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EQUITY MARKET REACTION TO SHARP PRICE CHANGES: EVIDENCE FROM POLAND

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Abstract

We examine investors' reaction to sharp price changes using two equity market indices in Poland: WIG and WIG20. Using daily market returns for the two indices from April 1991 and April 1994 to November 2012, we identify the event days as the days where market indices exhibited positive or negative daily price changes of 3 percent or more as well as two and three standard deviations from the mean of the market returns. By following the market behaviour through price trend for 30 days after the event days, two conclusions can be reached: (a) The arrival of unexpected news that cause sharp price changes impacts volatility of market indices, and (b) the subsequent price adjustments after the initial sharp price changes take an upward corrective pattern only after the initial negative price changes, but not after positive price changes.

Keywords: Poland's equity markets; overreaction and under-reaction; market efficiency

JEL classification: G14; G15

1. INTRODUCTION

The sustained economic development of the emerging economies requires a gradual development of financial markets and regulations overseen the financial markets. Since early 1990s, the countries in Central and Eastern Europe (CEE) have seen a rapid economic growth compared with other developed countries in the region. Along with this economic growth, the financial markets and the banking system of these countries have been instrumental in providing funds and liquidity to the economy and have also experienced a significant growth. As financial markets in the CEE countries are less developed compared with other advanced economies, the banking system has been playing a major role in supplying funds and liquidity into the economy¹. However, the sustained long-term economic growth of these countries will depend on further improvement of their financial markets. Developed financial markets of the emerging countries would also provide non-domestic investors an opportunity to diversify their portfolio through international diversification.

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Among the CEE countries, since 1991 transition to market economy, the economic growth of Poland has been impressive. Poland has been one of the fastest growing economies in Europe in the past two decades. One of the major contributors to this economic growth has been the numerous regulatory measures taken by policy makers to improve efficiency of financial system². Like other CEE countries, the primary and secondary financial markets (both for debt and equity markets) in Poland are small and are not well developed, and the banking system is still the major provider of funds to the economy. However, capital markets can be a major source of capital for economic development in future.

The equity market in Poland started in April 1991 and has been growing since then both in terms of volume and market capitalization³. The growth of equity markets accelerated since 1994, after the introduction of mass privatization of public institutions and with the passage of accounting regulations that required Polish companies listed in equity markets to comply with uniform accounting principles based on the international standards. In this study we contribute to the existing research on development of equity markets in emerging markets by examining the reaction of equity market participants to market shocks that resulted in sharp price changes in equity indices. The remainder of this paper is organized as follows: In the next section we provide a brief summary of existing research on the reaction of investors to sharp price changes in equity markets in different countries. [Section 3](#) briefly presents new developments in financial markets in Poland. [Section 4](#) describes the methodology and data. [Section 5](#) provides the results and [Section 6](#) concludes the paper.

2. LITERATURE REVIEW

The research on investors' overreaction to sharp price changes started after publication of the seminal paper by [DeBondt and Thaler \(1985, 1987\)](#) who argued that investors initially overreact to market news by setting equity prices higher (lower) than their fundamental values after the announcement of good (bad) news which leads to subsequent price reversal. There have been numerous studies examining the investors' reaction to sharp price changes using equity indices from developed countries of Europe and USA⁴. Equity markets of emerging economies in Europe and Asia have also been subject of numerous studies⁵. The results from the above studies are not conclusive, but generally indicate that there is a price reversal in equity markets after sharp price changes which in turn supports contrarian hypothesis that recommends purchasing a losing stock and selling a winning stock in order to earn an abnormal profit.

The results obtained and the conclusions reached from the studies on US and advanced European markets as well as the studies from other emerging economies may not be appropriate for the case of Polish equity market because of the differences in degree of market development and the unique characteristics of each equity market and its participants. Although there are some studies which examine different characteristics of equity markets in Poland, we are aware of only one published study on the reaction of equity market participants to sharp price changes in equity indices in five CEE countries including Poland, namely [Stoica et al. \(2013\)](#). [Nivet \(1997\)](#) studies the efficiency of Poland equity market using daily return of WIG index for the period of 1991-94. He shows that the stock market returns do not follow a random walk, and concludes that Polish equity market is not efficient in its weak form⁶. The same conclusion is also made by [Gilmore and McManus \(2003\)](#), who used daily returns of Polish equity indices for the period of July 1999 through September 2000 and applied both univariate and multivariate tests. [Rockinger and Urga \(2000\)](#) evaluated the market efficiency

of several Central European equity indexes, including Poland, over the period of April 1994 through June 1999. Using daily returns, they reported that Hungarian equity markets satisfy the weak-form efficiency, while the Czech and Polish equity markets are not efficient although moving towards efficiency. [Worthington and Higgs \(2004\)](#) test the random walk hypothesis for both developed and emerging countries (Czech Republic, Hungary, Poland, and Russia). Using unit root test, univariate and multivariate variance ratio tests, they report that among emerging markets, only the Hungarian market shows evidence of a random walk and hence is a weak-form efficient. More recently, [Stoica et al. \(2013\)](#) study the investors' reaction to the arrival of unexpected information in five CEE countries (Bulgaria, Czech Republic, Hungary, Poland, and Romania) pre and post 2008 financial crisis. They conclude that except for Czech Republic, investors in other CEE markets overreact to positive sharp price changes and underreact to negative sharp price changes. They suggest the contrarian strategy of taking a short position following a positive sharp price change and a long position following negative sharp price changes. To contribute to better understanding of reaction of investors to sharp price changes, in this paper we examine the reaction of equity market participants to sharp price changes in the two major equity indices in Poland, WIG, and WIG20.

3. RECENT DEVELOPMENT IN FINANCIAL MARKETS IN POLAND

One of the challenges faced by transition economies is developing their financial system conducive to a sustainable growth of their economies. In the wake of the Soviet Union breakdown in 1989, the post-socialist Poland was challenged with inevitability of creating new political and financial systems. Since 1992, after tackling a post-transition recession and hyperinflation, Poland has managed a positive yearly GDP growth rate of ranging from 1% to 7%⁷. Over the last five years, Polish GDP growth rate has been one of the top five among 27 European Union countries. Moreover, while the global economic crisis in 2008 and 2009 has slowed down the economic activity in Europe and pushed many European economies in recession, Poland was the only European Union country that generated a positive 1.6% growth rate in 2009 and thus avoided recession. Currently, Polish economy with a GDP of \$488 billion in 2012, is tenth largest in Europe and twenty-fourth largest in the world, and has the S&P rating of A.

