The Short-Run Relationship between Stock Market Prices and Macroeconomic Variables in Lithuania: An Application of the Impulse Response Function

Donatas Pilinkus, Vytautas Boguslauskas

Kaunas University of Technology
Laisvės al. 55, LT-44309, Kaunas, Lithuania
e-mail: pilinkus@pilinkus.com, vytautas.boguslauskas@ktu.lt

Scientific literature has been seemingly enriched by various theoretical and empirical studies analysing the relationship between stock market returns and macroeconomic forces during the last few decades. It is often argued that stock prices are determined by some fundamental macroeconomic variables. This implies that macroeconomic variables can influence investors’ investment decisions and motivates many researchers to investigate the relationships between stock market prices and macroeconomic variables. Different authors select different macroeconomic variables seeking to detect their relationship with stock market prices in various countries. Simultaneously, a number of econometric techniques such as the arbitrage pricing theory, the impulse response function, the error variance decomposition analysis, the vector error correction model, the cointegration analysis, the Granger causality tests and others may be applied for checking the existence of relationship between stock market prices and macroeconomic variables.

The current paper attempts to present several classifications of macroeconomic variables, then to select macroeconomic variables for seeking their relationship with stock market prices, and, finally, to define what macroeconomic variables have positive and what macroeconomic variables have negative effects on stock market prices in Lithuania in the short run.

Augmented Dickey Fuller test has been employed to check the stationarity of the selected time series since a spurious regression may occur if a time series is not stationary. The Impulse response function has been chosen to test the existence of the short-run relationship between stock market prices and macroeconomic variables. As the results of the Impulse response function are reliable only with a stationary time series the data has been turned into stationary after the second difference.

The study embraces six macroeconomic variables (seasonally adjusted gross domestic product at previous year prices, harmonised consumer price index as compared to 2005, the narrow money supply, unemployment rate, short-term interest rates, and exchange rate of the Litas against the US dollar) and the main Lithuanian stock market index – the OMX Vilnius index. The data are monthly and extend from the January of 2000 to the June of 2009.

In general, the results of the paper clearly indicate that macroeconomic variables are significant determinants for stock market prices in Lithuania. Gross domestic product and money supply have a positive effect on stock market prices while most of the time unemployment rate, exchange rate, and short-term interest rates negatively influence stock market prices. The findings of the paper are similar to the results of some other empirical studies. If harmonised consumer price index is considered, then it is the best example of an unstable relationship between a macroeconomic variable and stock market prices in Lithuania.

Keywords: macroeconomic variables, stock market prices, short-run relationship, impulse response function, Lithuania.

Introduction

The relationship between stock market prices and macroeconomic variables has been widely investigated in the scientific literature (Fama, 1981; Ibrahim, 1999; Gunes, 2007, etc.). For this purpose, scientists apply different econometric instruments: the arbitrage pricing theory has been employed by Fama (1981), Schwert (1990), Tursoy, Günsel, Rjoub (2008); the impulse response function has been applied by Sims (1980), Nishat, Shaheen (2004), Adam, Tweneboah (2008); the error variance decomposition analysis has been incorporated by Laopodis (2007); the vector error correction model has been found relevant by Granger (1987), Kwon, Shin (1999); different types of cointegration analysis have been included by Lee (1992), Hassan (2003), Dritsaki (2005); the Granger causality tests have been considered by Lee (1992), Hasson (2003), Dritsaki (2005), etc.

At the same time, scientists select different macroeconomic variables in their studies. Some authors choose only one or two macroeconomic factors – e.g., Comincioli (1995) seeks for the relationship between the stock market index and gross domestic product, Gallegati (2005) also prefers only one macroeconomic factor, though it is an industrial production index, Arabian, Afshar, Anjela (2008) operates with gross domestic product and oil prices; other researchers are apt to analyzing more than ten different macroeconomic variables (Tursoy, Günsel, Rjoub, 2008). Simultaneously, authors analyze data at different time periods, i.e. daily data (Kurihara, Nezu, 2006), monthly data (Kandir, 2008; Stavarek, 2004), quarterly data (Ahmed, 2008; Comincioli, 1995) or annual data (Hussain, Mahmood, 2001; Naceur, Ghazouani, Omran, 2007).
Those scientists who employ the Impulse response function mainly analyze the short-run relationship between macroeconomic variables and stock market prices. This econometric technique has been applied to a number of countries: Pakistan (Nishat, Shaneen, 2004), Malaysia (Ibrahim, 2003), the United States (Fama, Schwert, 1977), India (Darat, Mukherjee, 1987), Japan (Mukherjee, Naka, 1995), Canada (Darrat, 1990), etc. All scientific studies show the relationship between stock market prices and macroeconomic variables. For example, Nishat and Shaneen (2004) have detected a significant opposite relationship between the Karachi stock market index and the consumer price index and a positive relation between the industrial production index and the stock market index; a positive influence of the industrial production index has been proved for a number of European countries as well (Siliverstovs, Duong, 2005; Snieska, 2008) and so no. This technique has not been applied for Lithuania so far.

