Abstract
This paper estimates the effects of selected macroeconomic variables on the stock market index in Slovakia. The EGARCH (Nelson, 1991) model is employed in estimating the variance equation. It finds that Slovakia’s stock market index is positively associated with real GDP and the German or U.S. stock market index and negatively influenced by the ratio of government borrowing to GDP, the domestic real interest rate, the expected inflation rate and the EU area or U.S. government bond yield. The stock market index exhibits a quadratic relationship with the nominal effective exchange rate (NEER), suggesting that they have a positive (negative) relationship if NEER is less (greater) than the critical value of 108.04. Therefore, to maintain a robust stock market, the authorities are expected to pursue economic growth, fiscal prudence, a lower real interest rate, a lower expected inflation rate, and a nominal effective exchange rate conducive to stock market performance.

Key words: Stock market index, monetary policy, fiscal policy, interest rates, exchange rate, inflation.

1. INTRODUCTION
The recent global financial crisis has caused many transition economies including Slovakia to suffer declining economic and business activities. The Slovak Share Index declined 56.7% during September 2008 - May 2010, which was similar to the 56.8% decline of S&P 500 during its recent worst-performing period. Since May 2010, the stock market index has shown a humped shape, improving initially and declined gradually. As of April 19, 2013, it was still 60.55% below the all time high of 464.29 on September 17, 2008 (www.Bloomberg.com). The substantial decline of stock prices is expected to have negative impacts on investment spending, consumption spending, international capital flows, the demand for money, and other related variables.

1 Department of Management & Business Administration College of Business Southeastern Louisiana University Hammond, LA 70402, USA, e-mail: yhsing@selu.edu
This paper attempts to examine the potential effect of macroeconomic variables on the stock market index for Slovakia and has several focuses. First, theoretical analysis is presented to determine the possible relationship between the Slovak stock market index and selected macroeconomic variables including the government deficit or the exchange rate. Second, international financial markets such as the world stock market index and the world interest rate are considered as international investors compare the attractiveness of financial assets in different countries in order to increase the rate of return on their investments. Third, the EGARCH model (Nelson, 1991) is applied in empirical work in order to estimate the variance equation properly.

2. LITERATURE SURVEY

There are several recent studies examining the stock market for Slovakia and related countries. Mateus (2004) examines the risk and predictability for 13 EU accession countries. For Slovakia, in the unconditional asset pricing test, the coefficient of the average short-term interest rate in G-7 countries is significant at the 1% level whereas the coefficients of other explanatory variables are insignificant at the 10% level. In the time-series regression of country excess returns on instrumental variables, the coefficients of the dividend yield of the MSCI world equity market, the local price-to-book value, and the lagged stock market index are significant.

Égert and Koubaa (2004) indicate that most of stock returns for six Central and Eastern European countries including Slovakia can be better captured by asymmetric models whereas stock returns for G-7 countries can be modeled by linear relationships. Effects of negative shocks on stock returns in these transition economies were much larger than effects of positive shocks. Negative impacts also occur not smoothly but abruptly.

Samitas and Kenourgios (2007) study the determinants of stock prices in four transition economies. For Slovakia, in the VEC model, only the coefficients of the domestic interest rate and the error correction term are significant at the 5% level whereas the coefficients of industrial production, the interest rate in the U.S. and Germany, industrial production in the U.S. and Germany are insignificant. In the long-run cointegrating equation, the coefficients of the domestic interest rate, industrial production in the U.S. and Germany, and the interest rate in the U.S. and Germany are significant whereas the coefficient of industrial production in Slovakia is insignificant.

Morales (2008) analyzes the relationship between stock returns and exchange rates for four central EU countries including Slovakia and finds that there is lack of evidence of spillovers from stock returns to exchange rates and that there is lack of significant spillovers from exchange rates to stock returns. He also shows that the degree of volatility in exchange rates and stock returns declines after joining the EU.
Diebold and Yilmaz (2008) analyze the relationship between the stock return and macroeconomic fundamentals using a sample of 42 countries including Slovakia. They show that macroeconomic fundamental volatility Granger causes stock market return volatility and that real stock return volatility is positively influenced by real GDP growth volatility and real PCE (private consumption expenditure) volatility and negatively affected by initial real GDP per capita.

