
IMPACTS OF MACROECONOMIC VARIABLES ON THE STOCK MARKET INDEX IN POLAND: NEW EVIDENCE

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Received 25 January 2011; accepted 23 May 2011

Abstract. Applying the GARCH or ARCH model, this paper finds that Poland's stock market index is positively associated with industrial production or real GDP and the German stock market index, negatively affected by the government borrowing/GDP ratio, the real interest rate, the nominal effective exchange rate, the expected inflation rate, and the government bond yield in the euro area, and exhibits a quadratic relationship with the M2/GDP ratio. It suggests that the stock market index and the M2/GDP ratio show a positive (negative) relationship if the M2/GDP ratio is less (greater) than the critical value of 43.68%. Hence, to maintain a healthy stock market, the Polish authorities are expected to pursue economic growth, reduce government borrowing, avoid currency appreciation, and keep a relatively low interest rate or a relatively low expected inflation rate. Although currency appreciation has a negative impact on the stock market index, it is possible that the negative relationship might change if a certain threshold value is reached in the future.

Keywords: stock market index, macroeconomic variables, ARCH, GARCH.

Reference to this paper should be made as follows: Hsing, Y.; Hsieh, W.-j. 2012. Impacts of macroeconomic variables on the stock market index in Poland: new evidence, *Journal of Business Economics and Management* 13(2): 334–343.

JEL Classification: E44, G15.

1. Introduction

The recent global financial crisis had caused the Warsaw Stock Exchange index to decline approximately 69% during July 2007 – February 2009 compared with the 57% decline of the S&P 500 index. Although it has recovered to some extent, as of January 25, its index value of 47,131.09 was still 30% below the all-time high of 67,568.51 on July 6, 2007. The substantial decrease in stock values has significant negative impacts on household consumption and business investment spending.

This paper examines the relationship between the stock market index and macroeconomic variables for Poland in order to provide a framework for the systematic analysis, to make predictions, and to provide a tool for simulating the effect of changes in macroeconomic policies. First, this paper attempts to test whether the stock market index

and the money supply may exhibit a quadratic pattern, showing a positive relationship if the money supply is less than a certain critical value and a negative relationship if the money supply is greater than a certain critical value. Increased money supply may initially raise the stock market index due to more liquidity, more output and portfolio adjustment. However, a further increase in the money supply beyond a certain threshold would reduce the stock market index because of inflationary expectations and its negative impact on the stock price. Second, the GARCH or ARCH model (Teresienè 2009; Aktan *et al.* 2010) is applied in order to determine whether the error variance may be a function of the past squared error and/or the past error variance.

2. Previous research

There are several representative works on the subject for the U.S. and other advanced countries. Fama (1981, 1990) and Fama and French (1989) show that the U.S. stock price has a positive relationship with production growth and some selected financial variables and a negative relationship with inflation and money growth and that expected returns on stocks are higher (lower) near business cycle troughs (peaks). Chen, Roll and Ross (1986) indicate that the U.S. stock price has a positive relationship with industrial production and a negative relationship with inflation.

Bulmash and Trivoli (1991) find that the U.S. stock market index is positively associated with M2 money supply in the short run and negatively affected by M2 money supply in the long run, and the short-term and long-term interest rates. Abdullah and Hayworth (1993) reveal that U.S. stock returns are positively correlated with inflation and money growth and negatively impacted by trade deficits, budget deficits, and short-term and long-term interest rates. Ajayi and Mougoue (1996) report that exchange rate depreciation has a negative effect on the stock price for eight advanced countries in the short-run and long-run.

Nieh and Lee (2001) demonstrate that there is no long-term equilibrium relationship between the stock price and the exchange rate for each of the G-7 countries. Kim (2003) finds that more industrial production, a lower inflation rate, a lower interest rate, real depreciation of the U.S. dollar would cause the U.S. S&P 500 index to rise and that the interest rate plays a major role. Ratanapakorn and Sharma (2007) show that the S&P 500 index is positively influenced by industrial production, the inflation rate, the money supply, the Treasury bill rate, and the yen/US dollar exchange rate and negatively impacted by Government bond yield. Humpe and Macmillan (2009) reveal that more industrial production, a lower consumer price index, and a lower long-term interest rate would increase the U.S. stock price and that the coefficient of the money supply is insignificant.