Transition to market economy in Poland started with privatization of government owned institutions accompanied with Foreign Direct Investment (FDI), which granted foreign investors the right to invest in joint ventures and purchase shares of Polish state owned enterprises⁸. Establishment of an independent central bank, the National Bank of Poland (NBP) in 1989, and Warsaw Stock Exchange (WSE) in 1991 had a profound impact on initiating and developing a new financial system to promote competitive market economy. The NBP has played a major role in assuring the stability of banking system and thereby ensuring domestic financial stability. At the same time, reviving the Warsaw Stock Exchange (WSE) in 1991 not only facilitated privatization process of government owned enterprises by providing liquidity to the shares of newly listed companies, but it also contributed to the efficient flow of FDI, as well as ensured faster integration of Polish markets with its international counterparts⁹. Along with transition reforms, Polish government initiated a process of integrating its economy and domestic financial markets with that of its European and international counterparts, through accession to different international economic organizations such as: European Community (EC) in 1989¹⁰, World Trade Organization (WTO) in 1995, the Organization for Economic Cooperation and Development (OECD) in 1996, and the European

Union (EU) in 2004. The commitment to openness and the enforcement of the reforms as a condition for joining these international organizations elevated Polish regulatory and market environment to be in line with those of advanced European countries. As a result, Poland has been considered a pioneer among the CEE countries in stabilizing economy, attracting foreign investment and leading in the development of financial system.

As in other emerging economies experiencing economic growth, the role of financial system in overall growth of economy becomes more important as evidenced by the increasing ratio of financial assets to GDP¹¹. However, in Poland, where the banking system has the largest share of the market (69.5% in 2012), financial institutions are still the major providers of funds to the economy¹².

The Polish financial market has its origins in the 19th century, when bills, bonds and shares were traded at the Warsaw Mercantile Exchange until the start of the World War II in 1939. The exchange remained closed for over fifty years during which the communist party imposed the centralized command economy. The current financial market in Poland consists of equity, bond, money, foreign exchange, and derivatives markets. However, except for the equity market, the other financial markets are at their early stage of development. Following the implementation of necessary regulations and institutional reforms, a modern WSE was established on April 12, 1991. On the first trading session of WSE on April 16, 1991, trading started on the Main List with five listed companies and market turnover value of \$ 2,000. Since then, Polish stock exchange has grown into the largest in the CEE region with four different markets and twenty six indices¹³. The WSE Main List remains a primary market with \$ 237.6 billion capitalization and 438 listed companies traded either on main or parallel market in 2012, where companies with a free float less than 10% and €1 million are listed on parallel market. The average value of equities trading on the Main List was \$ 263.7 million with 46,388 transactions per session and with an average value of \$ 5,684 per transaction. WIG and WIG20 are the major indices in terms of volume and value of transactions. All companies listed on the main market – 354 in 2012 – are covered by the total return index WIG while twenty largest blue-chip stocks constitute the price index WIG20¹⁴. The trading value of WIG20 companies represent 80% of total value of the Main List, which makes WIG20 a good proxy for the performance of the whole equity market.

The market value of top ten constituents in WIG and WIG20 accounted for 59 and 84 percent of portfolio respectively in 2012. Furthermore, the market value of companies in WIG and WIG20 was 96 and 47 percent of the WSE Main List total capitalization. The largest domestic company in both indices had a market value of \$14.9 billion, while the smallest one had a value of \$ 2.9 million in WIG and \$425.8 million in WIG20. Although foreign companies constituted 11% of WIG index and 5% of WIG20 index, their cumulative market value accounted for 29% of WSE Main List capitalization. The market cap of the largest foreign company was \$ 29.4 billion and the smallest – \$ 10.6 million.

4. DATA AND RESEARCH METHOD

4.1. Data

In this study, we focus our attention on investors' reaction to sharp price movements in market indices rather than on individual stocks¹⁵. We use daily closing values of the two major stock market indices in Poland: WIG and WIG20. Our sample consists of daily closing values of the two indices from the date of inception – April 1991 for WIG and April

1994 for WIG – to November 2012. [Figure 1](#) shows the trend of the two indices and [Figure 2](#) illustrates their returns.