Therefore, the objective of this paper is to define the short-run relationship between Lithuanian stock market prices and macroeconomic variables by employing the Impulse response function. A set of macroeconomic variables will be offered for similar studies in the future. The object of the article is the relationship between macroeconomic variables and stock market prices. Research methods are the logical analysis and synthesis of scientific literature, the comparison and generalization method, the statistical grouping method.

Scientific novelty: though scientific literature has been seemingly enriched by theoretical and practical studies analysing the relationship between macroeconomic variables and stock market prices in different countries there is few similar studies in Lithuanian (Norvaišienė, Stankevičienė, Krušinskas, 2008; Ginevičius, Podvezko, 2009; Melnikas, 2008); moreover, no scientists have investigated the short-run relationship between macroeconomic variables and stock market prices in Lithuania applying the Impulse response function.

Classification of macroeconomic variables according to the business cycle

In the most general sense, macroeconomic variables are treated as statistical indicators that reflect an overall economic situation of the country during some period of time (Rogers, 1998) or as regular data issued by state institutions and indicating the welfare of a country (Mohr, 1998; Darnay, 1998; Ciegis, Ramanauskiene, Startiene, 2009; Kumpikaite, Ciarniene, 2008). The first attempts to calculate macroeconomic variables could be dated as back as the First World War when warring countries wanted to measure the strength of their enemies. Nowadays a large spectrum of macroeconomic variables is regularly published to indicate various tendencies in both private and public life.

According to the business cycle, it is possible to distinguish the following groups of macroeconomic variables (Rogers, 1998):

- **Pro-cyclic macroeconomic variables** are positively correlated with the overall state of the economy, i.e. they tend to increase when the overall economy is growing. Gross domestic product is considered to be a classical example of pro-cyclic macroeconomic variables.
- **Countercyclic macroeconomic variables**, on the contrary, move in the opposite direction of the overall economic cycle: rising when the economy is weakening, and falling when the economy is strengthening. The unemployment rate gets larger when the economy gets worse that’s why it is attributed to this group.
- **Acyclic macroeconomic variables** have no relation to the health of the economy and are generally of little use.

The National Bureau of Economic Research offers another classification according to the timing how macroeconomic variables change relative to the changes of the economy as a whole (Shiskin, Moore, 1968):

![Figure 1. Leading, lagged and coincident macroeconomic variables](Source: developed by the author)
Leading macroeconomic variables are indicators which change before the economy changes. Stock market returns are considered as a leading indicator, as they usually begin to decline before the economy declines and they improve before the economy begins to pull out of a recession.

Lagged macroeconomic variables are ones that do not change direction until a few quarters after the economy does. The unemployment rate is a lagged economic indicator as unemployment tends to increase for 2 or 3 quarters after the economy starts to improve.

Coincident macroeconomic variables are ones that simply move at the same time the economy does and, for example, the gross domestic product is attributed to this group of indicators.

Figure 1 depicts how leading, lagged and coincident indicators move compared to gross domestic product throughout time.

Leading macroeconomic variables dominate in scientific literature since their fluctuations set signals and help predict what the economy will be like in the future (Chen, 2009; Dua, 2004). It is relevant to state that a separate macroeconomic variable is doomed to subjectivity, thus a set of macroeconomic variables is required for a more precision picture on economic developments.