Several recent studies are examining the relationship between the stock market index and macroeconomic and global variables for Poland and related countries. Hanousek and Filer (2000) indicate that the stock market index and economic variables in Poland are mainly connected with lags, suggesting the rejection of the semi-strong efficiency hypothesis and possible profitable trading activities using public information. They also

find that the Polish stock market index is not linked to the German DAX or the U.S. DJIA based on the contemporaneous or lagged values. Poshakwale and Murinde (2001) find the presence of nonlinearity and conditional heteroskedasticity in the stock markets in Poland and Hungary and reject the day-of-the-week effect and that conditional volatility of the stock market index declines in Poland more consistently than that in Hungary.

Studying the linkage between seven CEE stock markets with the U.S. and German stock markets, Syllignakis and Kouretas (2006) indicate that there exists a common permanent component for five of the stock markets including Poland, that short-term mutual dependence strengthened during the Russian and Asian crises, and that stock volatility increased significantly during the Russian crisis.

Samitas and Kenourgios (2007) report several major findings for the four EU countries, namely, Poland, Hungary, Czech Republic and Slovakia: (1) the domestic industrial production has more impact on the stock market index than the domestic interest rate; (2) the U.S. interest rate has more effect on the stock market index than the U.S. industrial production; (3) the domestic economic activity in these four countries and the German factor are more important in affecting the stock market index than the U.S. global factor. Wang and Moore (2008) find significant correlation or linkage between the stock markets in Poland, the Czech Republic and Hungary and the eurozone market during and after the financial crises. The accession to the EU has also enhanced the correlation. Financial market developments in the Czech Republic and Hungary have increased the correlation with the eurozone market.

Investigating volatility spillovers between stock returns and exchange rate fluctuations for four CEE countries including Poland, Morales (2008) shows that there is lack of support for volatility spillovers from stock returns to exchange rates and that there is also lack of evidence of significant spillovers from exchange rate changes to stock returns. He also indicates that volatility in both variables decreases after the accession to the EU. Based on a sample of 42 emerging countries including Poland during 1990–2004 and the estimation of macroeconomic determinants of stock market development, Yartey (2008) reveals that stock market capitalization relative to GDP is positively affected by per capita GDP, investments and capital flows and that the coefficients of the real interest rate and the inflation rate are not significant at the 10% level.

Horobet and Dumitrescu (2009) reveal that the real stock market index for Poland is positively affected by real GDP, the CPI and the real interest rate and negatively impacted by M1 money supply and the real effective exchange rate, suggesting that the appreciation of the zloty will reduce the real stock market index.

3. The model

Extending Hanousek and Filer (2000), Poshakwale and Murinde (2001), Samitas and Kenourgios (2007), Teresienè (2009), Horobet and Dumitrescu (2009), Aktan *et al.* (2010) and other previous studies, we can express Poland's stock market index as:

$$S = h(Y, B, M, R, E, \pi^e, S^*, R^*), \tag{1}$$

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where: S – the stock market index in Poland, Y – real output, B – government borrowing, M – the money supply, R – the real interest rate in Poland, E – the nominal effective exchange rate (An increase means appreciation), π^e – the expected inflation rate, S^* – the foreign stock market index, R^* – the foreign interest rate.

The sign below each of the variables shows the partial derivative of the stock market index with respect to a change in each of the variables. Poland’s stock market index is positively influenced by real output and the foreign stock market index, negatively affected by the domestic real interest rate and the expected inflation rate, and may be affected positively or negatively by government borrowing, the money supply, the nominal effective exchange rate or the foreign interest rate.