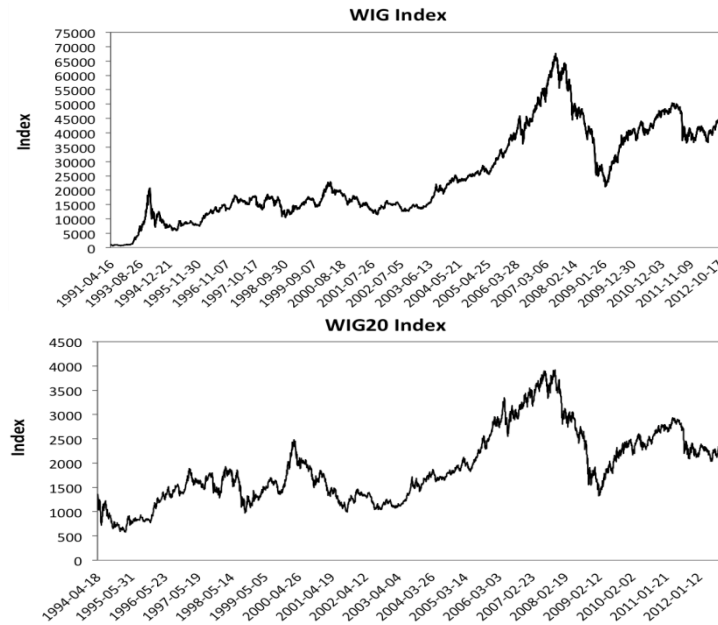


Figure no. 1 – Warsaw Stock Exchange indices

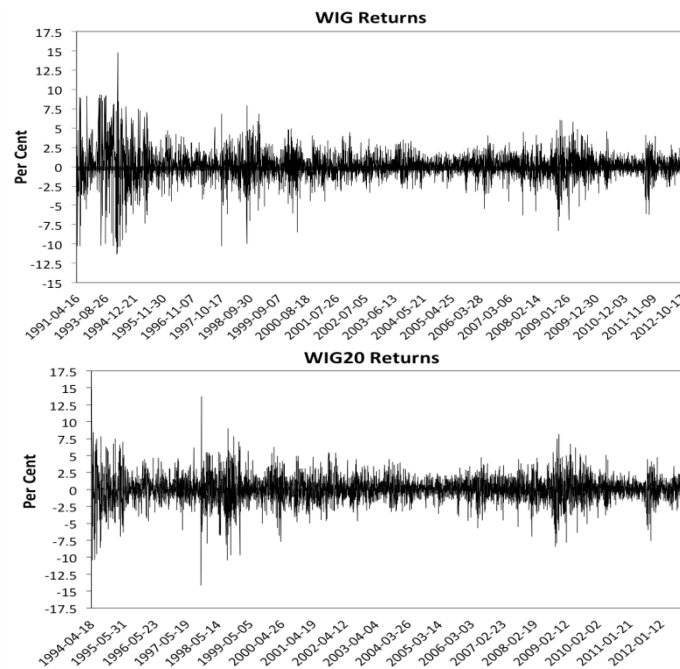


Figure no. 2 – Warsaw Stock Exchange returns

As it is evident from Figure 1, after a long relatively stagnant period from the date of inception until the end of 2002, the value of both indices sharply increased and reached their peaks in the second half of year 2008. Due to global financial crises, the equity indexes in Poland, like other equity markets in the world, took a sharp downturn until the first half of 2009. However, the decline in equity indices of Poland was not as severe as equity indices in developed and other emerging economies. Starting the second half of 2009, the indices then resumed an upward trend but so far have not reached their pre financial crises levels. The distinctive feature of variability of return of the WIG and WIG 20 can be seen from Figure 2. There is a high volatility of returns for both indices before the middle of 1999. Following this, the variability of returns subdued until the last global financial crises of 2008, when the volatility again increased and this high volatility persisted until 2010. Similar pattern of variability of returns can be seen from Figure 1 for both indices. Table 1 presents the summary statistics for two major indices in Poland compared with indices in other CEE countries. The average daily returns of WIG are the highest among its peers followed by BET Romanian. However, BUX Hungary and PX Czech Republic have the highest range of daily returns. In terms of variability measured by standard deviation of return, WIG has the highest standard deviation of return followed by WIG20 index. The striking observation is when we compare the average daily return and risk of the two indices in Poland. The average daily return of WIG is four times that of WIG20 (0.08% versus 0.02%). At the same time volatility of returns measured by standard deviation is almost the same, but the range of return of the WIG20 is slightly higher than the range of returns offered by WIG (29.00% versus 26.12%). This preliminary observation indicates that, on average, the WIG20 index provides a better investment opportunity than WIG since investors can earn higher returns by investing in WIG20 as compared to WIG for the same amount of risk.

Table no. 1 – Summary statistics for market indices of the Central and Eastern Europe (CEE) countries

Index	Days	Mean Return (in %)	STD (in %)	Max (in %)	Min (in %)
WIG Poland	4,954	0.08	1.97	14.78	-11.34
WIG 20 Poland	4,622	0.02	1.95	14.84	-14.16
PX Czech Republic	4,656	0.02	1.53	15.39	-16.19
BUX Hungary	3,909	0.03	1.86	13.62	-18.03
BET Romania	3,794	0.04	1.83	10.56	-13.12
SAX Slovakia	4,243	0.00	1.30	11.88	-14.81

4.2. Research Method

We calculate the daily returns of the WIG and WIG20 equity market indices using equation (1) as follows:

$$R_{it} = \ln (I_{it} / I_{it-1}) \times 100 \quad (1)$$

where R_{it} is the daily return of stock index i on day t , I_{it} and I_{it-1} are the closing values of stock index i on days t and $t-1$ respectively, i represents the WIG and WIG20 indices used in this study, and \ln is a natural logarithm¹⁶.

The next step in our analysis is to identify event days. We select a set of event days that are represented by large price changes in the WIG and WIG20 indices. Researchers have used different ranges of price changes to identify the event days for large price shocks¹⁷. In this study, we apply three measures of large price changes: positive and negative daily price changes of 3 percent or more; two standard deviations from the mean of market returns; and three standard deviations from the mean of market returns. Therefore, overall there are six measures of sharp price change in this study: three positive and three negative¹⁸. If the percentage changes in the value of the indices are equal to or more than the predefined sharp price change ranges, then that day is labelled as an event day. The event days are labelled “positive (negative)” if the news was favourable (unfavourable) and percentage change in indices values were greater (less) than or equal to each of the above defined three thresholds. As time passes and investors thoroughly analyse the importance and magnitude of the news, their initial reaction to the news may be revised upward or downward depending on their realization of the news. There are two contrary opinions explaining the secondary reaction of investors to sharp price changes initiated by news. Based on [DeBondt and Thaler \(1985\)](#), investors initially overreact to the announcement of both positive and negative news on the event days, and later on as they correct their overreaction, market would take a reversal trend. Contrary to the above, [Brown, Harlow and Tinic \(1988 and 1993\)](#), argue that the dissemination of news (both good and bad) increases market volatility and induces investors to set equity prices below their fundamental values. As more information about the event day news becomes available, investors would correct their initial reactions and the subsequent price trend is expected to be upward for both positive and negative news event days. The overreaction of investors relates to the negative changes only while the under-reaction to the positive changes.

Subsequent to the identification of the event days, is the selection of the event windows. The event window is a period of time in days during which changes in price are to be analysed. We use thirty-day window to track the daily price movement of indices after each of the positive and negative event days¹⁹. We believe that a longer window is more appropriate in the study of emerging markets because of slower pace of information flow in these markets, such that the investors require a longer time to correct their initial overreaction. After identifying the event days and selecting thirty-day trading window, we eliminated those event days that were followed by another event day within the defined trading window of the previous event day. Of course, this step reduced the number of observations to be used in the remaining part of the study. More importantly, however, it eliminated a distorting effect of the overlapping trading windows and minimized a bias with respect to the initial price shock²⁰. [Table 2](#) provides the number of event days for the WIG and WIG20 for the three defined price change thresholds used in this study. We also provide the remaining event days after dropping the event days that fell within the thirty-day trading window after an initial price shock.

Table no. 2 – Number of event days for the three measures of sharp price changes

	Measures of Price Changes		+/-3%	Mean	Mean	Total
				+/-2 STD	+/-3 STD	
Warsaw Stock Exchange WIG	Number of event days	Positive	240	136	56	432
		Negative	218	120	50	388
		Total	458	256	106	820
	Remaining event days	Positive	20	17	6	43
		Negative	11	9	10	30
		Total	31	26	16	73
Warsaw Stock Exchange WIG20	Number of event days	Positive	249	128	26	403
		Negative	239	129	41	409
		Total	488	257	67	812
	Remaining event days	Positive	18	22	7	47
		Negative	12	12	12	36
		Total	30	34	19	83

As is evident from Table 2, the total number of event days identified for the two equity indices and three measures of price changes is 1,632 days; 820 event days for WIG (of which 432 event day are positive event days, and 388 days are negative event days), and 812 event days for WIG20 (of which 403 days are positive event days and 409 event days are negative event days). Therefore the total number of positive event days is 835 (432 event days for WIG and 403 event days for WIG20), and total number of negative event days is 797 (388 negative event days for WIG and 409 negative event days for WIG20). Table 2 provides a detailed distribution of positive and negative event days for each of the equity indices for the three measures of price changes. As explained above, to avoid any double counting effects, for each index, we drop the event days that occur within thirty days of the previous price shock. Table 2 also provides information on the remaining event days for each index and the three measures of price changes after eliminating the subsequent price changes within the overlapping thirty-day trading window. For the WIG index (WIG20 index), there are 73 (83) remaining event days, of which 43 (47) represent positive event days and the remaining 30 (36) represent negative event days. The list of the remaining event days used in this study for further analysis with the corresponding price changes is provided in Panels A and B of Table 3.

