The Park Place Economist

Volume 23 | Issue 1 Article 10

4-2015

Time Series Analysis of the Risk Premium of the Polish Immediate Interest Rate

Nikki Castle '15
Illinois Wesleyan University, dcastle@iwu.edu

Time Series Analysis of the Risk Premium of the Polish Immediate Interest Rate

Abstract

Although the 25th anniversary of the fall of the Berlin Wall and the beginning of the reunification of post-war Europe was celebrated on November 9 this past fall, study of Europe continues to be divided into two camps: East and West. In these past twenty-five years, former Soviet satellites have rebuilt their economies following the regime change from communism to capitalism. Poland, for example, was the only country in Europe to show contin-uous positive growth throughout the global financial crisis of 2008 and 2009 (EC, 2014). Meanwhile, the European Union (EU) has continued to expand, further integrating economies in both Eastern and Western Europe. In order to gain membership into the Union, a state must demonstrate commitment to the EU goal of economic integration, which is defined as a six-step process in which economic and monetary union is merely a step. A decade ago, in 2004, ten additional European countries were granted accession into the EU after meeting the convergence demands for membership. These ten Central, Eastern, and Mediterranean countries are Malta, Cyprus, Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia, Slovenia, and Hungary (EC, 2014). The growth of the European Union represents a shared commitment among its member states – even those in Eastern Europe – to achieve higher degrees of economic integration. The physical boundary between Eastern and Western Europe has now been long demolished and the EU's emphasis on open trade and economic integration has resulted in the shrinking of economic barriers, but the division between Eastern and Western Europe is still important to the discussion of contemporary European issues. As an emerging Eastern economy which demonstrated stability through the Great Recession, Poland will serve as the focal point of this study, which aims to determine if immediate interest rates in Poland are better explained by those in Eastern or Western European economies. It is an interesting country to study as it is potentially bridging a previously perceived gap between Eastern and Western Europe.

Time Series Analysis of the Risk Premium of the Polish Immediate Interest Rate

Nikki Castle

I. Introduction

Although the 25th anniversary of the fall of the Berlin Wall and the beginning of the reunification of post-war Europe was celebrated on November 9 this past fall, study of Europe continues to be divided into two camps: East and West. In these past twenty-five years, former Soviet satellites have rebuilt their economies following the regime change from communism to capitalism. Poland, for example, was the only country in Europe to show continuous positive growth throughout the global financial crisis of 2008 and 2009 (EC, 2014). Meanwhile, the European Union (EU) has continued to expand, further integrating economies in both Eastern and Western Europe. In order to gain membership into the Union, a state must demonstrate commitment to the EU goal of economic integration, which is defined as a six-step process in which economic and monetary union is merely a step. A decade ago, in 2004, ten additional European countries were granted accession into the EU after meeting the convergence demands for membership. These ten Central, Eastern, and Mediterranean countries are Malta, Cyprus, Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia, Slovenia, and Hungary (EC, 2014). The growth of the European Union represents a shared commitment among its member states – even those in Eastern Europe – to achieve higher degrees of economic integration. The physical boundary between Eastern and Western Europe has now been long demolished and the EU's emphasis on open trade and economic integration has resulted in the shrinking of economic barriers, but the division between Eastern and Western Europe is still important to the discussion of contemporary European issues. As an emerging Eastern economy which demonstrated stability through the Great Recession, Poland will serve as the focal point of this study, which aims to determine if immediate interest rates in Poland are better explained by those in Eastern or Western European economies. It is an interesting country to study as it is potentially bridging a previously perceived gap between Eastern and Western Europe.

Immediate interest rates are very short term rates which are held for a maximum of twenty-four hours. They include rates for business loans, interbank rates, or call money rates which pertain to money left at the disposal of a bank (OECD, 2005). In this study, these rates will be measured as a risk premium, which is the difference between the rate of interest and another which serves as a baseline. Studying the risk premium as opposed to the interest rate itself provides a point of comparison between changes in the Polish rate and changes in the interest rate of the base country. Moreover, the nature of the calculation to determine a risk premium makes it an ideal measure of convergence, which would be represented by a decrease in the risk premium of Polish rates. The European Union emphasizes convergence of interest rates as a goal to achieve greater economic integration because a fixed or common interest rate contributes to free movement of resources (EC 2013). The German interest rate is commonly used as the base country in similar studies because the German economy has remained relatively stable since the foundation of the European Union, making it a sound candidate as the basis of convergence goals.

The period of study begins in 2002, when the Euro first began to circulate as paper and coin currency. This is the ideal point of initiation as it maximizes the length of the study while ensuring that the German interest rate is not subject to volatility due to change in currency during the study period. Data extracted from the FRED Database compiled by the St. Louis Fed shows that the immediate interest rate in Poland has decreased from a peak of 12% in January of 2002 to 2.8% as recently as December 2013, which can be observed in Figure 1 in the Appendix (FRED, 2014). In this study, multivariate linear regression will be utilized to explain changes in the Polish interest rate risk premium as a function of the same risk premium for other European countries in both Eastern and Western Europe.

II. Literature Review

The existing literature on risk premiums on interest rates in the European Union is extensive, but not exhaustive. Although both short and long term rates are represented, very little research has been conducted using immediate rates. The use of immediate rates for a time series analysis provides data which reacts much more quickly to changes in perceived risk than a longer term bond, drawing from existing theory. Seminal to the discussion is the theoretical paper from John Cox *et al.,* titled "A Theory of the Term Structure of Interest Rates" (1985). This work formulates a relationship between both long and short term bond prices, consumer maximizing behavior and rational expectations. Risk aversion is one of the factors influencing consumer preferences. Cox *et al.* explain that a risk premium may account for differences in bond prices that cannot be explained by differences in the pay structure of the bond itself if consumers deem one type of bond to carry higher risk than another.

Although Cox *et al.* primarily discuss risk in terms of the length of maturity of the bond, researchers have expanded on this seminal theoretical work by examining other determinants of financial risk, such as region or level of international economic integration. Such work has been conducted either by developing more specific theoretical models, or by using data to empirically test existing theories or determine relationships between variables. In the article entitled "Regional Lending Risk in Eurodollar Markets," Sten Thore studies Eurodollar markets instead of the government bonds that Cox *et al.* have examined (1986). Eurodollar markets are more closely related to exchange rates than interest rates, referring to the value of the U.S. dollar when it is used outside the United States. Thore develops the literature by calculating risk premiums which capture a premium on the interest rates of regions classified as higher risk due to factors ranging from corruption to unfavorable economic trends. Thore's study includes Eurodollar markets in regions in South America and Asia as well as in Europe. Conversely, Baele *et al.* connect the study of risk premiums specifically to the European Union in the article "Measuring European Financial Integration" (2004). Financial integration is measured across the countries in the Eurozone with five variables, including two types of bonds. Baele *et al.* build on Cox *et al.*'s time-varying risk premiums by comparing local interest rates to the euro area interest rate. This comparison is emphasized to assess the level of economic integration throughout EU member states; if domestic interest rates and euro area interest rates are converging, this is consistent with the furtherance of the Union's goals to achieve higher levels of economic integration. Baele *et al.* theorize that integration will occur more rapidly with short term bonds than long term bonds. This hypothesis is important to note in the continuation of our study, since it reveals that an examination of long term rates may yield different results from a study of immediate interest rates.

Existing literature also includes empirical tests of the seminal theoretical paper, including Caporale's "Domestic and External Factors in Interest Rate Determination" (1997). In this paper, determinants of German interest rates are analyzed both as a function of rates in the European Monetary System and in other European countries. This is similar to the approach used in our study, which explains variation in Polish risk premiums discounted by the German rate using similar risk premiums in countries which do not use the Euro.

The existing body of work on the determinants of changes in interest rates, both long and short term, is very diverse. This study is similar to previously conducted empirical works because it uses region, through European economic integration, as the primary determinant of change in interest rates. However, our study includes data through December 2013 which is more recent than most empirical tests conducted to date.

III. Data and Methodology

The data employed to conduct this study are taken from the FRED Database compiled by the St. Louis Federal Reserve Bank. The immediate interest rates have a time series structure, and have been col-lected monthly from January 2002 to December of 2013. For each country studied, there are 144 observa-tions. Because Germany has maintained a relatively stable economy and has even emerged as a financial supporter of the European Union throughout this time period, it will be used as the reference point for calcu-lating risk premiums. Moreover, Germany's immedi-ate rates are effectively identical to the immediate rates in all other Eurozone countries. This fact negates the need to address risk premiums among countries using the euro. The Polish risk premium will be compared to that of the Czech Republic, Denmark, Hungary, the Slovak Republic, Sweden, and the United Kingdom.

$$\textit{Polish Risk Premium} = \alpha + \beta_1 (\textit{Danish Risk Premium})_{t-1} + \beta_2 (\textit{Hungarian Risk Premium})_{t-1} + \beta_3 (\textit{Slovak Risk Premium}) + \beta_4 (\textit{Swedish Risk Premium})_{t-1} + \beta_5 (\textit{British Risk Premium}) + \varepsilon$$

Interest rates are measured in percentages, as is the standard practice.