Increased government borrowing or debt may enhance infrastructures, increase aggregate expenditures (AE) and business opportunities, promote economic growth, and raise stock prices. On the other hand, huge government borrowing or debt would raise the long-term interest rate (LR), crowd out private spending, slow down the economy, raise future tax burdens (TX), and hurt stock prices (Darrat 1990a, 1990b):

$$\frac{\partial S}{\partial B} = \left(\frac{\partial S}{\partial AE} \times \frac{\partial AE}{\partial B} \right) + \left(\frac{\partial S}{\partial LR} \times \frac{\partial LR}{\partial B} \right) + \left(\frac{\partial S}{\partial TX} \times \frac{\partial TX}{\partial B} \right) > \text{ or } < 0, \tag{2}$$

where

$$\frac{\partial AE}{\partial B} > 0, \quad \frac{\partial LR}{\partial B} > 0, \quad \frac{\partial TX}{\partial B} > 0.$$

An increase in the money supply would cause the stock market index to rise or decline due to the liquidity effect, the output effect, portfolio adjustment, and inflationary expectations (Abdullah, Hayworth 1993; Mukherjee, Naka 1995; Cheung, Ng 1998; Ratanapakorn, Sharma 2007; Humpe, Macmillan 2009). In order to test a potential nonlinear relationship between the stock market index and the money supply, the following equation is considered:

$$S = f(Y, B, M, M^2, R, E, \pi^e, S^*, R^*). \tag{3}$$

The critical value for M that maximizes the stock market index can be derived from the first-order condition:

$$\frac{\partial S}{\partial M} = \beta_3 + 2\beta_4 M = 0, \tag{4}$$

where

$$\bar{M} = -\frac{\beta_3}{2\beta_4},$$

where β_3 and β_4 are the respective coefficients of M and M^2 in equation (3), $\beta_3 > 0$, and $\beta_4 < 0$.

Currency appreciation is expected to result in the financial and economic effects. A stronger currency would increase international capital inflows (CF), hurt exports (XP),

reduce import costs (IM), and reduce domestic prices (PR). Therefore, the net impact of currency appreciation is unclear:

$$\frac{\partial S}{\partial E} = \left(\frac{\partial S}{\partial CF} \times \frac{\partial CF}{\partial E} \right) + \left(\frac{\partial S}{\partial XP} \times \frac{\partial XP}{\partial E} \right) + \left(\frac{\partial S}{\partial IM} \times \frac{\partial IM}{\partial E} \right) + \left(\frac{\partial S}{\partial PR} \times \frac{\partial PR}{\partial E} \right) > \text{ or } < 0, \quad (5)$$

where

$$\frac{\partial CF}{\partial E} > 0, \quad \frac{\partial XP}{\partial E} < 0, \quad \frac{\partial IM}{\partial E} < 0, \quad \frac{\partial PR}{\partial E} < 0.$$

A higher foreign interest rate tends to make the foreign assets more attractive, reduce international capital inflows to Poland, and reduce the demand for stocks. On the other hand, a higher foreign interest rate could cause the foreign currency to appreciate and reduce the competitiveness of the foreign country.

4. Empirical results

The source of the data came from the *International Financial Statistics*, which is published by the International Monetary Fund. S is represented by the share price index with 2005 as the base year. Y is represented by industrial production index with 2005 as the base year. M is measured by the M2/GDP ratio. We expect that M2 tends to accommodate the increase in GDP. If the M2/GDP ratio rises beyond a certain level, it may signal too much money supply relative to GDP, resulting in potential inflationary pressures that would reduce the stock market index. R is represented by the Treasury bill rate minus the expected inflation rate, which is the average inflation rate of the past four quarters. To be consistent with Grambovas (2003) and Samitas and Kenourgios (2007), S* is represented by the German share price index with 2005 as the base year. R* is measured by the government bond yield in the euro area. Because Poland has been joining the EU since 2004, the selection of the government bond yield in the euro area is appropriate. Except for the real Treasury bill rate and the expected inflation rate with negative values, other variables are measured by the logarithmic scale. The quarterly sample runs from 2000.Q1 to 2010.Q2. The data for the government bond yield in the euro area before 2000.Q1 are not available.

Figure 1 describes monthly movements in the Polish stock market index (2005 = 100) during 2007–2009. As shown, it reached the highest value in July 2007 and the lowest value in February 2009. Empirical results for equation (2) are presented in Table 1. Figures in the parenthesis are z-statistic for testing the significance of estimated coefficients. In Version I, the GARCH and ARCH model are considered. The ARCH model is selected because the error variance is found to be a function of the lagged squared error. As shown, 96.3% of the variation in the stock market index can be explained by the nine right-hand side variables. Except that the coefficient of the real Treasury bill rate is significant at the 10% level, other coefficients are significant at the 1% level. The stock market index has a positive relationship with industrial production and the German stock market index, a negative relationship with the government borrowing/GDP ratio, the real Treasury bill rate, the nominal effective exchange rate, the expected