Table no. 3 – Event days and corresponding price changes (in %)

Panel A: Warsaw Stock Exchange WIG						
Date	Positive corresponding price changes			Negative corresponding price changes		
	+ 3%	Mean + 2 STD	Mean + 3 STD	- 3%	Mean - 2 STD	Mean - 3 STD
1991-12-17	---	---	---	---	---	-7.6622
1992-01-07	---	5.8940	---	---	---	---
1992-07-07	---	---	8.3831	---	---	---
1992-12-03	4.4675	4.4675	---	---	---	---
1994-09-13	---	---	---	---	---	-7.5298
1994-12-12	---	---	5.9975	---	---	---
1995-02-24	---	---	7.2627	---	---	---
1995-05-30	---	---	---	---	---	-6.2617
1995-06-05	---	4.9274	---	---	---	---

Panel A: Warsaw Stock Exchange WIG						
Date	Positive corresponding price changes			Negative corresponding price changes		
	+ 3%	Mean + 2 STD	Mean + 3 STD	- 3%	Mean - 2 STD	Mean - 3 STD
1995-07-17	3.2815	---	---	---	---	---
1995-11-20	---	---	---	---	-3.8751	---
1996-03-11	---	---	---	-4.4740	-4.4740	---
1996-05-07	---	4.2382	---	---	---	---
1996-08-05	3.8716	---	---	---	---	---
1996-11-06	3.0626	---	---	---	---	---
1997-03-14	---	---	---	---	-4.2684	---
1997-04-02	---	---	---	-3.1978	---	---
1997-08-08	---	5.0748	---	---	---	---
1997-08-11	3.2174	---	---	---	---	---
1997-10-29	---	---	6.8323	---	---	---
1998-01-12	---	---	---	---	---	-6.1407
1998-02-09	---	4.1279	---	---	---	---
1998-03-10	3.5410	---	---	---	---	---
1998-10-01	---	---	---	---	---	-6.9817
1999-01-18	---	---	6.8039	---	---	---
1999-01-29	4.2787	---	---	---	---	---
1999-01-29	---	4.2787	---	---	---	---
1999-03-24	---	---	---	-5.1692	-5.1692	---
1999-09-15	---	---	---	-3.5810	---	---
2000-02-28	---	---	---	---	-6.0259	-6.0259
2000-04-17	---	---	---	---	---	-8.4678
2000-05-24	---	---	---	---	-4.1148	---
2000-05-30	3.3630	---	---	---	---	---
2000-10-16	---	4.0400	---	---	---	---
2000-11-13	---	---	---	-3.2829	---	---
2001-03-12	---	---	---	---	-4.5160	---
2001-04-18	3.3651	---	---	---	---	---
2001-11-13	3.0927	---	---	---	---	---
2002-01-03	---	4.4220	---	---	---	---
2002-01-09	3.9973	---	---	---	---	---
2002-05-16	3.1627	---	---	---	---	---
2002-09-03	---	---	---	-3.3562	---	---
2003-10-06	3.5059	---	---	---	---	---
2004-01-05	3.3174	---	---	---	---	---
2005-10-13	---	---	---	-3.3990	---	---
2006-02-28	---	---	---	-3.0893	---	---
2006-06-27	---	4.0553	---	---	---	---
2006-07-27	3.0134	---	---	---	---	---
2007-02-27	---	---	---	---	-4.4968	---
2007-03-08	3.1480	---	---	---	---	---
2007-08-16	---	---	---	---	---	-6.3059
2007-08-22	---	4.4638	---	---	---	---
2007-09-19	3.2378	---	---	---	---	---
2007-11-15	---	---	---	-3.1578	---	---
2008-01-24	---	4.0961	---	---	---	---

Panel A: Warsaw Stock Exchange WIG						
Date	Positive corresponding price changes			Negative corresponding price changes		
	+ 3%	Mean + 2 STD	Mean + 3 STD	- 3%	Mean - 2 STD	Mean - 3 STD
2008-03-18	3.0659	---	---	---	---	---
2008-11-24	---	6.0204	6.0204	---	---	---
2009-02-17	---	---	---	---	---	-6.8813
2009-04-08	---	4.4577	---	---	---	---
2009-07-14	---	4.1246	---	---	---	---
2009-09-22	---	4.1082	---	---	---	---
2009-10-02	---	---	---	-3.0434	---	---
2010-02-05	---	---	---	-3.3469	---	---
2010-05-10	---	4.5794	---	---	---	---
2010-05-26	3.6182	---	---	---	---	---
2011-09-22	---	---	---	---	-6.2436	-6.2436
2011-11-30	3.9903	---	---	---	---	---
Total Observations	20	17	6	11	9	10

Panel B: Warsaw Stock Exchange WIG20						
Date	Positive corresponding price changes			Negative corresponding price changes		
	+ 3%	Mean + 2 STD	Mean + 3 STD	- 3%	Mean - 2 STD	Mean - 3 STD
1994-09-13	---	---	---	---	---	-7.6535
1994-12-08	---	---	---	---	---	-5.8462
1995-02-24	---	---	7.5072	---	---	---
1995-05-30	---	---	---	---	---	-6.3261
1995-06-05	---	5.0536	---	---	---	---
1995-07-18	3.0159	---	---	---	---	---
1995-11-20	---	---	---	---	-3.9917	---
1996-03-11	---	---	---	-4.6706	-4.6706	---
1996-05-07	---	4.6565	---	---	---	---
1996-08-05	4.0993	4.0993	---	---	---	---
1996-11-06	3.0445	---	---	---	---	---
1997-02-13	---	4.2028	---	---	---	---
1997-04-01	---	---	---	-6.0018	-6.0018	-6.0018
1997-08-07	---	---	6.2006	---	---	---
1997-08-08	---	4.1283	---	---	---	---
1997-09-03	3.0361	---	---	---	---	---
1997-11-12	---	---	---	---	---	-6.2441
1998-01-12	---	---	---	---	---	-8.0061
1998-03-09	---	5.0722	---	---	---	---
1998-06-15	---	---	---	---	---	-6.8408
1998-11-02	---	---	7.8194	---	---	---
1999-01-18	---	6.2809	6.2809	---	---	---
1999-01-22	---	---	---	-3.2277	---	---
1999-04-19	---	5.7201	---	---	---	---
1999-04-20	---	---	---	-3.1738	---	---
1999-06-11	4.3260	4.3260	---	---	---	---
1999-09-24	---	---	---	---	-5.0074	---