Allen, Golab and Powell (2010) investigate the behavior of stock markets for 12 Eastern and Central European countries. For Slovakia, they indicate that the correlation between the Slovak and some of the other stock markets increased from the period 1995-2004 to the period 2004-2009 and that the Slovak stock market was less volatile in the post-EU period.

Syllignakis and Kouretas (2011) examine stock markets for 7 CEE countries including Slovakia. They find that CEE stock returns show a significant increase in the correlations with the German and U.S. stock returns especially during the period of 2007-2009 and that macroeconomic fundamentals such as exchange rates and domestic and foreign monetary variables have significant explanatory power in explaining the correlations.

Eichler and Maltritz (2011) research the relationship between stock returns and exchange rate crises based on a sample of 33 emerging economies including Slovakia. They find that a currency crisis has a negative impact on stock returns and that the stock market and currency crises can happen simultaneously.

These previous studies have made significant contributions to the understanding of the behavior of the stock market in Slovakia and related countries in areas of macroeconomic fundamentals, return and volatility spillovers, currency crises, linkages across stock markets, econometric methodologies, etc.

3. THE MODEL

Extending previous studies, we can express the Slovak stock market index as:

\[ S = f(Y, D, R, \pi^e, E, W) \]

\[ + ? - ? - + ? \]

where

- \( S \) = the Slovak stock market index,
- \( Y \) = real output,
- \( D \) = the government deficit,
- \( R \) = domestic real interest rate,
- \( \pi^e \) = the nominal effective exchange rate (NEER),
- \( \pi^e \) = the expected inflation rate,
- \( E \) = the world stock market index, and
- \( W \) = the world interest rate.
We expect that in the long run, the Slovak stock market index has a positive relationship with real output and the world stock market index, a negative relationship with the domestic real interest rate and the expected inflation rate, and an unclear relationship with the government deficit, the exchange rate or the world interest rate. Note that the money supply is not included in equation (1) because since Slovakia adopted the euro on January 1, 2009, the data for the money supply measured in the koruna have discontinued.

More government deficit is expected to increase aggregate expenditures (AE) and business sales at least in the short term, the price level (P), the nominal interest rate (r), the demand for financial assets including stocks (F) due to the theoretic portfolio approach, and future tax liabilities (T) (Brunner, 1961; Cagan, 1972; Barro, 1974; Feldstein, 1982; Hoelscher, 1986; Darrat, 1990a, 1990b):

\[
\frac{\partial S}{\partial D} = S_{AE} AE_D + S_P P_D + S_r r_D + S_F F_D + S_T T_D > 0 \text{ or } < 0. \tag{2}
\]

where

\[ AE_D > 0, P_D > 0, r_D > 0, F_D > 0, T_D > 0. \]

The sign of the first and fourth terms is positive whereas the sign of the remaining terms is negative. Hence, the net impact of more government deficit is unclear.

Currency appreciation is expected to reduce exports (X), import costs (C) and domestic prices and increase international capital inflows (CF) to Slovakia (Abdallah and Hayworth, 1993; Mukherjee and Naka, 1995; Choi, 1995; Ajayi and Mougoue, 1996; Abdalla and Murinde, 1997; Nieh and Lee, 2001; Wongbangpo and Sharma, 2002; Kim, 2003):

\[
\frac{\partial S}{\partial E} = S_X X_\varepsilon + S_C C_\varepsilon + S_P P_\varepsilon + S_{CF} CF_\varepsilon > 0 \text{ or } < 0. \tag{3}
\]

where

\[ X_\varepsilon < 0, C_\varepsilon < 0, P_\varepsilon < 0, CF_\varepsilon > 0. \]

The sign of the first term is negative whereas the sign of the remaining terms is positive. Therefore, the net impact is uncertain. A preliminary analysis of the sample data suggests that there seems to exist a nonlinear or bell-shaped relationship between the Slovak stock market index and the nominal effective exchange rate. Hence, the estimated regression will include a squared term of the nominal effective exchange rate:
\[ S = f(Y, D, R, \varepsilon, \varepsilon^2, \pi^e, E, W) \] (4)

Taking the partial derivative of \( S \) with respect to \( \varepsilon \) and solving for the first-order condition, we obtain the critical value of \( \varepsilon \) which maximizes \( S \):

\[ \varepsilon = -\frac{\beta_4}{2\beta_5}, \] (5)

where \( \beta_4 \) and \( \beta_5 \) are the estimated coefficients for \( \varepsilon \) and \( \varepsilon^2 \), respectively.