To compile the data, each series was extracted into MS Excel directly from the FRED database. Data for countries which did not include data from every month of every year throughout the studied time period were eliminated. This criterion eliminated data for Estonia and Slovenia as they were only available beginning in the years 2007 and 2004, respectively.

Data from countries which had kept suffi-ciently longitudinal and reliable records were exported into the EViews statistical package for further analy-sis. Seasonal means were observed, and overall the data showed little evidence of seasonality. However, in Hungary and the Czech Republic, there is a very slight January effect. This means that the interest rates are typically higher in January than other months as a result of the beginning of a new fiscal year. In the Slo-vak Republic, a stronger January effect was observed, showing a monthly mean of almost one full percentage point above the average. Data were seasonally adjusted before proceeding.

As can be observed in the data plots in the appendix, the risk premium for all countries in the study except for Sweden decreases over time. The Swedish risk premium instead increases over time. The Polish case is interesting, especially consider-ing the aims to meet European Union convergence goals. Figure 1 clearly illustrates that from 1999 until 2007, the Polish immediate interest rate rap-idly dropped to almost meet the rate in the euro zone. However, presumably as a result of the finan-cial crisis of 2008-2009, the interest rates diverge once more and do not show promising signs of re-convergence based on the time plot depicted. The maximum value of the Polish risk premium was recorded at 17.07 percentage points in late 2000. Conversely, the minimum value was recorded early in 2007 at 0.56 percentage points.

The lowest risk premium throughout the studied time period is observed in Denmark; figure 3 shows that the immediate interest rates in Denmark and in the euro-zone are nearly identical. Figure 4 clearly illustrates a spike in the Danish risk premium in late 2008. At a glance, this peak seems to suggest a major deviation from the steadily downward slope of the trend, but a comparison to figure 3 clarifies that this is likely the result of a lagged response to the Great Recession of 2008. The plot of the risk premium in every country displays oscillation around either an upward or downward sloping trend. This is evidence of the presence of business cycles. Two business cycles can be counted in all countries except Poland, where only one business cycle is evident.

After performing these basic assessments of the data, multivariate regression will be conducted using the Ordinary Least Squares method. The equation employed is as above.

In the above equation, the independent vari-able is the Polish risk premium, which will depend on the following dependent variables: the risk premium of the previous month in Poland, Denmark, Hungary, the Slovak Republic, Sweden, and the United Kingdom. These countries were chosen because of data avail-ability, and because they represent both emerging and developed European Union economies outside the euro zone. Because of the trends in the existing literature, I expect that the coefficients of Eastern Eu-

ropean countries should have positive signs and the highest magnitudes, since they should best explain changes in economic variables in Poland as fellow Eastern European countries. The diversity of these variables as well as the large range of observations are strengths in this study.

IV. Results

Prior to running a regression to test the relationship between the Polish risk premium on immediate interest rates and those of other European countries in this study, it was necessary to conduct standard transformations to the data to ensure reliability. This involved ensuring that the series is both seasonally adjusted and stationary. A stationary series has constant mean and variance over time. If a series is not stationary, running a regression may result in a false positive. Data were seasonally adjusted in EViews using the additive moving average

$$\textit{Polish Risk Premium} = -0.185 + 2.718(\textit{Czech Risk Premium}) + 2.822(\textit{Danish Risk Premium}) + 0.599(\textit{Hungarian Risk Premium}) - 2.867(\textit{Swedish Risk Premium}) + 2.868(\textit{British Risk Premium}) + 2.506(\textit{Polish Risk Premium})_{t-1} + \varepsilon$$

method. This method was chosen over any multiplicative method because some of the data is less than zero, so it would be impossible to seasonally adjust using, for example, the multiplicative Census X12 method. Next, data for each country was subjected to the Augmented Dickey Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests to check for unit roots and stationarity, respectively. If a series contains a unit root, it cannot be stationary. The null hypothesis of the ADF test is that the series contains a unit root. If the p-value of the t-statistic of the ADF test is less than 0.05, one can reject the null hypoth-esis with 95% confidence, therefore implying that the series is stationary. Conversely, the null hypothesis of the KPSS test is that the series is stationary. If the p-value of the t-statistic of this test is greater than 0.05, one fails to reject the null hypothesis. So, the series is stationary. Each test was conducted both in levels and in first order differences of their logarithmic values. In levels, the values of the data are the risk premiums of immediate interest rates; in first order differences, the values of the data are rates of change of the risk premiums of immediate interest rates. The results of these tests are tabulated in Table 1 of the Appendix. For most countries, the results of both the ADF and KPSS tests show that the series are stationary in first order differences but not in levels. For Poland and the Czech Republic, both the ADF and KPSS tests suggest that the series is not stationary in levels. However, in first order differences, the ADF test shows the series is stationary, whereas the p-value of the KPSS test is still below 0.05, suggesting that the series is still not stationary in first order differences. For Hungary, the null hypothesis of the ADF test in levels as well as that of the KPSS test in first order differences can be marginally rejected. This presents some ambiguity, however, the results of the KPSS test in levels and the ADF test in first order differences are consistent with the other countries. Therefore, it is appropriate to conduct the remainder of this study analyzing the series in first order differences which are stationary, instead of the series in levels which are not.

Listing the first order differences of the Polish risk premium as the dependent variable and those of the Czech Republic, Denmark, Hungary, Sweden, and the United Kingdom as the independent variables, a preliminary regression was run. The coefficients for the variables of Hungary and the Czech Republic were not statistically significant, since the p-values associated with their t-statistics were not lower than 0.05. Therefore, the null hypothesis that the coefficients are statistically equivalent to zero could not be rejected. An alternative regression was run excluding these two variables, and the remaining coefficients were significant. However, residual diagnostic tests for homoskedasticity showed that the residuals of the regression were heteroskedastic, or that their variance was not constant. Another regression was run, this time including a lagged value of the Polish risk premium as an independent variable alongside those of the five base countries. For this regression, all coefficients were significant. The estimated parameters of that regression are as shown in the previous equation.

The value of each coefficient represents the percentage of change in the Polish risk premium which can be explained by a ten percent change in the value of the relevant coefficient. A negative sign indicates an inverse relationship between the two variables, or that domestic immediate interest rates move in the opposite direction of the German immediate interest rate. So, the Polish risk premium can be

expected to decrease as the Swedish rate increases, but will increase as the same rate increases in the Czech Republic, Denmark, Hungary, and the United Kingdom. The rates in all countries of study are complementary to one another except Sweden, for which the rate is a substitute. Therefore, an investor facing unfavorable changes in immediate interest rates in Denmark may choose to operate in the Swedish financial markets instead where the rates would be changing in the opposite direction.

The positive relationship between Polish risk premiums and that of the United Kingdom is particularly telling, since London has functioned for years as the financial capital of the world. Immediate interest rates in Poland are well predicted (relative to other variables in this regression) by British immediate interest rates, and move in the same direction with respect to those in Germany and, therefore, the Euro Zone. A positive relationship also still exists between Polish risk premiums and those of Hungary and the Czech Republic, but had lower explanatory power than expected, relative to the United Kingdom. In fact, the variable with the least explanatory power is the Hungarian risk premium. This defies the expectation that Hungary, as a fellow emerging Eastern European economy, would be a strong predictor for behavior of Polish financial markets. As expected, this series exhibits inertia as proven by the positive sign of the coefficient associated with the lagged variable. The magnitude of the coefficient of the lagged term is 2.506, which is higher only than that of the Hungarian risk premium. This implies that changes in the Polish risk premium are generally better predicted by changes in financial markets of other European countries than the previous month's risk premium in Poland.

Descriptions of the robustness of this regres-sion (as well as the values of the coefficients) are presented in Table 2 in the Appendix. The overall goodness of fit of the regression is captured in the Ad-justed R-squared, which is chosen over the R-squared because it includes a penalty for the number of in-dependent variables in the equation. The Adjusted R-squared is 0.310, which means that the equation can explain 31% of variation in the Polish risk premium of immediate interest rates. For time series data, this is a relatively high Adjusted R-squared, so the model is effective in explaining variation in the dependent variable. To complete the discussion of residual diagnostics, a plot of the residuals can be found in the Appendix, labeled Figure 1. The null hypothesis of the Jarque-Bera test for normality must be rejected, so the residuals are not normally distributed. Heteroskedasticity tests indicate that the residuals are homoskedastic, so their variance is relatively constant. The Lagrange Multiplier test was used to determine if the series exhibits autocorrelation. With two lags, we fail to reject the null hypothesis that there is no autocorrelation in the series. Overall, despite the lack of normality in the residual distribution, residual diagnostics suggest that this model is reliable.

V. Conclusions

Existing literature has largely divided European economies and financial markets into two camps: East and West, or Emerging and Developed. Twenty-five years after the dissolution of the Soviet Union, many former Soviet satellites continue to strive for convergence and integration with the core of the European Union. As Eastern European economies continue to meet EU convergence demands, it becomes less and less useful to divide European economies along these lines.