Panel B: Warsaw Stock Exchange WIG20						
Date	Positive corresponding price changes			Negative corresponding price changes		
	+ 3%	Mean + 2 STD	Mean + 3 STD	- 3%	Mean - 2 STD	Mean - 3 STD
2000-02-03	---	---	6.2461	---	---	---
2000-04-17	---	---	---	---	---	-7.7057
2000-05-16	---	4.1567	---	---	---	---
2000-06-06	---	---	---	-3.2443	---	---
2000-11-06	---	4.0870	---	---	---	---
2001-04-18	---	4.8273	---	---	---	---
2001-07-20	---	---	---	---	-4.4691	---
2001-11-14	---	3.9369	---	---	---	---
2002-01-09	---	4.6224	---	---	---	---
2002-01-22	3.4643	---	---	---	---	---
2002-05-16	4.3472	4.3472	---	---	---	---
2002-09-03	---	---	---	-4.6759	-4.6759	---
2003-01-03	3.5060	---	---	---	---	---
2003-03-10	3.4569	---	---	---	---	---
2003-07-07	3.5953	---	---	---	---	---
2003-10-06	---	4.0752	---	---	---	---
2004-01-05	---	3.9791	---	---	---	---
2004-03-01	3.0191	---	---	---	---	---
2004-04-22	---	---	---	-3.1057	---	---
2005-03-02	---	---	---	-3.5901	---	---
2005-10-13	---	---	---	---	-4.0185	---
2005-11-02	3.2183	---	---	---	---	---
2006-02-28	---	---	---	-4.1175	-4.1175	---
2006-07-13	---	---	---	---	-4.5286	---
2006-09-04	3.8357	---	---	---	---	---
2007-02-27	---	---	---	---	-4.5714	---
2007-03-08	3.5607	---	---	---	---	---
2007-08-22	---	4.4570	---	---	---	---
2007-09-19	3.8458	---	---	---	---	---
2008-01-21	---	---	---	---	---	-6.9672
2008-03-25	---	3.9956	---	---	---	---
2008-04-11	---	---	---	-3.2679	---	---
2008-11-24	---	---	8.1548	---	---	---
2009-02-17	---	---	---	---	---	-7.8215
2009-04-02	---	---	6.7226	---	---	---
2009-06-22	---	---	---	---	---	-6.4076
2009-10-02	---	---	---	---	-5.0718	---
2009-11-16	3.0433	---	---	---	---	---
2010-02-05	---	---	---	-4.0299	-4.0299	---
2010-05-26	4.3597	4.3597	---	---	---	---
2011-09-22	---	---	---	---	---	-7.5431
2011-09-27	---	4.0802	---	---	---	---
2011-11-30	4.7224	4.7224	---	---	---	---
2012-07-12	---	---	---	-3.0745	---	---
Total Observations	18	22	7	12	12	12

Before analysing the abnormal returns and cumulative abnormal return of market indices over the thirty-day post event window, we examine the volatility of stock indices. For each of the market indices and for each of three measures of large price changes, we sub-categorize the sample into: non-event days (NED)²¹, all post-event days (PED), and its subsamples of post-favourable (PFED) and post-unfavourable (PUED) event days. Using standard deviation of each of the above four subcategories, and using F-test, we test the following four null hypotheses for equality of the variance of returns as follows: NED = PED; NED = PFED; NED = PUED; PFED = PUED. In all cases, we expect the null hypotheses to be rejected. The rejection of the null hypothesis provides evidence to indicate that there is a statistically significant difference between the level of risk during non-event periods and the level of risk in the post-event periods. Table 4 provides the results of F-test for pairs of sub-categories. The equality of variance of sample pairs is rejected in all cases except for the PFED and PUED pair. Table 5 provides detailed information on the number of days, average variance of each of the above categories along with the results of F-test repeated from Table 4. It is striking to see that the variance of returns of PED (and its subcategories, PFED and PUED) is higher than the variance of NED²².

Table no. 4 – Comparative variance of returns and F-test for event days (positive and negative) for three measures of sharp price changes for the two indices

Warsaw SE	Method	F-Test			
		NED & PED	NED & PFED	NED & PUED	PFED & PUED
WIG	+ / -3%	***	***	***	
	Mean + / - 2 STD	***	***	***	
	Mean + / - 3 STD				
WIG 20	+ / -3%	***	***	***	
	Mean + / - 2 STD	***	***	***	
	Mean + / - 3 STD	***	***	***	

***, **, * indicate significance at 0.01, 0.05, and 0.1 levels, respectively.

NED – Non-Event Days

PED – Post-Event Days

PFED – Post-Favourable Event Days

PUED – Post-Unfavourable Event Days

Table no. 5 – Comparative variance of returns and F-test for event days (positive and negative) for three measures of sharp price changes for the two indices

Panel A: F-test results for +/- 3%						
Sample		No. of days	Variance (in %)	F-test Samples	F-test	
WIG	Non-Event Days (NED)	3992	4.4052	NED & PED	3.32	***
	Post-Event Days (PED)	930	1.3263	NED & PFED	3.54	***
	Post-Favourable Event Days (PFED)	600	1.2458	NED & PUED	3.03	***
	Post-Unfavourable Event Days (PUED)	330	1.4531	PFED & PUED	1.17	
WIG 20	Non-Event Days (NED)	3691	4.3121	NED & PED	3.06	***
	Post-Event Days (PED)	900	1.4073	NED & PFED	3.21	***
	Post-Favourable Event Days (PFED)	540	1.3446	NED & PUED	2.87	***
	Post-Unfavourable Event Days (PUED)	360	1.5041	PFED & PUED	1.12	

***, **, * indicate significance at 0.01, 0.05, and 0.1 levels, respectively.

Panel B: F-test results for Mean +/- 2 STD						
Sample		No. of days	Variance (in %)	F-test Samples	F-test	
WIG	Non-Event Days (NED)	4147	4.0814	NED & PED	1.89	***
	Post-Event Days (PED)	780	2.1892	NED & PFED	1.77	***
	Post-Favourable Event Days (PFED)	510	2.3093	NED & PUED	2.08	***
	Post-Unfavourable Event Days (PUED)	270	1.9659	PFED & PUED	1.17	
WIG 20	Non-Event Days (NED)	3567	4.1407	NED & PED	1.98	***
	Post-Event Days (PED)	1020	2.0898	NED & PFED	1.93	***
	Post-Favourable Event Days (PFED)	660	2.1420	NED & PUED	2.09	***
	Post-Unfavourable Event Days (PUED)	360	1.9784	PFED & PUED	1.08	

***, **, * indicate significance at 0.01, 0.05, and 0.1 levels, respectively.

Panel C: F-test results for Mean +/- 3 STD						
Sample		No. of days	Variance (in %)	F-test Samples	F-test	
WIG	Non-Event Days (NED)	4457	3.7257	NED & PED	1.02	
	Post-Event Days (PED)	480	3.8170	NED & PFED	1.08	
	Post-Favourable Event Days (PFED)	180	4.0277	NED & PUED	1.01	
	Post-Unfavourable Event Days (PUED)	300	3.6875	PFED & PUED	1.09	
WIG 20	Non-Event Days (NED)	4032	3.5027	NED & PED	1.27	***
	Post-Event Days (PED)	570	4.4643	NED & PFED	1.32	***
	Post-Favourable Event Days (PFED)	210	4.6307	NED & PUED	1.25	***
	Post-Unfavourable Event Days (PUED)	360	4.3740	PFED & PUED	1.06	

***, **, * indicate significance at 0.01, 0.05, and 0.1 levels, respectively.

To calculate the Cumulative Abnormal Returns (CARs) for windows (both positive and negative) for each of the three defined thresholds of price changes, we first calculate abnormal returns as the deviation of each return from the mean return of the non-event days for each index i on day t ($t = +1 \dots +30$) following an unexpected event d . Formally,

$$AR_{itd} = R_{itd} - \overline{R}_i \quad (2)$$

where

AR_{itd} = Abnormal return for stock index i on day t , given event d

$d = 1 \dots n$, where n represents each of the positive and negative price shocks.