The second-order condition requires that \( \beta_5 < 0 \).

A higher world interest rate is expected to cause currency depreciation and increase its exports but reduce international capital inflows to Slovakia and the demand for financial assets including stocks.

4. EMPIRICAL RESULTS

The source of the data came from the International Financial Statistics (IFS), which is published by the International Monetary Fund. \( S \) is represented by the share price index for Slovakia with 2005 as the base year. \( Y \) is represented by real GDP measured as an index number at the 2005 price. \( D \) is measured by government borrowing as a percent of GDP. Note that the data for the government budget deficit began available in 2007.Q1 and are not adequate for regression analysis. \( R \) is measured by the difference between the money market rate and the expected inflation rate. \( \varepsilon \) is represented by the nominal effective exchange rate (NEER), which is a trade-weighted exchange rate. An increase means currency appreciation. \( \pi^e \) is measured by the average inflation rate of the past four quarters derived from the consumer price index. \( E \) is represented by the German share price index with 2005 as the base year. \( W \) is represented by the euro area government bond yield. Except for the ratio of government borrowing to GDP, the expected inflation rate and the domestic real interest rate with potential negative values, other variables are measured in the logarithmic scale. The sample ranges from 2000.Q1 to 2010.Q2 and has a total of 42 observations.

The unit root test shows that all the variables in level have unit roots and that all the variables in first difference are stationary at the different significance levels. In order to determine whether the regression may be spurious, the ADF test on the regression residuals is performed. Based on the AIC, a lag length of five is selected. The critical value at the 1% significance level is -2.631, and the test statistic is -3.898. Hence, these time series variables are cointegrated and have a long-term stable relationship.
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The EGARCH (Nelson, 1991) model is applied in empirical work in order to estimate the variance equation properly and to capture potential asymmetry in the behavior of the stock market index. Table 1 presents estimated parameters and related statistics. Figures in the parenthesis are z-statistics. In the base model in Version I, the value of $R^2$ is 0.900, suggesting that 90.0% of the variation in the Slovak stock market index can be explained by the eight explanatory variables. All the coefficients are significant at the 1% level. The Slovak stock market index is positively influenced by real GDP, the nominal effective exchange rate and the German stock market index and negatively associated with the government borrowing/GDP ratio, the domestic real interest rate, the squared nominal effective exchange rate, the expected inflation rate, and the euro area government bond yield.

Several comments can be made. The Slovak stock market index appears to be more sensitive to a percent change in real GDP or the euro area government bond yield than other variables. A 1% increase in real GDP will result in a 1.271% increase in the Slovak stock market index; and a 1% increase in the euro government bond yield will lead to a 1.139% increase in the Slovak stock market index. The significant quadratic relationship indicates that currency appreciation leads to a higher (lower) stock price if the nominal effective exchange rate is less (greater) than 108.04. Hence, the positive export effect is greater (less) than the negative effects if NEER is less (greater) than 108.04. The negative significant coefficient of the euro area government bond yield implies that its negative impact on decreased international capital inflows may outweigh its positive impact on exports due to currency depreciation.

Several other versions are estimated. In Version II, the German share price index is replaced by the U.S. share price index. Its coefficient is positive and significant at the 1% level. The signs and significance of other coefficients are similar. The estimated coefficients of 0.364 for the German stock market index in Version I and 0.766 for the U.S. stock market index in Version II suggest that the Slovak stock market index is more sensitive to a percent change in the U.S. stock market index than the German stock market index.

In Version III, if the 10-year U.S. government bond yield substitutes for the euro area government bond yield, its negative coefficient is significant at the 1% level. The value of $R^2$ is estimated to be 0.885. The signs and significance for other coefficients are similar. An analysis of the coefficients suggests that the Slovak stock market index is more sensitive to a percent change in the euro area government bond yield than the 10-year U.S. government bond yield. When the German and U.S. stock market indexes and the euro area and 10-year U.S. government bond yields are included in one regression, the sign of the U.S. stock market index becomes negative, and the sign of the 10-year U.S. government bond yield becomes positive mainly due to a high degree of multicollinearity. To save space, the results are not printed here and will be available upon request.
5. SUMMARY AND CONCLUSIONS

This study has examined the relationship between the Slovak stock market index and selected macroeconomic variables. The EGAECH model is employed in estimating the variance equation. A higher real GDP, a lower ratio of government borrowing to GDP, a lower domestic real interest rate, a lower expected inflation rate, a higher German or U.S. stock market index, or a lower euro area or U.S. government bond yield would help improve the Slovak stock market performance. The Slovak stock market index shows a positive (negative) relationship with the nominal effective exchange rate if the latter is less (greater) than 108.04.

