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CROSS MARKET DEPENDENCIES. THE ANALYSYS OF SELECTED INVESTMENT STRATEGIES

(Summary)

The relationship between capital markets is important topic both from a theoretical and practical point of view. This problem is usually considered on the basis of market efficiency theory and ability to predict future price of financial instruments basing on historical data.

In this article we verify the hypothesis states the higher susceptibility and predictability of capital markets in emerging economies compared with developed countries against the situation on the world's largest stock exchanges. The impact of changes on American Stock Exchange (DJIA) and Japanese (NIKKEI) on the German (DAX) as well as Polish (WIG) stock exchange is investigated. Empirical research in the period 2012–2014 includes, among others, correlation, Granger causality analysis and co-integration in order to determine short-term and long-term relationship between individual time series. We proposed 6 investment strategies based on interdependencies between these markets and rated them in terms of effectiveness in predictive ability meaning.

Keywords: inter-market dependencies; investment strategies

Klasyfikacja JEL: C58

1. Introduction

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Empirical research in the period 2012–2014 includes, among others, correlation, Granger causality analysis and co-integration in order to determine short-term and long-term relationship between individual time series. We proposed 6 investment strategies based on interdependencies between these markets and rated them in terms of effectiveness in predictive ability meaning.

2. Theoretical considerations on between-market relationships

In terms of globalization, information flows between markets immediately. Changes on the world's leading stock markets mostly imply noticeable fluctuations on stock markets in other countries. It is interesting how these changes are able to determine rates of return of selected assets, particularly considering the fact of time zones' existence. It is expected that there is a one-way causality change on the markets of developed countries (Germany, USA, Japan) on Polish capital market. At the same time investment practice shows that the correlation between markets returns varieties in terms of strength and direction, which will be verified empirically in this paper. It was decided to check how the use of econometric and statistical tools allow to obtain permanent positive returns on investment on the capital market, taking into account between-market dependencies.

The fundamental problem in the estimation of econometric models for financial time series is the market efficiency. Efficiency is defined as the correctness of the process of determining the price of a financial instrument in accordance with its actual value and the ability of market participants to respond to the incoming data in terms of quickness, direction and magnitude adjustments[1]. There are many definitions of financial markets efficiency and its types. We define efficient market as informatively efficient. Such market is characterized by the fact that the prices of financial instruments quickly and fully reflect all information concerning them. It is difficult to fully identify efficient markets. The problem of market efficiency is empirically verifiable by distinguishing three types of efficiency: weak hypothesis, semi-strong form and strong one[2]. In this study, weak hypothesis of market efficiency is verified according to which securities prices reflect all the up-to-date information from the past (concerning historical prices, trading volumes). That means that any information disclosed

[1] **J. Brzeszczyński**, **R. Kelm**, *Ekonometryczne modele rynków finansowych; Modele kursów giełdowych i kursów walutowych*, Wydawnictwo WIG-Press, Warszawa 2002, pp. 8–9.

[2] **E. Fama**, *Efficient Capital Markets: A review of Theory and Empirical Work*, Journal of Finance 1970/25, pp. 386–391.

for the time being is discounted and expressed in current prices. Any tools such as technical or fundamental analysis or econometric models should not result in permanently higher returns than average[3].

The rate of diffusion of information is a reference point for analyzing the efficiency of the market. In the era of global digitization arbitrary stream of information flows almost instantly. However, there are some restrictions on investors' reactions to changes in the other markets in situations where the former does not exist physically. This problem is thus reduced to the analysis of market interdependence taking into account the period in which they operate, and therefore time zones. Taking into consideration the time zone output in Poland (Warsaw GMT + 1h), shortly after the opening of the Stock Exchange in Warsaw the German stock exchange (Deutsche Börse) opens. Depending on whether there is a summer or winter time, the opening of exchanges in the United States occurs at 15.30 or 14.30 local time. After the market closes in the US, market in Japan opens, which is closed for about 2 hours before the market opens the next day in Poland.

Observation of the market shows that the opening of the stock market in Poland is positively affected by positive changes of indices in Japan and the US the previous day. Typically, a stock exchange in emerging markets which include the Polish market behave in a similar manner to developed stock exchanges.