R_{itd} = Return of index i on day t for event d

\overline{R}_i = Mean return of index i for non-event days.

Thus, the abnormal return AR_{itd} measures the difference between stock returns on each of the days within each window following a price shock and the mean stock return for all non-event days.

Having calculated the abnormal return (AR_{itd}) as above, we then calculate, as a second step, the mean of abnormal returns (\overline{AR}_{it}) for index i on day t as:

$$\overline{AR}_{it} = (1/n) \left(\sum_{d=1}^n AR_{itd} \right), t = +1 \dots +30 \quad (3)$$

Finally, the CARs are generated by using the following equation:

$$\begin{aligned} CAR_{i1} &= +\overline{AR}_{i1} & (4) \\ CAR_{it} &= CAR_{i(t-1)} + \overline{AR}_{it}, t = 2 \dots 30 \end{aligned}$$

We perform a standard t-test to test whether the calculated CARs are statistically different from zero. The t-statistic is obtained as:

$$t = \frac{CAR_{it}}{\left[Var(CAR_{it})\right]^{1/2}} \quad (5)$$

If the values of CARs following positive and negative price shocks are statistically significantly positive (or at least non-negative), this may indicate that the investors have under-reacted to good news and overreacted to bad news. Alternatively, if the CARs exhibit a statistically significant corrective price reversal pattern [statistically negative (positive) CARs following positive (negative) price shocks], then investors have overreacted to both good and bad news.

5. EMPIRICAL RESULTS

The results from the F-test, as presented in [Table 4](#), are used to compare the volatility of returns of post-event days and its components (positive and negative post-event days) with the variance of non-event days for the two indices and the three measures of price changes. As it is evident from [Table 4](#), for both indices and the three measures of price changes, the null hypotheses of equality of average variance of non-event days and post-event days (and its components, post-favourable event and post-unfavourable event days) are rejected at 1% level of significance. However, the null hypothesis of equality of average variance of post-favourable event days and post-unfavourable event days cannot be rejected. This indicates that the arrival of news (good and bad) changes market volatility, and the change is similar for both positive and negative news. [Table 5](#) presents the comparative variance of returns and corresponding F-test results for NED and PED (and its components, PEFD and PEUD) for the two indices and three measures of price changes. As is evident from [Table 5](#), except for the very sharp price changes (Mean +/- 3 STD), the variance of return of post-event days (and its components, PFED and PUED) is lower than the variance of non-event days. These results contradict the results reported by [Rezvanian et al. \(2011\) and 2012](#)) and [Mehdian et al. \(2004\)](#) for the equity markets in China, India, and Turkey, respectively.

To examine the subsequent reaction of investors after the initial price shocks, we used equation 4 to calculate CAR values for the subsequent 30 days for both indices. Panel A of [Table 6](#) and the corresponding graphs in Panel A of [Figure 3](#) present the CARs' trend for positive and negative price changes for the three measures of price changes for WIG market index. Similar information is provided in Panel B of [Table 5](#) and corresponding graphs in Panel B of [Figure 3](#) for WIG20 market index. As apparent from [Table 5](#) and [Figure 3](#), the price trend after a negative shock for the three price change measures follows a clear pattern of price reversal for both indices, evident from positive and increasing CAR values after the initial negative price shock. Further examination of price reversal after negative price shock reveals that, for both indices, the price reversal is stronger after a larger negative price shock. For

example, in the case of WIG20 and for the largest negative price shock of Mean - 3 STD, the CAR value increases from 0.51% in the day after price shock and reaches its maximum level of 8.075% 24 days later. Similar upward trend price reversal patterns, with different strength, can be seen for all three price measures in both indices. It seems that the price reversal pattern after a negative price shock for both indices reaches its maximum levels sometime between 24 to 30 days after the initial price shock. The above trend may signify that the investors in Poland overreact to negative news by pushing the equity price below its fundamental value, and thereby creating an environment conducive for subsequent price reversal and a possible opportunity for larger return. This overreaction is more pronounced for the larger negative price shocks. Similar results have been reported by [Rezvanian et al. \(2012\)](#) using National Stock Exchange and Bombay Stock Exchange indices in India, and [Rezvanian et al. \(2011\)](#) using the four major equity market indices from People's Republic of China, namely, Shanghai Stock Exchange Class "A" and Class "B", and Shenzhen Stock Exchange Class "A" and Class "B".

In contrast to the clear price reversal pattern after a sharp negative price change, the CAR values after the initial positive price shock do not provide a consistent pattern. For example, the CAR values for WIG index after the positive price shock (measured as +3% and Mean + 3STD) are negative and increasing, indicating investors' overreaction to positive price shock with subsequent price reversal. However, we could not detect similar pattern for the same price shock measures in the WIG20 index, although, similar pattern is detected for only the positive price shock measure of Mean + 3 STD. Therefore, it is difficult to draw any consistent price trend from investors' behaviour after the initial positive price shock from either of the equity indices of Poland.

Table no. 6 – Post-event Cumulative Abnormal Returns (in %)

Panel A: WIG						
Days	CARs Favourable (in %)			CARs Unfavourable (in %)		
	+ 3%	Mean + 2 STD	Mean + 3 STD	- 3%	Mean - 2 STD	Mean - 3 STD
1	0.493	0.991	-0.898	0.113	-0.017	-0.117
2	0.097	0.760	-2.115	0.994	0.500	0.976
3	0.015	0.758	-0.993	0.990	0.905	0.206
4	-0.531	1.078	-1.617	0.780	0.707	0.611
5	-0.942	0.224	-1.256	1.268	1.707	0.716
6	-1.009	-0.049	-0.728	1.542	1.943	0.635
7	-0.912	0.483	-1.403	0.907	1.941	1.051
8	-1.189	0.350	-2.480	0.674	2.023	-0.243
9	-0.835	0.275	-2.922	0.958	2.301	0.029
10	-0.952	1.078	-2.337	0.836	1.790	0.372
11	-1.051	0.654	-2.455	0.729	1.407	0.859
12	-1.001	0.639	-2.581	1.049	1.709	1.372
13	-1.342	1.490	-2.817	1.209	1.431	2.022
14	-1.439	1.743	-2.999	1.593	2.102	2.963
15	-1.578	2.108	-2.426	1.841	2.295	3.259
16	-1.210	2.165	-2.525	2.419	2.585	3.686
17	-1.691	1.983	-4.762	2.495	2.709	3.362
18	-1.697	1.558	-4.826	2.181	2.919	4.018
19	-1.871	1.398	-5.247	2.342	3.006	4.406
20	-1.912	1.743	-5.062	2.086	3.191	4.347

Panel A: WIG						
Days	CARs Favourable (in %)			CARs Unfavourable (in %)		
	+ 3%	Mean + 2 STD	Mean + 3 STD	- 3%	Mean - 2 STD	Mean - 3 STD
21	-2.097	2.291	-4.315	2.131	3.605	4.965
22	-2.189	2.660	-3.834	2.023	3.695	5.237
23	-2.559	2.434	-3.588	2.056	3.439	5.294
24	-2.520	2.161	-3.049	1.945	2.712	4.941
25	-2.090	2.021	-1.653	2.413	4.254	4.928
26	-2.005	1.738	-1.785	3.102	4.440	4.452
27	-2.048	1.375	-2.906	3.198	3.861	4.193
28	-2.069	1.423	-4.463	3.439	3.761	3.043
29	-1.887	1.971	-4.944	3.497	4.239	2.462
30	-1.755	1.742	-4.103	3.998	4.208	2.128

Numbers in **bold** indicate significance of CARs at 10% confidence level based on t-test results.