In this study, data from the FRED Database on immediate or overnight interest rates were used to calculate risk premiums for Poland, the Czech Republic, Denmark, Hungary, Sweden, and the United Kingdom. The basis for all of these risk premiums was Germany, which acted as a proxy for the Euro zone. Monthly data were collected from these countries from 2002 to 2013, adding up to a total of 143 observations (after adjustments). Estimations were based on the commonly accepted idea that economies of former Soviet satellite countries are likely to share more in common with one another than those in Western Europe. However, ultimately the hypothesis that risk premiums of the Czech Republic and Hungary would be most useful in predicting the Polish risk premium were refuted. It would be impossible to say definitively, based on this study, that Polish financial markets can be better predicted by either the Western or Eastern economies exclusively. The result is that the independent variables from either side of the continent are important in determining changes in Polish financial markets. This is consistent with the findings from Caporale's study on domestic and external determinants of interest rates (1997). In this study, Caporale finds that German policies are affected by, to a significant degree, the policies of other European countries both inside and outside the European Mon-

etary System. Similar integration is seen in this study, especially as the economic interdependence of Euro- has expanded.

In the future, additional studies should be conducted testing financial indicators other than immediate interest rates, specifically an interest rate with a longer term. Five year government bonds may be examined for this purpose. Currency exchange rates could also be a potential measure of integration in a similar study. Fitting an ARMA model or similar forecasting equation is another potential avenue for continuing research in order to see how trends of convergence or divergence may be expected to continue in the future.

pean countries increased as the European Union itself

Ultimately the results of this study suggest that it is no longer accurate to separate European economies into two camps. It has been a decade since the 2004 expansion of the European Union to include an additional ten countries, including Poland. Since this time, EU convergence demands are continuing to be met and these economies create more distance from the communist regime of the Soviet Union.

References

EC. Assessment of the 2013 national reform programme and convergence programme for POLAND. (2013, May 29). Retrieved September 6, 2014.

FRED, Federal Reserve Economic Data, Federal Reserve Bank of St. Louis: Immediate Rates: Less than 24 hours: Call Money/Interbank Rate for Poland; U.S. Department of Labor: Bureau of Labor Statistics.

OECD, Immediate Interest Rates, Glossary of Statistical Terms. (2005, 21 December).

Baele, L., Ferrando, A., Hordahl, P., Krylova, E., & Monnet, C. (2004). Measuring European Financial Integration. Oxford Review of Economic Policy, (4). 509.

Caporale, G., & Pittis, N. (1997). Domestic and external factors in interest rate determination. Applied Financial Economics, 7(5), 465-471.

Cox, J. C., Ingersoll, J. r., & Ross, S. A. (2002). A Theory of the Term Structure of Interest Rates.

A. Gallagher, M. P. Taylor (Eds.), Speculation and financial markets. Volume 2 (pp. 278-300). Elgar Reference Collection. International Library of Critical Writings in Economics, vol. 143.

Schuknecht, L., von Hagen, J., & Wolswijk, G. (2009). Government risk premiums in the bond market: EMU and Canada. European Journal of Political Economy, 25(3), 371-384.

Thore, S. (1986). Regional Lending Risk in Eurodollar Markets. The Scandinavian Journal of Economics, (2). 437.

Figure 1 – Plot of Polish Immediate Interest Rates (levels, %)

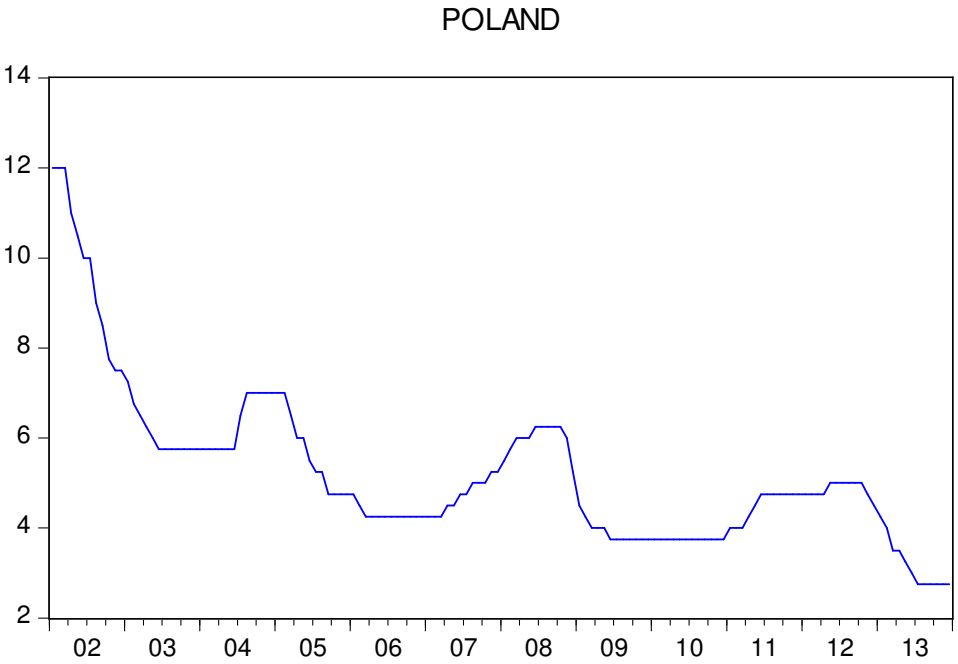


Figure 2

Immediate Interest Rates in Poland and Germany (%)