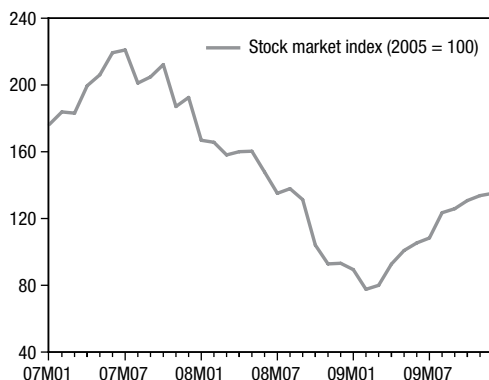


Fig. 1. The stock market index in Poland: 2007.M1–2009.M12

Table 1. Estimated regressions of Poland’s stock market index

	I	II	III
Industrial production	1.823 (16.581)		1.566 (22.419)
Real GDP		1.627 (12.160)	
Government borrowing/GDP ratio	-0.012 (-3.343)	-0.023 (-5.348)	-0.007 (-2.971)
M2/GDP ratio	28.128 (181.734)	25.685 (5.223)	19.413 (6.314)
(M2/GDP ratio) ²	-3.724 (-445.525)	-3.297 (-5.041)	-2.513 (-6.235)
Real Treasury bill rate	-0.004 (-1.855)	-0.006 (-3.111)	-0.006 (-3.719)
Nominal effective exchange rate	-0.441 (-3.007)	-0.525 (-2.791)	-0.446 (-3.500)
Expected inflation rate	-0.128 (-3.868)	-0.247 (-7.622)	-0.171 (-8.847)
German stock market index	0.704 (11.128)	0.965 (18.324)	0.429 (6.641)
U.S. stock market index			0.780 (6.714)
Euro area government bond yield	-0.210 (-2.947)	-0.498 (-7.004)	-0.117 (-2.073)
Constant	-57.716 (-81.427)	-53.964(-5.984)	-43.228(-7.556)
Variance equation			
RESID(-1) ²	0.318 (1.985)	1.013 (3.292)	1.095 (3.476)
RESID(-2) ²	-0.198 (-2.089)		
GARCH(-1)		-0.572 (-5.950)	
Constant	0.004 (3.743)	0.011 (3.429)	0.0009 (2.546)
Adjusted R-squared	0.963	0.904	0.967
Akaike information criterion	-1.911	-1.121	-2.184
Schwarz criterion	-1.373	-0.583	-1.646
F-statistic	90.266	33.035	102.108
Estimation method	ARCH(2)	GARCH	ARCH(1)
Sample period	2000.Q1–2010.Q2	2000.Q1–2010.Q2	2000.Q1–2010.Q2

Notes: An increase in the nominal effective exchange rate (NEER) means an appreciation of the Polish zloty. Figures in the parenthesis are z-statistics

inflation rate and the government bond yield in the euro area, and a quadratic relationship with the M2/GDP ratio.

Since the coefficients of the linear and quadratic terms for the M2/GDP ratio are significant at the 1% level, the critical value for the M2/GDP ratio that maximizes the stock market index is estimated to be 43.68%. Hence, the stock market index and the M2/GDP ratio will exhibit a positive relationship if the M2/GDP ratio is less than 43.68% and a negative relationship if the M2/GDP ratio is greater than the critical value of 43.68%.

To examine whether the above regression results may be spurious, the ADF test on the regression residuals is performed. Based on the AIC, a lag length of zero is selected. The test statistic of -4.993 is greater than the critical value of -2.623 in absolute values at the 1% level. Hence, the regression results are not spurious, and these time series variables have a long-term equilibrium relationship.

