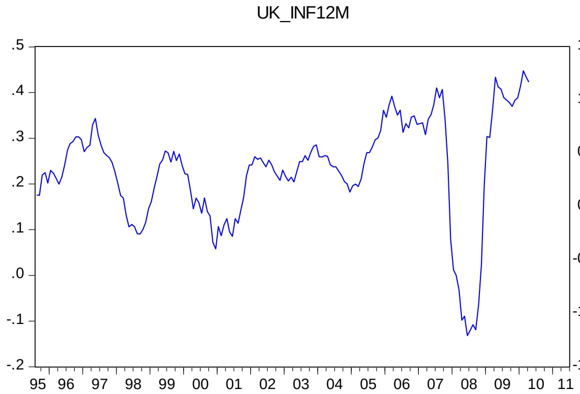


3-month maturity

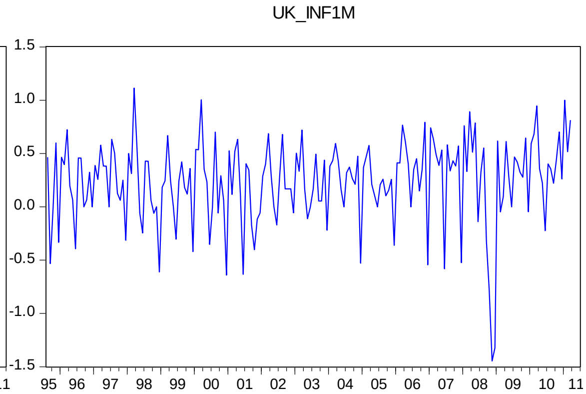


6-month maturity

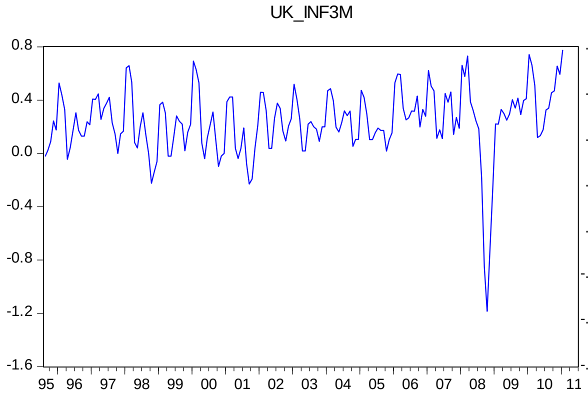
United Kingdom:



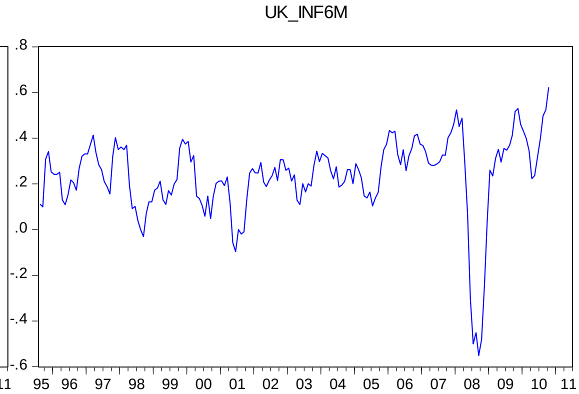
12-month maturity



1-month maturity



3-month maturity



6-month maturity