In comparison, the results in this study are consistent with Égert and Koubaa (2004), Mateus (2004) in the significance of the short-term foreign interest rate in the unconditional asset pricing test, Samitas and Kenourgios (2007) in the significance of the domestic interest rate, world output and world interest rates in the long-run relationship, Diebold and Yilmaz (2008), and Syllignakis and Kouretas (2011). However, the findings in this paper are different from Mateus (2004) in the insignificance of the variables except for the short-term foreign interest rate, Samitas and Kenourgios (2007) in the significance of the coefficient of domestic output in the long-run relationship and Morales (2008) in the significance of the coefficient of the exchange rate.

There are major policy implications. Macroeconomic policies can impact the Slovak stock market. To maintain a healthy stock market, the authorities are expected to pursue economic growth, fiscal discipline, a lower real interest rate, a lower expected inflation rate, or a proper nominal effective exchange rate conducive to stock market development. The authorities need to monitor the developments in the world financial market such as the movements in the German or U.S. stock markets and world interest rates since they also influence the Slovak stock market.

REFERENCES


IMPACTS OF MACROECONOMIC VARIABLES ON THE STOCK MARKET IN SLOVAKIA AND POLICY IMPLICATIONS


<table>
<thead>
<tr>
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<th>Version I</th>
<th>Version II</th>
<th>Version III</th>
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<tbody>
<tr>
<td>Log(real GDP)</td>
<td>1.271*</td>
<td>1.066*</td>
<td>1.234*</td>
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<tr>
<td></td>
<td>(7.528)</td>
<td>(10.342)</td>
<td>(15.903)</td>
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<tr>
<td>Government borrowing/GDP ratio</td>
<td>-0.406*</td>
<td>-0.281*</td>
<td>-0.392*</td>
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<td></td>
<td>(-3.340)</td>
<td>(-4.183)</td>
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<tr>
<td>Domestic real interest rate</td>
<td>-0.058*</td>
<td>-0.086*</td>
<td>-0.130*</td>
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<td></td>
<td>(-2.725)</td>
<td>(-7.005)</td>
<td>(-21.350)</td>
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<td>--------------------------</td>
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<tr>
<td>Log (NEER)</td>
<td>68.610* (201.422)</td>
<td>75.132* (399.171)</td>
<td>117.519* (616.116)</td>
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<tr>
<td>Log (NEER)^2</td>
<td>-7.326* (-126.794)</td>
<td>-8.035** (-233.339)</td>
<td>-12.671* (-6354.619)</td>
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<td>Expected inflation rate</td>
<td>-0.342* (-3.982)</td>
<td>-0.441 (-8.950)</td>
<td>-0.647** (-32.573)</td>
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<tr>
<td>Log (German stock market index)</td>
<td>0.364* (7.692)</td>
<td>0.766* (8.723)</td>
<td>0.434* (8.836)</td>
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<tr>
<td>Log (U.S. stock market index)</td>
<td>0.364* (7.692)</td>
<td>0.766* (8.723)</td>
<td>0.434* (8.836)</td>
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<tr>
<td>Log (Euro area government bond yield)</td>
<td>-1.139* (-5.378)</td>
<td>-0.872* (-7.072)</td>
<td>-0.327* (-3.880)</td>
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<tr>
<td>Log (U.S. government bond yield)</td>
<td>-1.139* (-5.378)</td>
<td>-0.872* (-7.072)</td>
<td>-0.327* (-3.880)</td>
</tr>
<tr>
<td>Constant</td>
<td>-161.870* (-291.132)</td>
<td>-178.017* (-782.439)</td>
<td>-274.609* (-463.474)</td>
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<tr>
<td>R²</td>
<td>0.900 0.884 0.885</td>
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<tr>
<td>Adjusted R²</td>
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<td>F-statistic</td>
<td>24.104 20.749 21.045</td>
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<td>SC</td>
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<td>EGARCH(1,1) EGARCH(1,1) EGARCH(1,1)</td>
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Notes:
The dependent variable is the log of the Slovak stock price index.
NEER is the nominal effective exchange rate.
* means that the coefficient is significant at the 1% level.