Several different versions are considered and tested. In Version II where real GDP index at the 2005 constant price replaces the industrial production index, the GARCH model is applied. Its positive coefficient of 1.627 is significant at the 1% level, and the critical value of the M2/GDP ratio is calculated to be 49.17%. The smaller value of adjusted R-squared suggests that Version I has higher explanatory power than Version II. In Version III where both the German and U.S. stock market indexes are included in the estimated regression, both positive coefficients are significant at the 1% level. The coefficients for the U.S. and German stock market indexes are estimated to be 0.780 and 0.429, respectively. Hence, if the U.S. stock market index rises 1%, Poland's stock market index will increase by 0.780%; and if the German stock market index rises 1%, Poland's stock market index will increase by 0.429%. If the PLN/USD exchange rate replaces the nominal effective exchange rate, its negative coefficient is only significant at the 10% level, suggesting that the PLN/USD exchange rate may not have a close correlation with the stock market index like the nominal effective exchange rate. To save space, some of these results are not printed here and will be available upon request.

In comparison, the results in this study are generally consistent with the findings of Hanousek and Filer (2000) that the German DAX has a positive impact, Poshakwale and Murinde (2001) that nonlinearity and conditional heteroskedasticity are found, and Horobet and Dumitrescu (2009) in the signs of real output, the money supply, and the effective exchange rate, but they are different from Grambovas (2003) that appreciation of a currency has a positive impact on a country's stock market index, Samitas and Kenourgios (2007) that the German factor is more important than the U.S. global factor, Yartey (2008) that the real interest rate and the inflation rate are insignificant, and Horobet and Dumitrescu (2009) in the sign of the CPI and the real interest rate. This paper has made an additional contribution by testing or incorporating the quadratic relationship between the stock market index and the M2/GDP ratio, the government bond yield in the euro area, the U.S. stock market index, and other related macroeconomic variables in the estimated regression.

5. Summary and conclusions

This paper has examined the macroeconomic determinants of Poland's stock market index based on quarterly sample during 2000.Q1–2010.Q2. The GARCH or ARCH model is employed in empirical estimation. More industrial production or real GDP, a lower government borrowing/GDP ratio, a lower real Treasury bill rate, currency depreciation, a lower expected inflation rate, a higher German or U.S. stock market index, or a lower government bond yield in the euro area would increase Poland's stock market index. The stock market index and the M2/GDP ratio exhibit a positive (negative) relationship if the M2/GDP ratio is less (greater) than the critical value of 43.68% when industrial production is used.

There are several policy implications. To maintain a robust stock market, the authorities need to promote economic growth, pursue fiscal discipline, and keep a relatively low interest rate and expected inflation rate. In conducting monetary policy, the central bank needs to be aware of the significant quadratic relationship between the stock market index and the M2/GDP ratio. A higher M2/GDP ratio initially causes a positive impact on the stock market index due to the output effect, liquidity effect or portfolio adjustment. However, if the ratio continues to rise beyond a certain critical level, its impact will become negative because of inflationary expectations. Although the nominal effective exchange rate has a negative impact on the stock market index during the sample period, it may be possible to yield a positive impact on the stock market index in the future because the positive effects of increased international capital inflows and reduced import costs and prices may dominate the negative effect of decreased exports.

References

- Abdullah, D. A.; Hayworth, S. C. 1993. Macroeconometrics of stock price fluctuations, *Quarterly Journal of Business and Economics* 32: 50–67.
- Ajayi, R. A.; Mougoue, M. 1996. On the dynamic relation between stock prices and exchange rates, *Journal of Financial Research* 19: 193–207.
- Aktan, B.; Korsakiene, R.; Smaliukiene, R. 2010. Time-varying volatility modelling of Baltic stock markets, *Journal of Business Economics and Management* 11: 511–532. <http://dx.doi.org/10.3846/jbem.2010.25>
- Bulmash, T. G.; Trivoli, G. W. 1991. Time-lagged interactions between stock prices and selected economic variables, *The Journal of Portfolio Management* 17: 61–67. <http://dx.doi.org/10.3905/jpm.1991.409351>
- Chen, N.; Roll, R.; Ross, S. A. 1986. Economic forces and the stock market, *Journal of Business* 59: 383–403. <http://dx.doi.org/10.1086/296344>
- Cheung, Y. W.; Ng, L. K. 1998. International evidence on the stock market and aggregate economic activity, *Journal of Empirical Finance* 5: 281–296. [http://dx.doi.org/10.1016/S0927-5398\(97\)00025-X](http://dx.doi.org/10.1016/S0927-5398(97)00025-X)
- Darrat, A. F. 1990a. Stock returns, money and fiscal deficits, *Journal of Financial and Quantitative Analysis* 25: 387–398. <http://dx.doi.org/10.2307/2330703>
- Darrat, A. F. 1990b. The impact of federal debt upon stock prices in the United States, *Journal of Post Keynesian Economics* 12: 375–389.