Panel B: WIG 20						
Days	CARs Favourable (in %)			CARs Unfavourable (in %)		
	+ 3%	Mean + 2 STD	Mean + 3 STD	- 3%	Mean - 2 STD	Mean - 3 STD
1	-0.152	-0.210	-0.473	0.480	-0.164	0.510
2	-0.421	0.137	0.133	0.980	-0.021	1.302
3	-0.663	-0.068	0.829	1.282	0.376	2.222
4	-1.092	-0.949	0.494	1.355	0.420	2.230
5	-0.749	-1.234	0.564	1.920	1.461	2.083
6	-0.886	-1.160	-0.072	1.889	2.000	2.419
7	-0.540	-1.133	-0.273	0.982	1.884	3.247
8	-0.976	-1.489	0.880	0.428	2.210	1.570
9	-0.758	-0.665	1.102	0.069	1.714	1.716
10	-0.636	-0.917	0.975	-0.194	1.780	1.847
11	-0.347	-0.995	0.830	0.018	2.223	2.546
12	-0.703	-1.427	0.435	-0.195	2.213	3.149
13	-0.894	-1.683	1.372	0.072	2.392	4.423
14	-0.471	-1.377	1.130	0.223	2.336	5.529
15	-0.758	-1.532	1.081	0.627	2.289	6.455
16	-0.663	-1.286	-0.147	1.124	2.465	7.829
17	-0.800	-1.521	-0.688	1.053	2.725	6.826
18	-0.323	-1.446	-0.081	1.112	2.461	7.368
19	-0.649	-1.298	0.434	1.570	2.159	6.537
20	-0.365	-1.154	-0.714	1.533	1.974	7.268
21	-0.342	-1.485	0.439	1.646	1.728	7.236
22	-0.616	-0.960	0.352	1.707	1.979	7.821
23	-0.945	-0.798	0.931	1.996	2.387	7.657
24	-0.485	-0.743	1.222	1.302	2.747	8.075
25	-0.018	-0.683	2.665	1.363	2.870	8.016
26	0.051	-1.068	3.006	1.138	2.920	7.794
27	-0.054	-1.322	2.178	1.425	3.705	7.231
28	0.341	-1.196	2.383	1.818	4.203	7.726
29	1.040	-0.562	2.106	2.072	4.397	7.240
30	0.861	-0.519	2.759	2.262	4.928	6.518

Numbers in **bold** indicate significance of CARs at 10% confidence level based on t-test results.

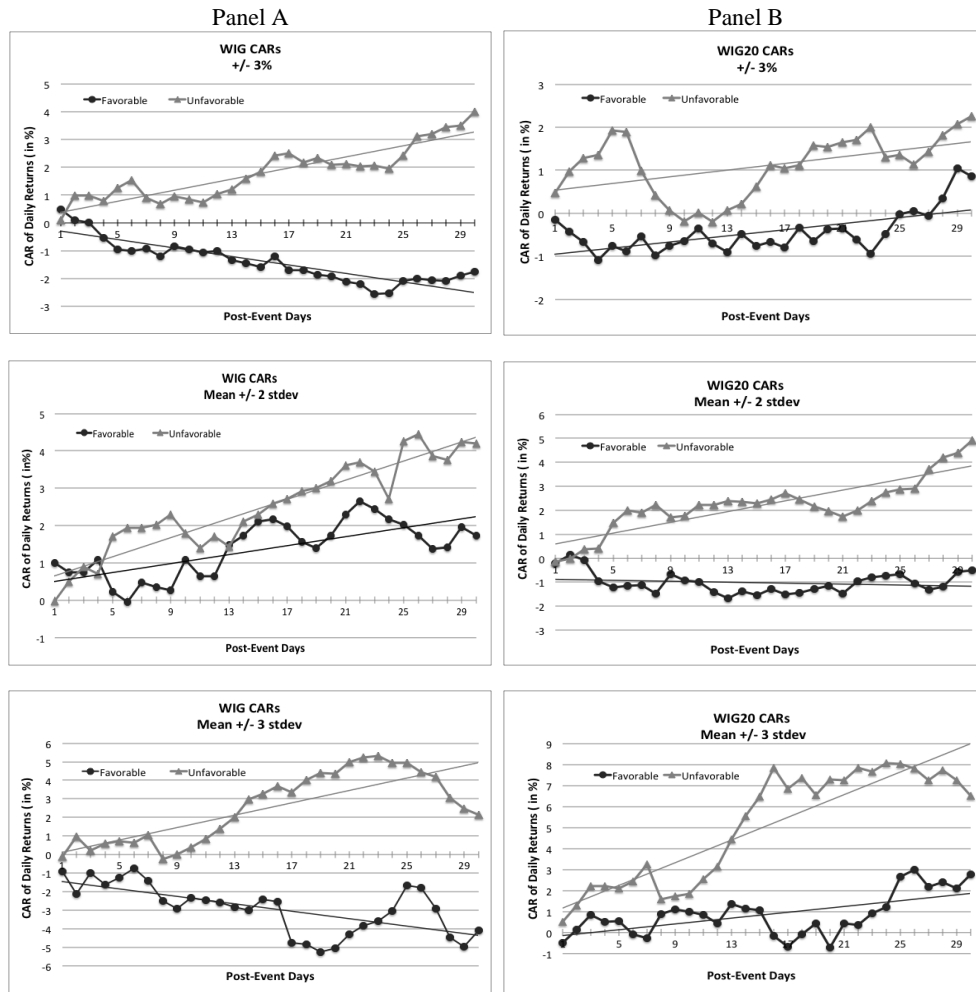


Figure no. 3 – Graphs of CARs for the WIG and WIG20 indices under the three measures of sharp price changes

6. SUMMARY AND CONCLUSIONS

This study examines the price patterns of the two major equity market indices in Poland after sharp price changes. Using daily stock returns from WIG and WIG20 equity markets, we examine the CARs trend after initial negative and positive large price changes. We apply three measures of large price changes: positive and negative daily price changes of 3 percent or more; two standard deviations from the mean of market returns; and three standard deviations from the mean of market returns. Therefore, overall we investigate the trend of the twelve possible CAR values 30 days after the initial large price changes; six positive and six negative sharp price event days for each of the equity indices.

The empirical results suggest that there is a consistent and statistically significant evidence of positive CAR values after a large negative price change in both indices.