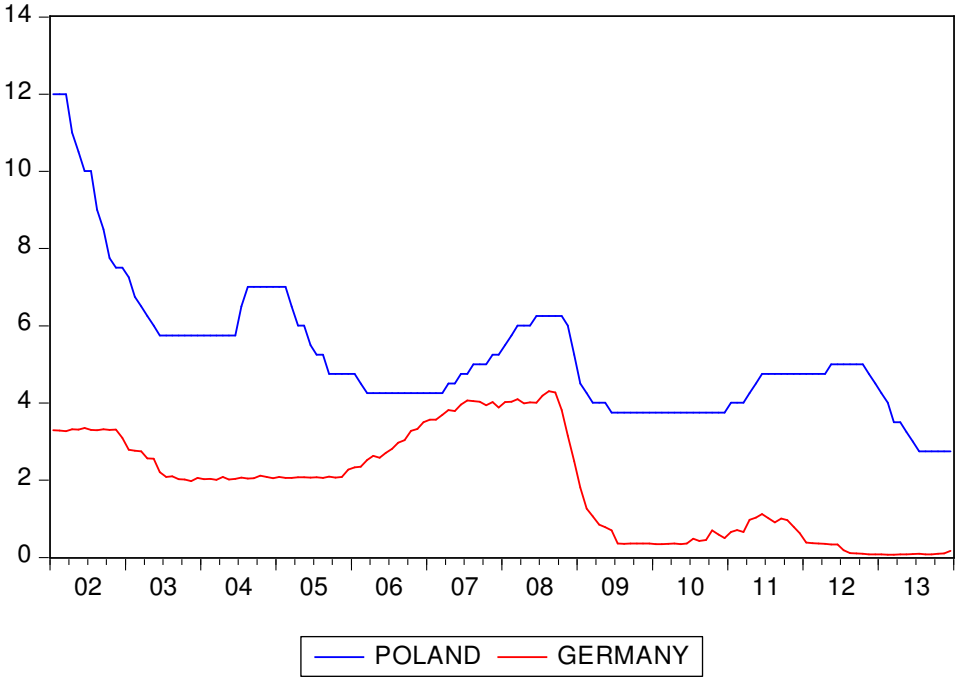


Figure 3

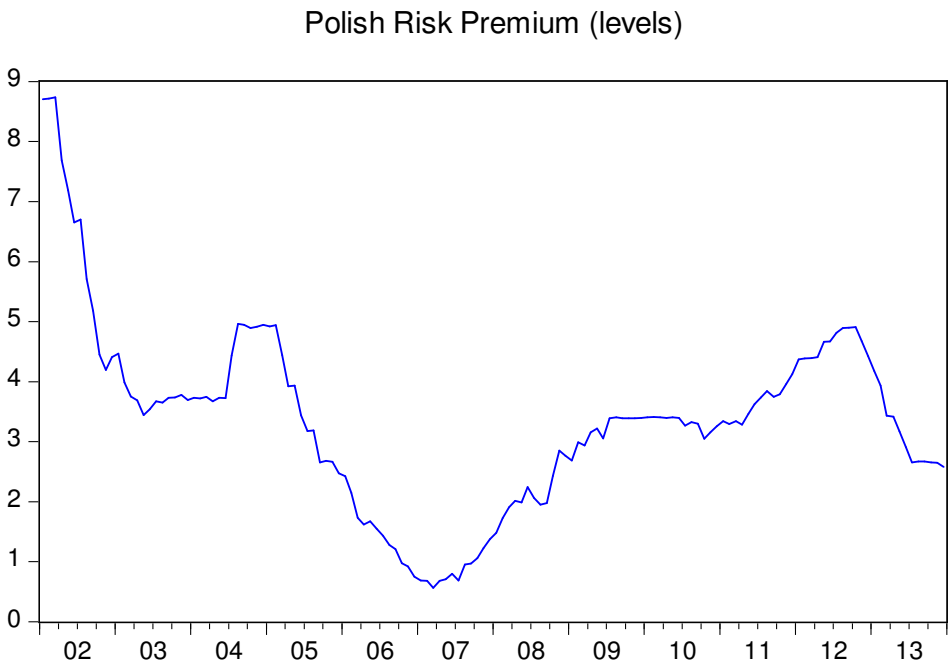


Figure 4

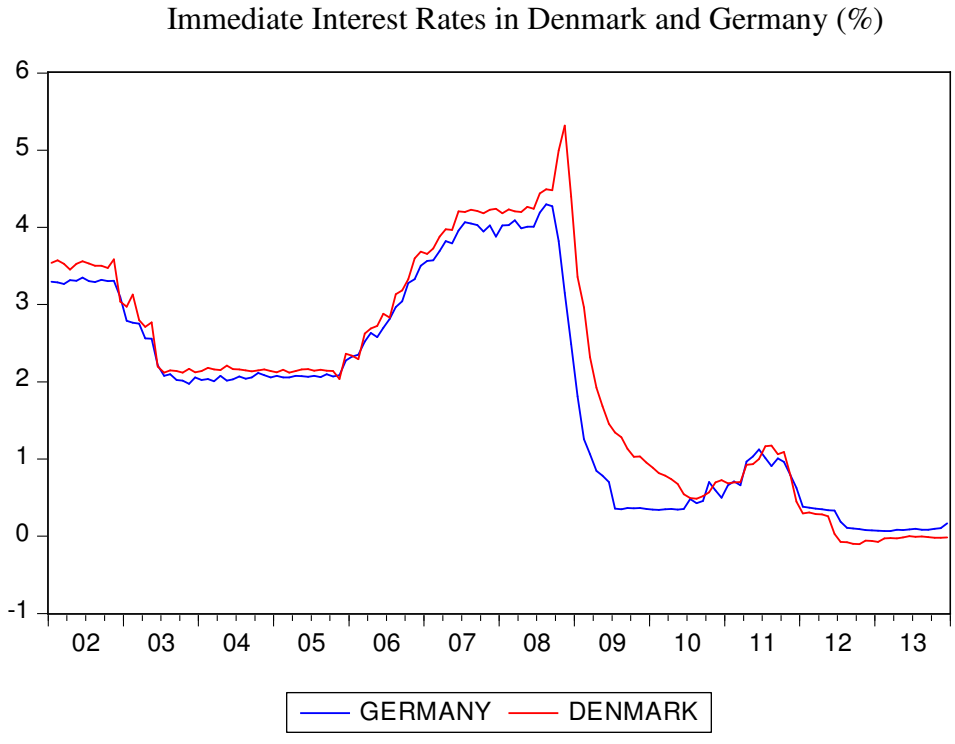


Figure 5

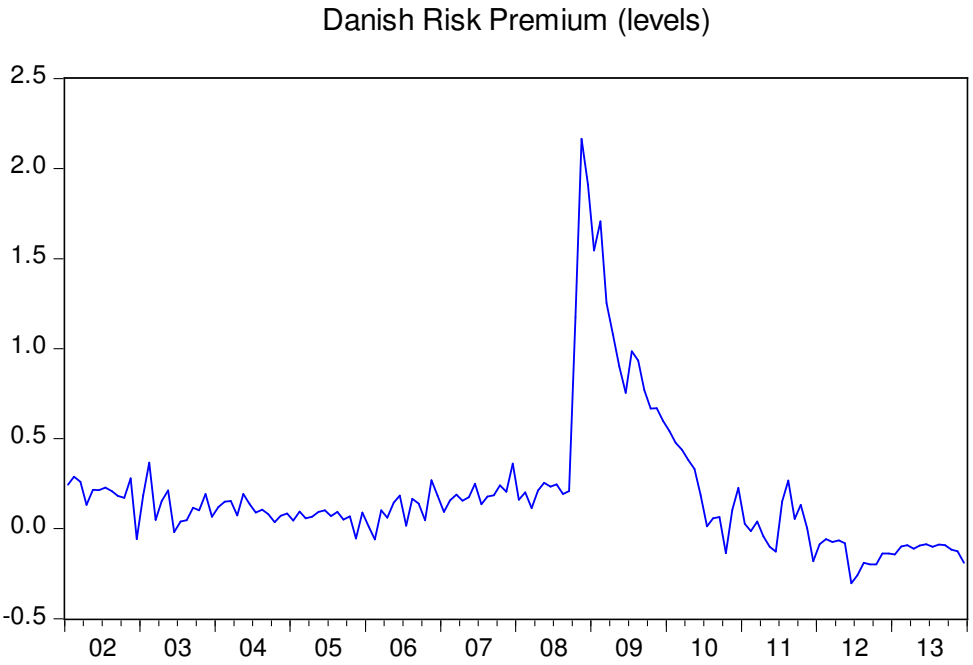


Figure 6

Immediate Interest Rates in Hungary and Germany (%)

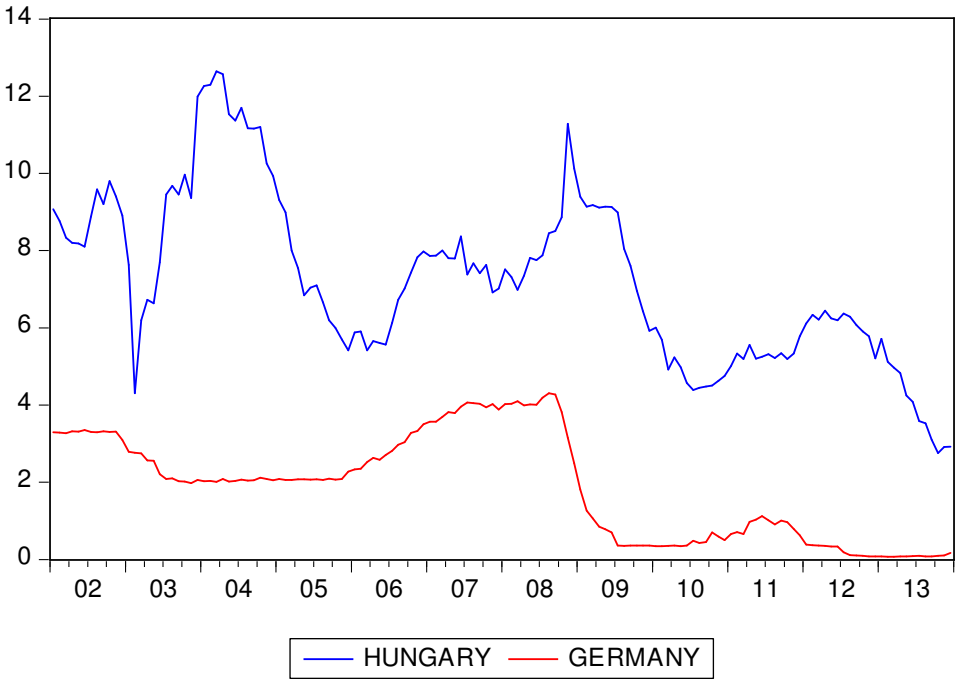


Figure 7

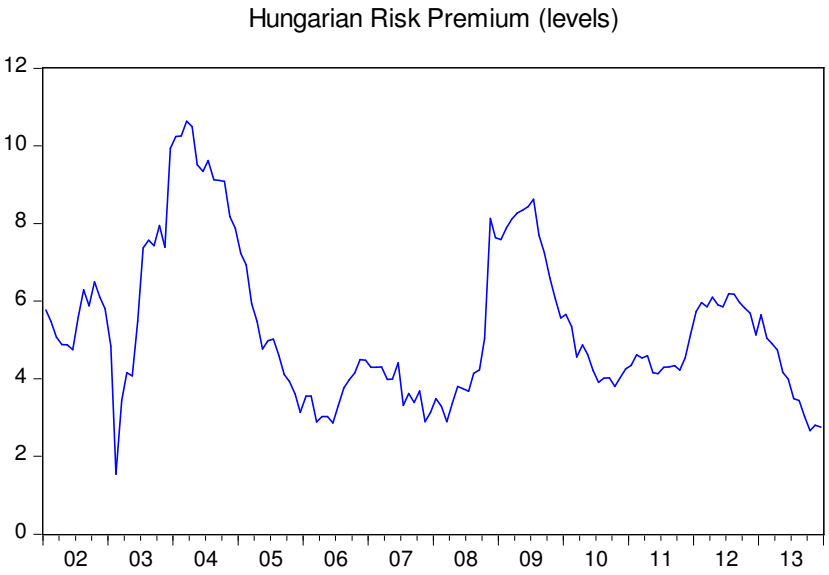


Figure 8

Immediate Interest Rates in the Slovak Republic and Germany (%)