Selection of macroeconomic variables by estimating their relationship with stock market prices

Different economic theories such as Classical, Keynesian, Monetary and others allocate unequal power to various macroeconomic variables (Dritsaki, Adamopoulos, 2005). Therefore, it is an uneasy task to select proper macroeconomic variables that could be most valuable in tracing the relationship between macroeconomic variables and stock market prices. The current issue has been investigated for a long time (Miller, Modigliani, 1961). As Chen, Roll and Ross (1986) state, selection of relevant and proper macroeconomic factors requires much efforts and it would be expedient to consider theoretical and empirical literature in this field of study before undertaking such a decision (Humpe, Macmillan, 2007).

Dritsaki (2005) notices the most important thing in selecting macroeconomic variables is to preserve that those variables would objectively reflect not only general situation in the country’s economy but also financial status of the country. In that respect, many scientists believe that financial resources are closely related to economic output of the country which is measured either by gross domestic product or industrial production volumes (Fama, 1981; Chen, Roll, Ross, 1986; Cheung, Ng, 1998; Binswanger, 2000; Lakstutiene, 2008). Some authors prefer industrial production index to gross domestic product since it is calculated every month (not every quarter) and, thus, more often reflects economic situation (Padhan, 2007). Moreover, industrial production index becomes vital if industrial sector prevails in the country under analysis (Agrawalla, Tuteja, 2007).

As DeFina (1991) points out, inflation negatively influences companies due to speedily increasing costs. Seeking for the relationship between stock market and macroeconomic variables inflation is most often measured by consumer price index (Atmadja, 2005; Dritsaki, 2005; Laopodis, 2007), though some scientists also include other inflation reflecting indices, for example, producer price index (Teresienė, Aarma, Dubauskas, 2008).

Another popular macroeconomic variable is interest rates in such type of studies. Some authors include only short-term interest rates (Dritsaki, 2005; Atmadja, 2005), others select only long-term interest rates (Siliverstovs, Doung, 2005) while the third group of scientists analyzes both short-term and long-term interest rates (Chen, Roll, Ross, 1986; Mukherjee, Naka, 1995). As a rule, short-term interest rates are influenced by business cycles and monetary policies and long-term interest rates are more related to long-term economic perspectives of the country (Humpe, Macmillan, 2007).

Money supply stands for another macroeconomic indicator which many scientists embrace when they seek for the relationship between stock market prices and macroeconomic forces (Urich, Wachtel, 1981; Chaudhuri, Smiles, 2004). Tan and Baharumshah (1999) argue that it is more expedient to analyze the narrow money M1 while others operate with broadly-defined money supply M2 (Tursoy, Gunsel, Rjoub, 2008). There is another group of scientists who avoid this scientific discussion and enrol both concepts of money supply in their empirical investigations.

Stock prices can be influenced by exchange rate fluctuations as the currency devaluation may lead to inflationary processes in the country what reduces consumer expenditure and profits earned by local companies. Analysis of the exchange rate fluctuations can be found in a number of empirical studies (Adam, Tweneboah, 2008; Ahmed, 2008; Ibrahim, 2003; Kwon, Shin, 1999). As economists most often speak about gross domestic product, inflation and unemployment analysing various economic phenomena, unemployment should be incorporated into such studies as well (Tursoy, Gunsel, Rjoub, 2008).

The aforementioned variables, i.e., gross domestic product, industrial production, inflation, interest rates, money supply, and unemployment rate, reflect domestic economic processes and the exchange rate fluctuations are more related with the international economic context.

Data and methodology

The macroeconomic variables used in this paper are as follows: seasonally adjusted gross domestic product (GDP) at previous year prices; harmonised consumer price index (HCPI) as compared to 2005, the narrow money supply (M1), i.e. currency in circulation and overnight deposits in Litas and foreign currencies; unemployment rate (UR) reflecting tendencies in the labour market; three months Vilnius interbank offered rate (VILIBOR3M) which is based on the quotes of not less than 5 local commercial banks, designated by the Bank of Lithuania, which are most active in Lithuanian money market; and the exchange rate of Litas against the US dollar (USD_LTL). The data are monthly and extend from the January of 2000 to the June of 2009.
The stock price movements are represented by the main Lithuanian stock market index – the OMX Vilnius (OMXV) index. A value of the index is acquired on the last business day of the month. The OMXV index indicates stocks which are quoted in the securities exchange of Vilnius. Most Lithuanian companies – “TEO LT”, “City Service”, “Klaipedos Nafta”, “Ukio bankas” and others – are included in the index, thus, it may be assumed that dynamics of OMXV index reflects the overall country’s economic situation quite reasonably.