However, a similar pattern cannot be detected after large positive price changes. We conclude that equity markets in Poland overreact to large negative unexpected macro news on the event days by pushing the value of index to less than its fundamental value. As markets gradually analyse the true value of information, they overcome their overreaction by taking corrective action by pushing the value of index upward toward to its true value. Contrary to the above, we could not find a similar consistent price reversal after a large positive price changes. It seems that investors in equity markets in Poland overreact only to large negative (rather than both negative and positive news) price changes. Overall conclusion from this study is that the announcement of negative macro news initially would increase volatility of equity indices and causes equity investors to overreact to negative macro news. Afterwards, as more information about the bad news (causing a large decline in equity induces) is widely available, and as equity investors more accurately analyse the news, they become more rational and take corrective action. This creates an environment that is conducive for subsequent price reversal and may create an opportunity for larger return. Our study also indicates that the price reversal is a gradual process and completes itself between 24 to 30 days after the initial large price decline. It is during this reversal period that we believe there is an opportunity for larger return. This above investment opportunity may also be more beneficial to international portfolio investors who are in the search of international diversification. The fact that historically, the market returns of equity indices in Poland are not highly correlated with the equity markets in Europe and US, and the fact the recent financial crises of from 2008-2011 did not have a severe adverse impact on the equity markets in Poland, provide another reason for investing in equity markets of Poland to benefit from international diversification.

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Notes

¹. Didier and Schmukler (2013) argue that contrary to the perception in the literature that equity markets in the most advanced emerging economies such as China and India are relatively well developed, the capital markets in these two countries have not been a significant sources of financing across firms and their activities has been more subdued than what the aggregate numbers suggest.

². For review of the recent regulatory measures taken by policy makers, please visit the Polish Financial Supervision Authority website: http://www.knf.gov.pl/en/Capital_market/Law/index.html.

³. Polish Stock Exchange organization called Gielda Papierow Wartościowych (GPW) is located in Warsaw, the capital of Poland.

⁴. For example, Brown, Harlow and Tinic (1988 and 1993), DeBondt and Thaler (1985), 1987), Kadiyala and Rau (2002), Atkins and Dyl (1990), Park (1995), Ajayi and Mehdian (1994a), Nam *et al.* (2001) and Ciobanu *et al.* (2008).

⁵. For example, Ajayi and Mehdian (1994b) study Hong Kong and Korea stock markets; Chan (1996) examines the Hong Kong equity market; Wang *et al.* (2000, 2004), Yeh and Lee (2000) and Rezvanian *et al.* (2011) investigate the Chinese equity markets, Da Costa (1994) study Brazil; Brailsford (1992), Allen and Prince (1995), and Gaunt (2000) study Australia; Diacogiannis *et al.* (2005) study Greece; Bowman and Iverson (1998) study New Zealand; Alonzo and Gonzalo (1990) study Spain; Mehdian *et al.* (2004) study Turkey. To address comparative investors' overreaction in different countries, a few other studies, such as Lasfer *et al.* (2003), investigate investors' reaction to sharp price changes in both advanced and emerging markets. Others, such as Mazouz *et al.* (2009), examine ten different Asian market indices. For an excellent review of short term predictability of stock prices conditional on large prior price change, refer to Amini *et al.* (2013).

⁶. This study was conducted at early stage of capital market development in Poland, when the number of listed companies and volume of trade were small. The Polish economy and capital markets in Poland have advanced since the mid 1990, and therefore the result of this study should be considered cautiously.

⁷. The GDP performance in Poland can be divided into the following stages: "Shock therapy" 1990-1993, "strategy for Poland" 1994-1997, "overcooling" 1998-1st half of 2002, "public finance reform program" 2nd half of 2002-2005, and "EU membership" since 2006. For more detailed discussion of GDP cycle in Poland please refer to Kolodko (2009).

⁸. There were more than 8,500 government owned enterprises registered for privatization in 1990, of which 86.4 percent completed privatization process by 2012.

⁹. There have been numerous reforms that facilitated Polish economy in transition period. These reforms resulted in dismantling of the old economic system, macroeconomic stabilization, domestic price liberalization, trade liberalization, privatization and restructuring of the inherited state-owned enterprises, social safety net, labor market reforms, and the advancement in business regulations for domestic firms, including procedures on registering property, implementation of new taxes procedure, enforcing contracts and resolving insolvency.

¹⁰. On September 19th 1989, Poland signed a five-year trade cooperation agreement with EC. The major objective of the agreement was to improve the conditions of access to Polish market for EC firms and therefore encourage direct investment.

¹¹. The ratio of financial assets held by banks to total financial assets in the economy was 62.19 percent in year 2000. This ratio has been declining, and it was 35.24 percent in 2012.

¹². This ratio was 1.26 in year 2000 and at the end of 2012 it jumped to 2.10.

¹³. These markets are: the Main List, NewConnect, Catalyst and WSE Energy. The indices include 24 indices of the Main List and 2 indices of NewConnect.

¹⁴. On September 23, 2013, the WSE introduced WIG30 which consists of 30 largest blue-chip stocks. The WIG20 index will be published until the end of December 2015.

¹⁵. With the exception of Richards (1996, 1997); Nam *et al.* (2001); Lasfer, Melnik, and Thomas (2003); and Ajayi and Mehdian (1994a, 1994b), other studies employ individual stock price data (rather than market index data) to examine investors' reaction to unexpected extreme price movements.

¹⁶. We performed Dickey-Fuller unit root test on each data series to test for stationarity of the series. The results, not reported, provide evidence to indicate that all return series used are stationary in their first differences.

¹⁷. For example, Bremer and Sweeney (1991) classify price changes of at least 10 percent as large; Lasfer *et al.* (2003) define large price shocks as those recorded when returns exceed by two standard deviations of the average market daily return, and Rezvanian *et al.* (2011) used different ranges of price changes – ± 8 , ± 7 and ± 5 percent – for the four different equity market indices in China.

¹⁸. The assumption is that as macroeconomic news (both good and bad) are announced, the investors will react to the news by bidding equity indices higher or lower depending on the strength and nature of the announced news.

¹⁹. Researchers have used different definition of windows in studies of investors' reaction to sharp price changes using the event study. For example, Howe (1986) Brown, Harlow and Tinic (1988), and Ketcher and Jordan (1994), take a short window of a day or two, but Chan (1988), Ball and Kothari (1989), Chen and Sauer (1997), and Rezvanian *et al.* (2011) take a long-term view and examine the subsequent price movement of the market index up to forty days after the initial sharp price changes.

²⁰. Specifically, if the previous and successive event days are both at the same direction, then the successive event day may cause an over-estimation of the effect of the previous event day. However, if the previous and successive event days are in different direction (that is one negative and the other positive, for example, previous event day is positive followed by a negative event day, and vice versa), then the market trend presented in thirty-day window is biased.

²¹. Non-event days are calculated by subtracting the event days and thirty trading days following the event days. We also subtracted the event days and the days following the event days where successive price changes fell within the thirty-day trading window after the initial price shock.

²². This result are in contrast with the results obtained by Stoica *et al.* (2013) who reported that in Poland the volatility of returns on non-event days is smaller than that on post-event (and its sub-categories of favorable and non-favorable) days.