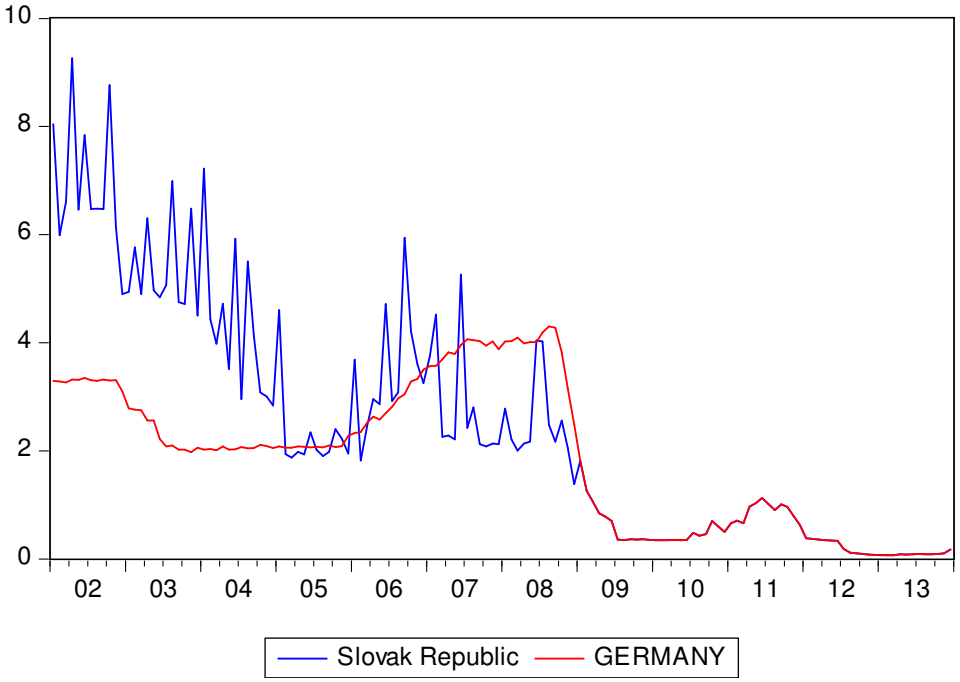


Figure 9

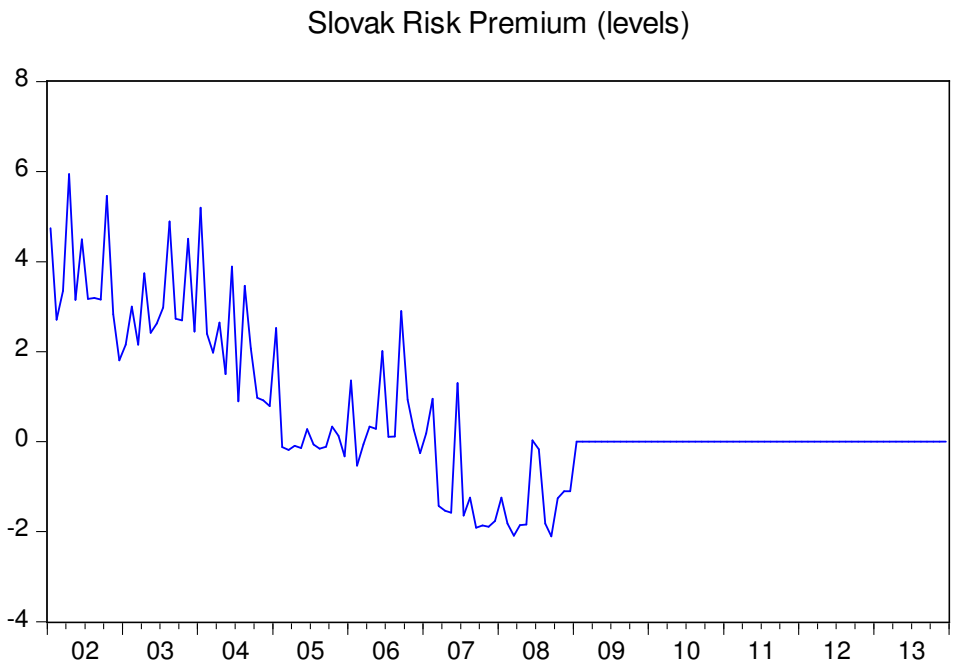


Figure 10

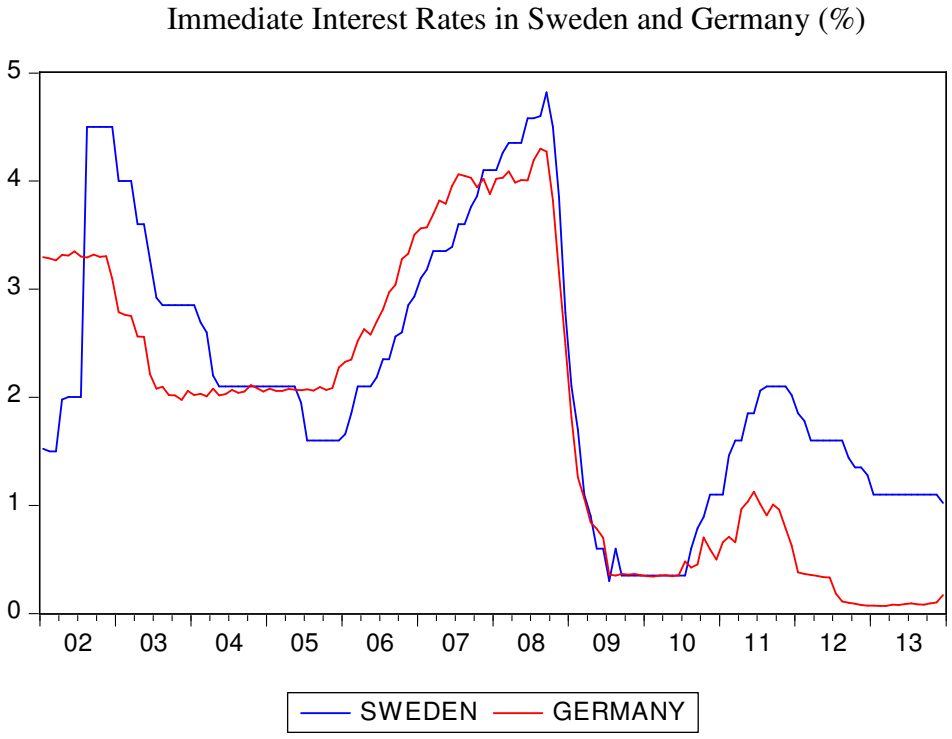


Figure 11

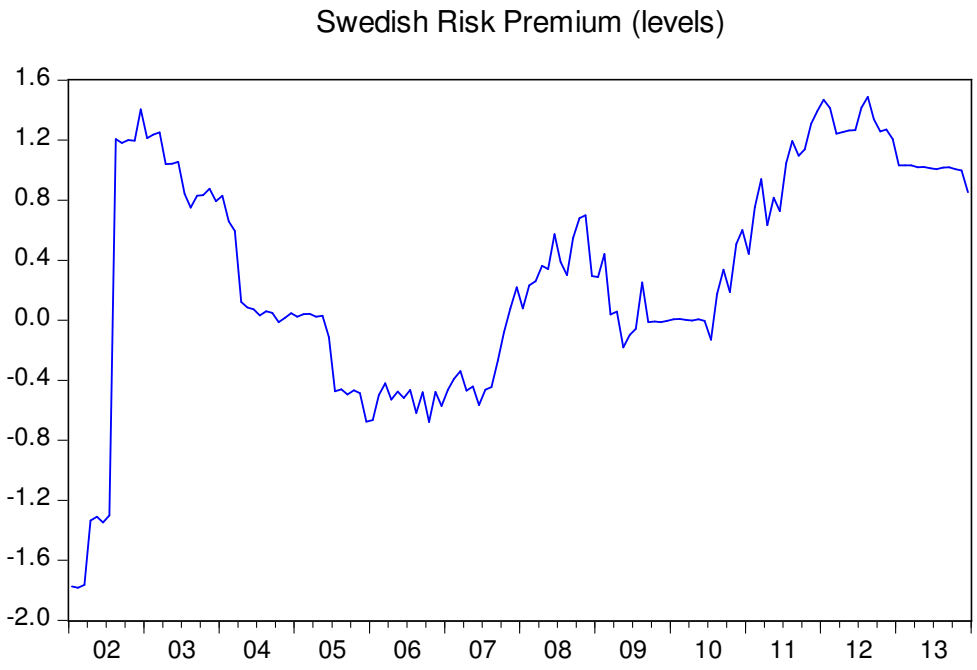


Figure 12

Immediate Interest Rates in the United Kingdom and Germany (%)