Time series analysis must be based on stationary data for drawing useful inferences. A data series is said to be stationary if its mean and variance are constant over time and the value of covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed. The correlation between a series and its lagged values are assumed to depend only on the length of the lag and not when the series started. This property is known as stationarity and any series obeying this is called a stationary time series.

The unit root test has been applied to check whether a series is stationary or not. Stationarity condition has been tested using Augmented Dickey Fuller (ADF) test. Compared to Dickey Fuller (DF) test, the ADF approach controls higher-order correlation by adding lagged difference terms of the dependent variable to the regression.

The impulse response function, as an econometric technique, has been employed to investigate the short-run (up to one year) impact caused by the vector auto regression model when it received some impulses. The impulse response function describes the response to the error by the endogenous variables. It depicts the current and future responses of endogenous variables to one standard deviation on the disturbing term.

### Research results on the short-run relationship between stock market prices and macroeconomic variables in Lithuania

Table 1 reports the ADF test statistics for the presence of unit root of the level, first and second differences over the sample period. For the level series, the results show the existence of unit root for all variables as it fails to reject the null hypothesis of nonstationarity with an exception of money supply. After the first difference, HPCI, UR, USD_LTL, and OMXV t-statistic results are higher than the critical values, however GDP, M1, and VILIBOR3M are still nonstationary. After second difference, the ADF test of unit root indicates that all variables are stationary and would not cause spurious regression outcomes.

### Unit root tests on level, first and second differences (critical values at 5% level are in the brackets)

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
</tr>
<tr>
<td>GDP</td>
<td>-2.319544 (-2.888157)</td>
</tr>
<tr>
<td>HPCI</td>
<td>2.663913 (-2.887425)</td>
</tr>
<tr>
<td>M1</td>
<td>-3.771975 (-2.890327)</td>
</tr>
<tr>
<td>UR</td>
<td>-1.575868 (-2.887425)</td>
</tr>
<tr>
<td>VILIBOR3M</td>
<td>-0.618338 (-2.890327)</td>
</tr>
<tr>
<td>USD_LTL</td>
<td>-1.185860 (-2.887190)</td>
</tr>
<tr>
<td>OMXV</td>
<td>-0.978956 (-2.887190)</td>
</tr>
</tbody>
</table>

Source: developed by the author

In Figure 2 it is possible to observe that GDP has an immediate positive effect on OMXV index. The effect peaks during the second month and remains positive throughout all twelve months. The result is similar to other studies (Ibrahim, 2003; Somoye, Akintoye, Oseni, 2009). In the meantime, the response of OMXV to HPCI is not as immediate as to GDP and the positive and negative effects interchange each other. The effect continues to be positive only after the ninth months. This support the Rapach’s (2002) claim that real stock prices positively respond to a permanent inflation shock in the long-run.

Figure 3 outlines the response of OMXV to M1 which is similar to that of GDP – even the peak of the effect remains the same, i.e. during the second months. The difference is that the positive effect of M1 is stronger compared to the influence of GDP innovations. The positive influence of money supply has been detected in other studies as well (Dumitrescu, Horobet, 2009).

The unemployment rate negatively influences OMXV index most of the time. Therefore, an increase in the unemployment rate causes a decrease of OMXV index and the effect peak is reached during the eighth month. The result is similar to Arestis, Baddeley, and Sawyer (2007) who conducted their analysis in the case of nine euro area countries.

Figure 4 discloses that the negative impact of the shock in the exchange rate is similar to the effect of unemployment rate innovations. The difference, however, is that the impact is immediate and it peaks not during the eighth month, as in the case of unemployment, but during the second and fifth months. The result of the negative relationship between the exchange rate and stock prices supports empirical finding of Aydemir and Demirhan (2009) as well as Akin and Basti (2008) for the Turkish market.