- Fama, E. F. 1981. Stock returns, real activity, inflation and money, *American Economic Review* 71: 545–565.
- Fama, E. F. 1990. Stock returns, expected returns, and real activity, *Journal of Finance* 45: 1089–1108. <http://dx.doi.org/10.2307/2328716>
- Fama, E. F.; French, K. R. 1989. Business conditions and expected returns on stocks and bonds, *Journal of Financial Economics* 25: 23–49. [http://dx.doi.org/10.1016/0304-405X\(89\)90095-0](http://dx.doi.org/10.1016/0304-405X(89)90095-0)
- Grambovas, C. A. 2003. Exchange rate volatility and equity markets, *Eastern European Economics* 41: 24–48.
- Hanousek, J.; Filer, R. K. 2000. The relationship between economic factors and equity markets in Central Europe, *Economics of Transition* 8: 623–638. <http://dx.doi.org/10.1111/1468-0351.00058>
- Horobet, A.; Dumitrescu, S. 2009. On the causal relationships between monetary, financial and real macroeconomic variables: evidence from Central and Eastern Europe, *Economic Computation and Economic Cybernetics Studies and Research* 43: 1–17.
- Humpe, A.; Macmillan, P. 2009. Can macroeconomic variables explain long-term stock market movements? A comparison of the US and Japan, *Applied Financial Economics* 19: 111–119. <http://dx.doi.org/10.1080/09603100701748956>
- Kim, K. 2003. Dollar exchange rate and stock price: evidence from multivariate cointegration and error correction model, *Review of Financial Economics* 12: 301–313. [http://dx.doi.org/10.1016/S1058-3300\(03\)00026-0](http://dx.doi.org/10.1016/S1058-3300(03)00026-0)
- Morales, L. 2008. Volatility spillovers between stock returns and foreign exchange rates: evidence from four eastern European countries, in *Conference Proceedings Paper presented to the Financial Management Association (FMA) European Conference, June 4–6, 2008, Prague, Czech Republic*.
- Mukherjee, T. K.; Naka, A. 1995. Dynamic relations between macroeconomic variables and the Japanese stock market: an application of a vector error correction model, *The Journal of Financial Research* 18: 223–237.
- Nieh, C.-C.; Lee, C.-F. 2001. Dynamic relationship between stock prices and exchange rates for G-7 countries, *Quarterly Review of Economics and Finance* 41: 477–490. [http://dx.doi.org/10.1016/S1062-9769\(01\)00085-0](http://dx.doi.org/10.1016/S1062-9769(01)00085-0)
- Poshakwale, S.; Murinde, V. 2001. Modelling the volatility in east European emerging stock markets: evidence on Hungary and Poland, *Applied Financial Economics* 11: 445–456. <http://dx.doi.org/10.1080/096031001300314009>
- Ratanapakorn, O.; Sharma, C. 2007. Dynamic analysis between the US stock returns and the macroeconomic variables, *Applied Financial Economics* 17: 369–337. <http://dx.doi.org/10.1080/09603100600638944>
- Samitas, A. G.; Kenourgios, D. F. 2007. Macroeconomic factors' influence on 'new' European countries' stock returns: the case of four transition economies, *International Journal of Financial Services Management* 2: 34–49. <http://dx.doi.org/10.1504/IJFSM.2007.011670>
- Syllignakis, M. N.; Kouretas, G. P. 2006. Long and short-run linkages in CEE stock markets: implications for portfolio diversification and stock market integration, *Working Paper* (July): 1–33.
- Teresienė, D. 2009. Lithuanian stock market analysis using a set of GARCH models, *Journal of Business Economics and Management* 10: 349–360. <http://dx.doi.org/10.3846/1611-1699.2009.10.349-360>
- Wang, P.; Moore, T. 2008. Stock market integration for the transition economies: time-varying conditional correlation approach, *The Manchester School* 76(Supplement s1): 116–133.
- Yartey, C. A. 2008. The determinants of stock market development in emerging economies: is South Africa different? *IMF Working Paper*.

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