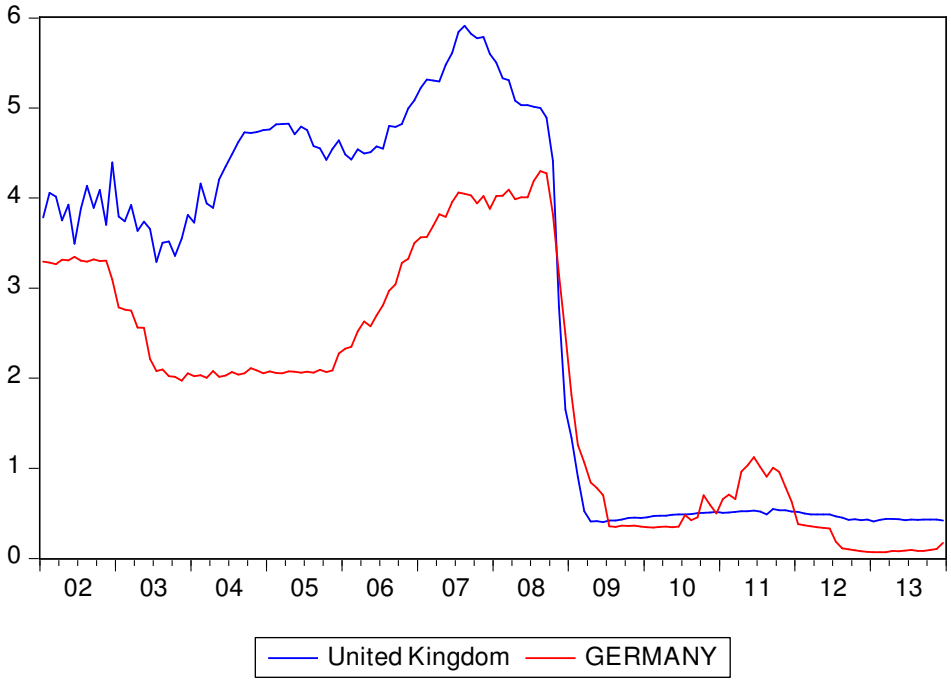


Figure 13

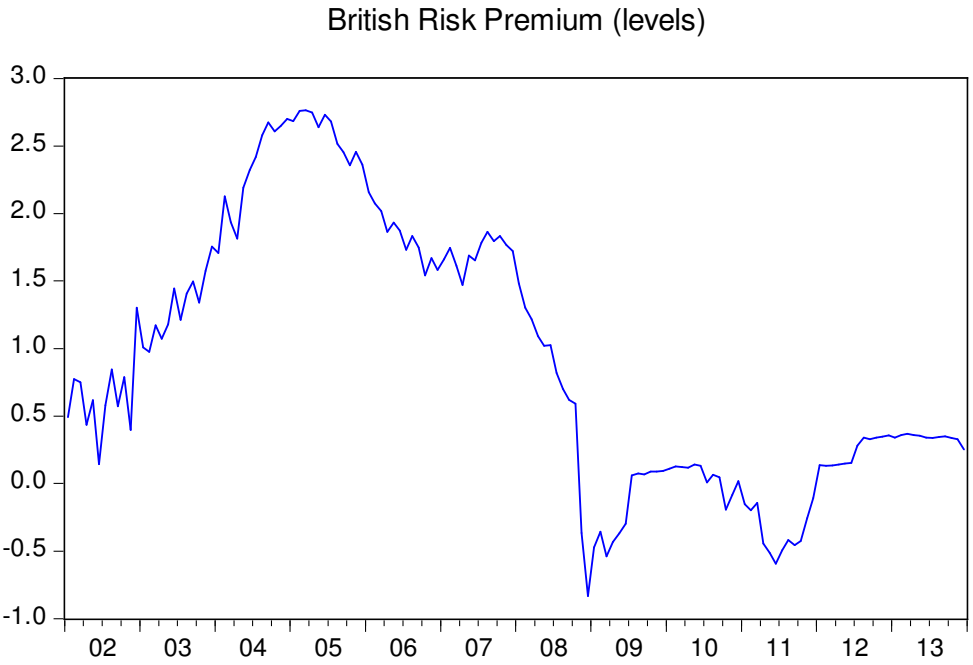


Figure 14

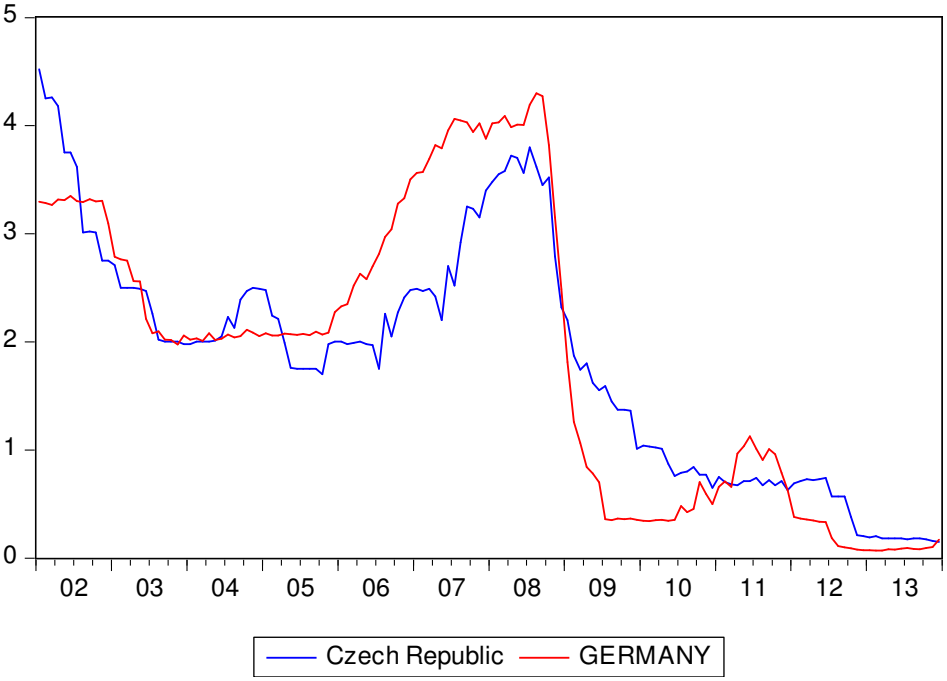


Figure 15

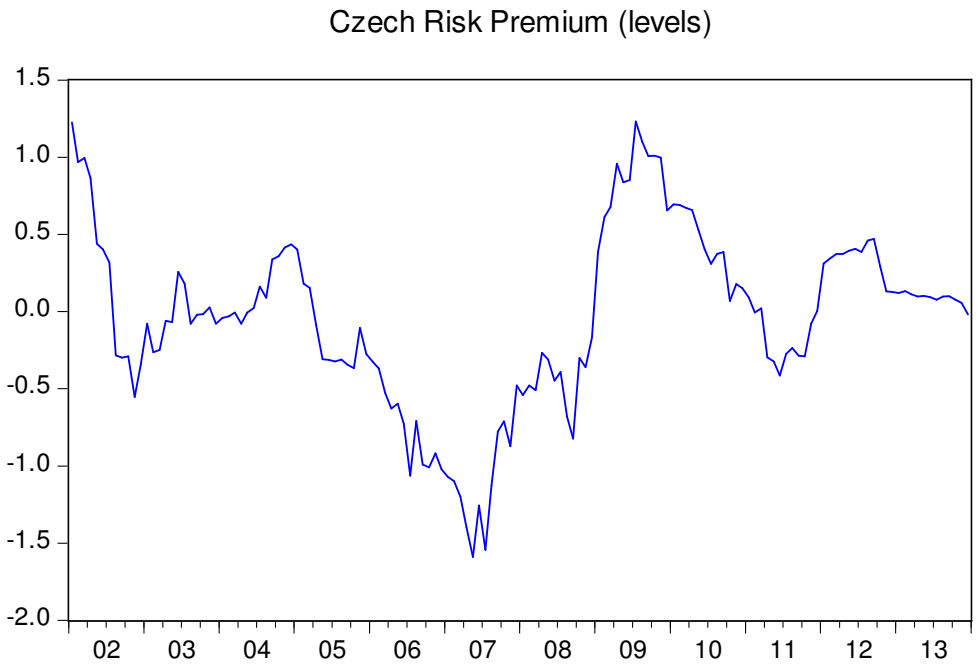


Figure 16

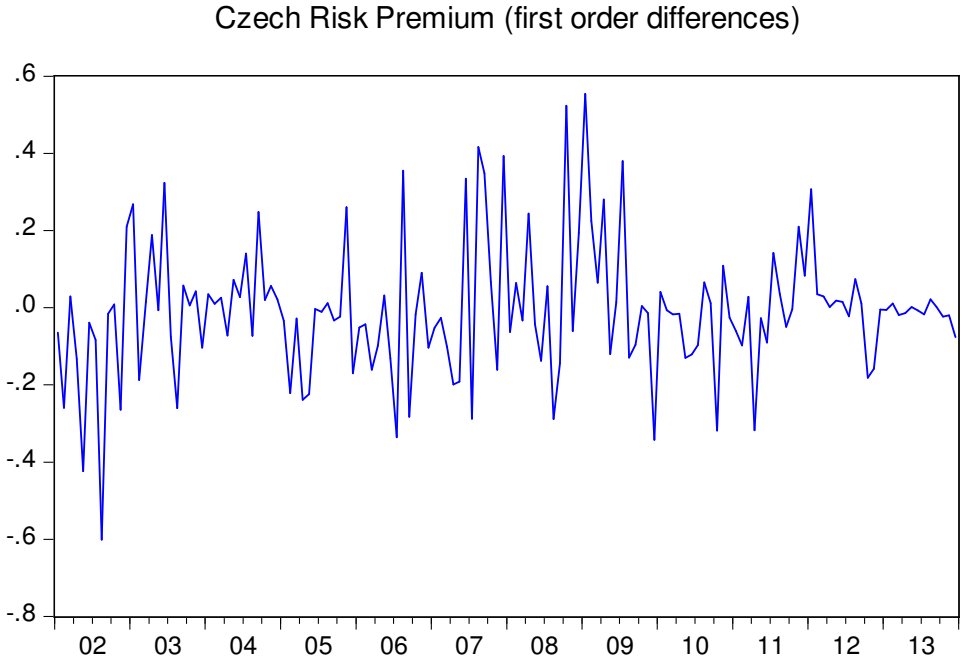


Figure 17

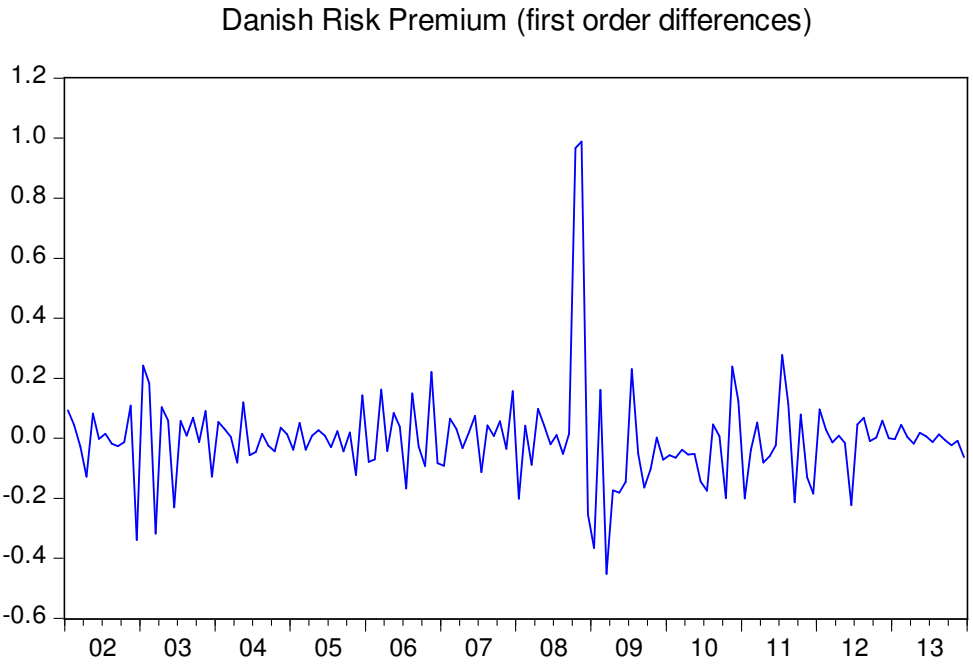


Figure 18

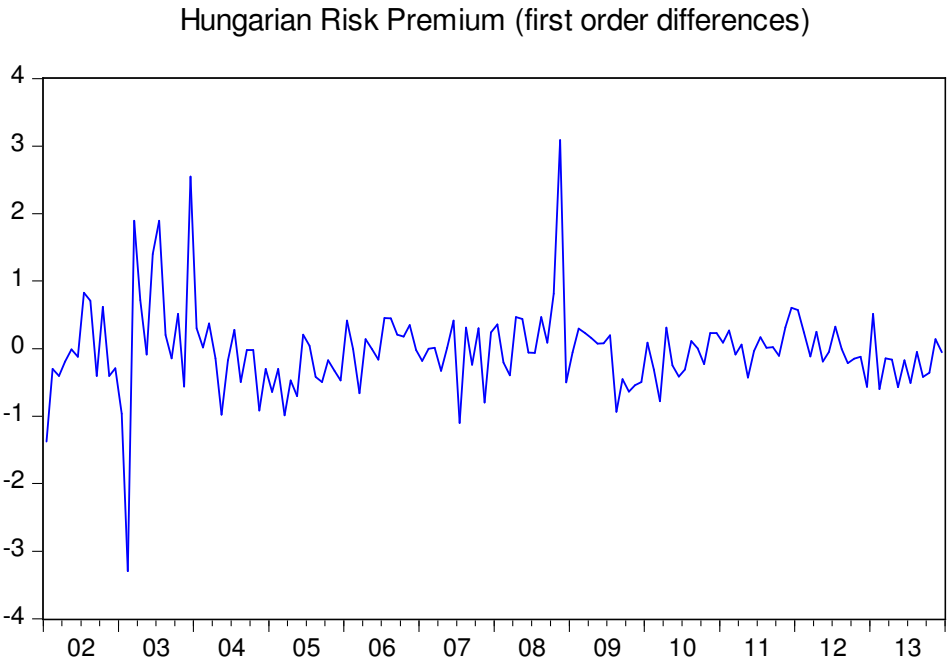


Figure 19

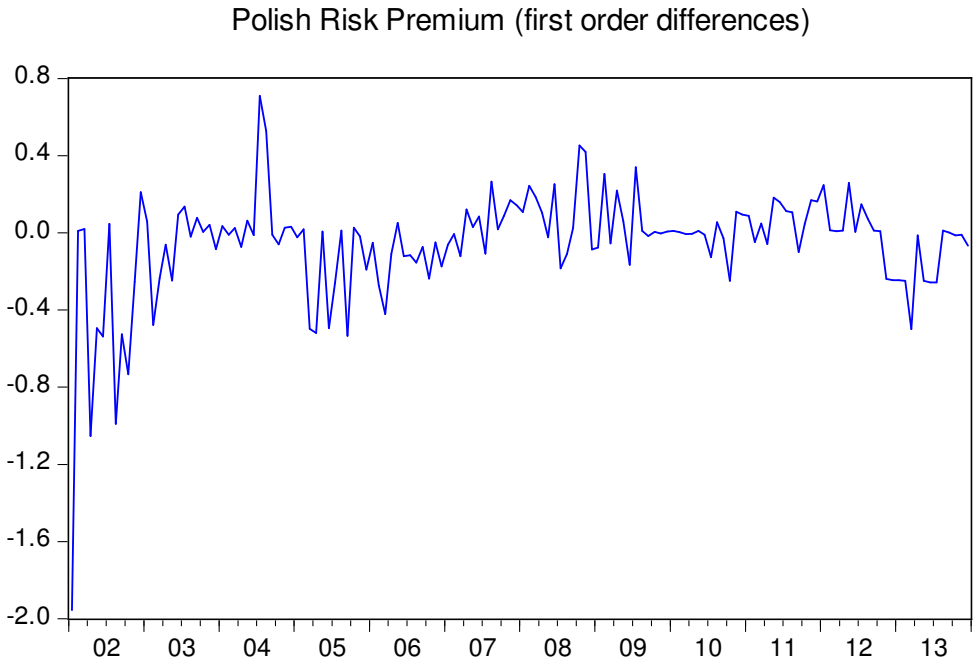


Figure 20

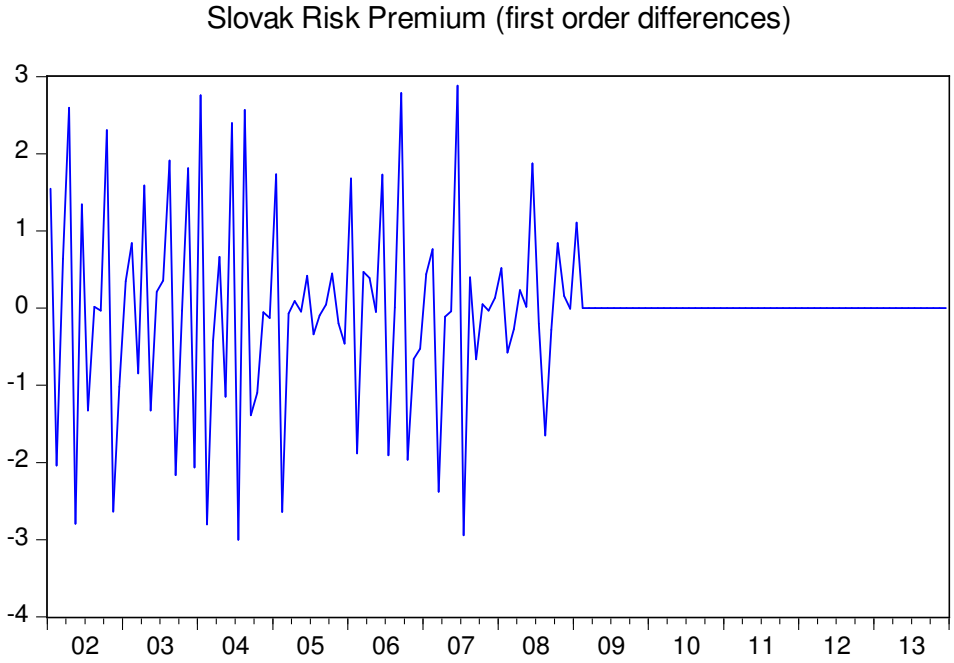


Figure 21

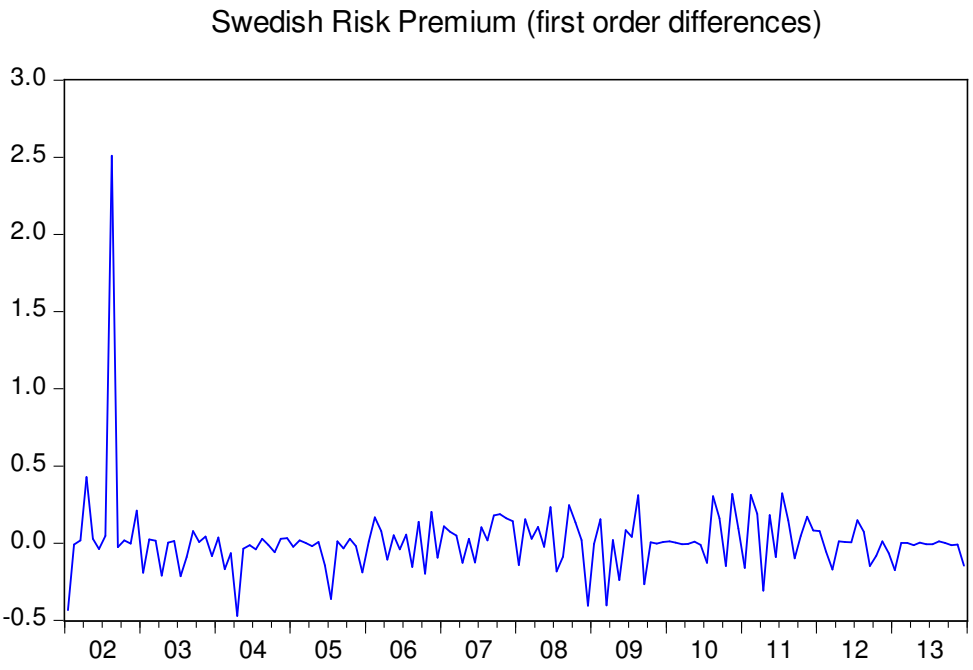


Figure 22