The influence of VILIBOR3M is more often negative than positive. Similarly, Alam and Uddin (2009) have also proved the existence of a significant negative relationship in fifteen developed and developing countries: Australia, Bangladesh, Canada, Chile, Colombia, Germany, Italy, Jamaica, Japan, Malaysia, Mexico, Philippine, South Africa, Spain, and Venezuela.
Figure 2. Responses to Cholesky one standard deviation innovations: responses of OMXV to GDP and HCPI.
Source: developed by the author

Figure 3. Responses to Cholesky one standard deviation innovations: responses of OMXV to M1 and UR
Source: developed by the author

Figure 4. Responses to Cholesky one standard deviation innovations: responses of OMXV to USD_LTL and VILIBOR3M
Source: developed by the author
The above evidence clearly indicates the existence of the short-run relationship between stock market prices and macroeconomic variables in Lithuania. Gross domestic product and money supply are the most influential positive determinants of the OMXV index while unemployment rate, exchange rate, and short-term interest rates mostly have a negative influence on stock prices quoted in the stock market of Lithuania.

Conclusions

The analysis carried out in this paper reveals that scholars and practitioners offer different classifications of macroeconomic variables. No matter what the classification is, macroeconomic variables are relevant indicators of movements in equity markets. This issue has been widely debated across a variety of markets and time horizons.

Many studies undertake different macroeconomic variables when searching for the relationship between macroeconomic factors and stock market prices. A set of six most relevant macroeconomic variables has been selected for the investigation in Lithuania, i.e. gross domestic product, inflation, interest rates, money supply, exchange rate, and unemployment rate. As OMX Vilnius index reflects stock price fluctuations of principal Lithuanian companies and, consequently, indicates the overall country’s economic situation it has been chosen as a representative for stock market price fluctuations. The paper reveals the selected variables verify to be proper as significant relationships have been perceived.

As a rule, time series are non-stationary, thus Augmented Dickey Fuller test has been employed to test if the data is stationary or not. The selected time series have become stationary only after second difference. The impulse response function has been selected to analyze the short-run relationship between macroeconomic variables and stock market prices as many scientists employ this econometric technique. The applied technique confirms similar results of other studies, i.e. gross domestic product and money supply have a strong positive effect on stock market prices in the short run while unemployment rate, exchange rate, short-term interest rates cause opposite movements for stock prices. This undoubtedly confirms the existence of the short-term relationship between stock market returns and macroeconomic variables in Lithuania.

References


Donatas Pilinkus

**Trumpalaikis sąryšys tarp akcijų kainų ir makroekonominio rodiklių Lietuvoje:** reakcijos į impulso funkcijos pritaikymas

Santrauka

Mokslinge literatūroje vis labiau analizuojamos sąryšys tarp makroekonominio rodiklių ir akcijų kainų. Šio ypač susidomėta paskutinės dešimtmečių dėl to, kad makroekonominiai rodikliai tapo svarbiausia informacija administravimo strategijoms verslo veikloje. Jų naudos ypatybė gali būti analizuojama iš vieno ar kelių perspektyvų.

Pirmiausia, makroekonominiai rodikliai yra atšakojimai į didžiulius makroekonominio statuso pokyčius. Tai gali būti apibrėžiamas kaip makroekonomizmas, kai atliekami kai kurią makroekonominės sistemos analizės bei operacijos. Šioje srityje yra daugiau kaip keturis dešimtmečius ir vis dar yra darbas, kurį reikia atlikti, kad būtų gauti tiksliai informacijos par makroekonominės sistemos pokyčiams.

Antrais, makroekonominiai rodikliai yra pagrindiniai įvairių makroekonominio strategijos, kaip nuspręsti dėl panaudojimo ir darbą reikalingo, atliekant veiksmų, vadovaujamų makroekonominės pokyčio ir kainų pokyčio įvertinimu. Tai gali būti naudojama atliekant makroekonominės strategijos planavimą ir įgyvendinimą, taip pat atliekant veiksmų įgyvendinimą ir įgyvendinimą planavimą.

Trečias, makroekonominiai rodikliai yra pagrindiniai įvairių makroekonominio strategijos, kaip nuspręsti dėl panaudojimo ir darbą reikalingo, atliekant veiksmų, vadovaujamų makroekonominės pokyčio ir kainų pokyčio įvertinimu. Tai gali būti naudojama atliekant makroekonominės strategijos planavimą ir įgyvendinimą, taip pat atliekant veiksmų įgyvendinimą ir įgyvendinimą planavimą.
nuo 2000-ųjų metų sausio mėn. iki 2009-ųjų metų birželio mėn. duomenys.


Infliacija dažniausiai atspinta šalies makroekonominius procesus. Tai taip pat teigina Gunsel, Rjoub, 2008).