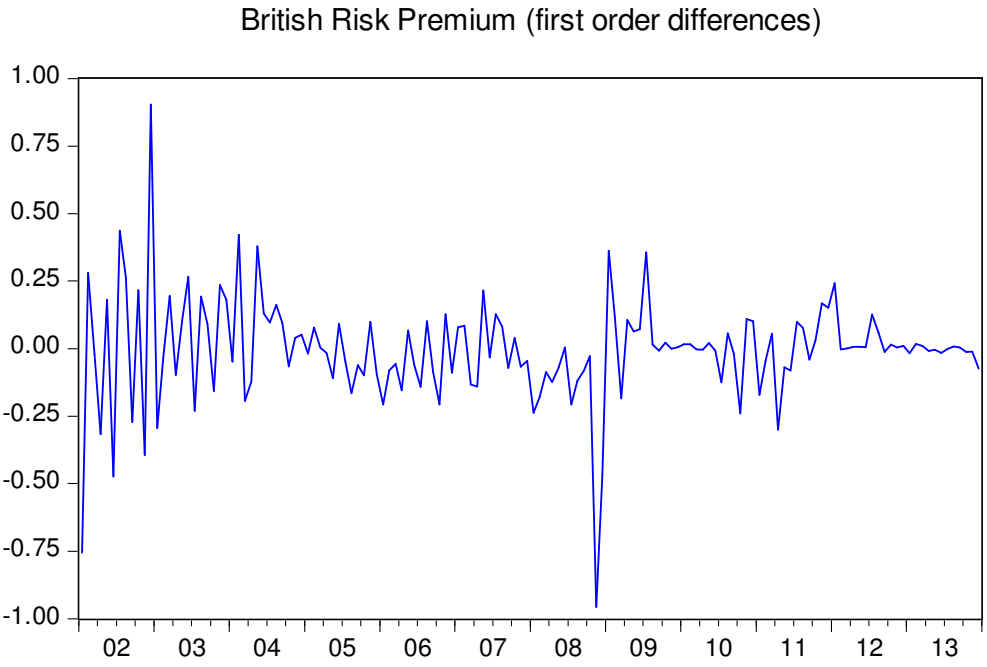


Table 1 – T-statistics of Stationarity Tests

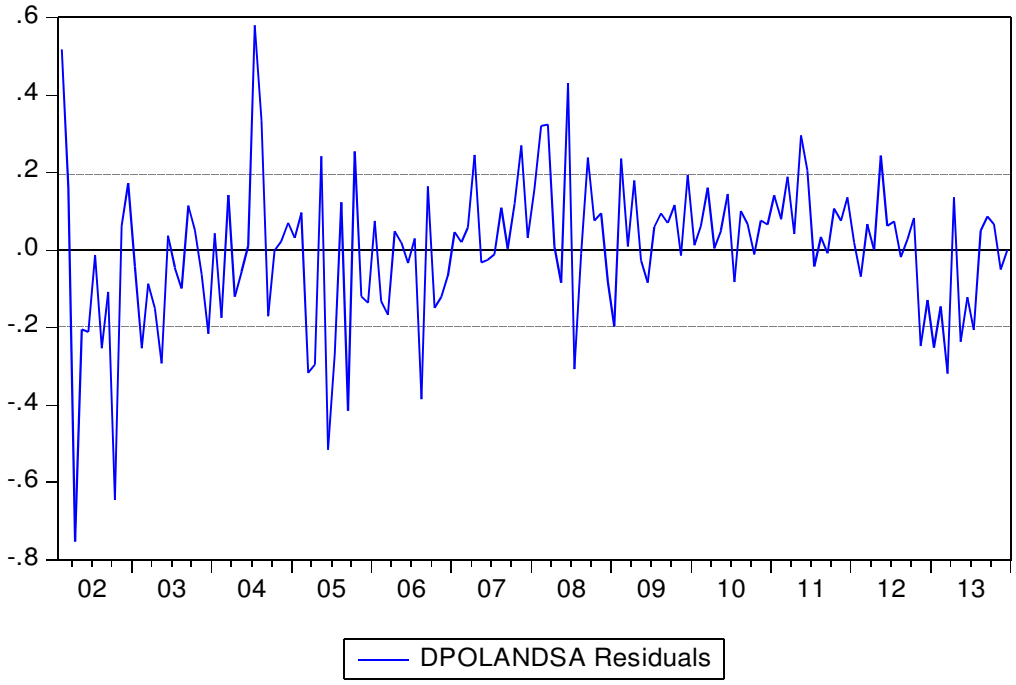
	Levels		First Order Differences	
	ADF	KPSS	ADF	KPSS
Germany	-1.5412	20.451***	-4.8091***	-1.3473
Poland	-1.4786	18.989***	-4.2209***	-2.0319**
Czech Republic	-1.6392	18.610***	-5.4737***	-3.7248***
Denmark	-1.4297	21.031***	-4.631***	-1.4558
Hungary	-2.8283*	37.384***	-14.528***	-1.720*
Sweden	-2.3548	25.213***	-10.686***	-0.1302
United Kingdom	-1.1944	21.075***	-4.8240***	-1.5368

Significance at the 1% (***), 5% (**), and 10%(*) levels

Table 2 – Estimation Results

Constant	-0.0185 (-1.0975)
Czech Republic	0.2718*** (2.4047)
Denmark	0.2822*** (2.3996)
Hungary	0.0599*** (2.1999)
Sweden	-0.2867*** (-3.8164)
United Kingdom	0.2868*** (2.6820)
Poland(t-1)	0.2506*** (4.1229)
Adjusted R-squared	0.3103
Standard Error of the Regression	0.1962
LM (2)	1.2873
Normality	37.087***
Breusch-Godfrey	1.3628
White's Test	1.8993*

Significance at the 1% (***), 5% (**), and 10%(*) levels (T-values in parenthesis)


.6
.4
.2
.0
-.2
-.4
-.6
-.8
02
03
04
05
06
07
08
09
10
11
12
13
DPOLANDSA Residuals