Japanese stock market has no direct impact on Polish stock exchange because of varying periods of time. Polish-Japan economic relations do not seem important enough on the local market to significantly determine the rate of return on the Warsaw Stock Exchange (WSE). Exceptionally positive opening exchanges in the US, which takes about an hour prior to the closing of the Polish stock market, may encourage investors clamber prices assets on the WSE. At the same time declines on the US market usually result in lower (than the previous day's closing price) opening of stock exchange in Poland. Despite the fact that this phenomenon as it would seem can be the object of interest to both institutional investors as an individual, there is still lack of empirical studies[4]. In this study we have posed the following research hypotheses:

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[3] **J. Brzeszczyński**, **R. Kelm**, *op. cit.*, p. 10.

[4] **R. Bhargava**, **A. Bose**, **D. Dubofsky**, *Exploiting International Stock Market Correlations with Open-End International Mutual Funds*, Journal of Business; Finance, and Accounting 1998/25, p. 774; **J. Bogle**, *The Battle for the Soul of Capitalism*, Yale University Press, New Haven 2005, p. 171; **J. Greene**, **Ch. Hodges**, *The dilution impact of daily fund flows on open-end mutual funds*, Journal of Financial Economics 2002/65, pp. 132–133.

H1: The relationship between changes in prices on the markets of developed and developing countries are unequal and unstable over time.

H2: Capital markets of emerging markets compared to ones of developed countries are characterized by a higher predictability of changes in prices of instruments.

3. Overview of recent empirical research

Literature discussing the interdependencies between the world's capital markets is extensive. Mostly in these studies authors are trying to empirically verify the impact of oncoming information on market price fluctuations of financial instruments and their rates of return[5]. The authors are looking for the linkages not only in the capital markets by sector or industry[6], but also bearing in mind that the progressive integration of the global financial market exchanges analyze the interdependence of different countries[7]. The results indicate the existence of dynamic relationships between developed and developing markets, among others[8].

[5] **I. Augustyński**, *Wpływ giełd światowych na główne indeksy giełdowe w Polsce*, Finansowy Kwartalnik Internetowy e-Finanse2011/7/1, p. 3; **B. Będkowska-Sojka**, *Intraday CAC40, DAX20 and WIG20 returns when the American macro news is announced*, Bank i Kredyt 2010/41/2, p. 8; **A. Dudek**, *Wpływ sytuacji na amerykańskiej giełdzie papierów wartościowych na zachowania inwestorów w Polsce – analiza ekonometryczna*, in: **D. Kopycińska** (ed.), *Ekonomiczne problemy funkcjonowania współczesnego świata*, Wydawnictwo Print Group, Szczecin 2009, pp. 7–9; **J. Hanousek**, **E. Kocenda**, *Foreign News and Spillovers in Emerging European Stock Markets*, Review of International Economics 2011/19, p. 177.

[6] **L. Menzly**, **O. Ozbas**, *Market segmentation and cross-predictability of returns*, Journal of Finance 2010/65, p. 1559.

[7] **R. Horvath**, **D. Petrovski**, *International Stock Market Integration; Central and South Eastern Europe Compared*, IOS Working Papers 2012, pp. 4–7; **T. Syriopoulos**, *Dynamic Linkages between Emerging European and Developed Stock Markets: Has EMU Any Impact?*, International Review of Financial Analysis 2007/16, p. 55.

[8] **M. Czupryna**, *O współzależności giełd na przykładzie giełdy polskiej i niemieckiej*, Annales Universitatis Mariae Curie-Skłodowska 2013/XLVII/3, p. 115; **A. Kanas**, *Linkages between the US and European equity markets: further evidence from cointegration tests*, Applied Financial Economics 1988/8, p. 610; **H. Li**, **E. Majerowska**, *Stock market integration: A multivariate GARCH analysis on Poland and Hungary*, Research in International Business and Finance 2008/24, p. 263–265; **B. Lucey**, **S. Voronkova**, *Linkages and relationships between Emerging European and Developed Stock Markets before and after the Russian Crisis of 1997–1998*, International Finance Review 2005/6, p. 386; **U. Mrzygłód**, **S. Nowak**, *The Analysis of Selected European Stock Market Cointegration*, Journal of Emerging and Transition Countries 2009/2, pp. 126–129; **G. Przekota**, *Analiza zależności między indeksami rynków akcji na giełdzie polskiej i amerykańskiej*, Badania Operacyjne i Decyzje 2007/3–4, p. 135; **M. Scheicher**, *The*

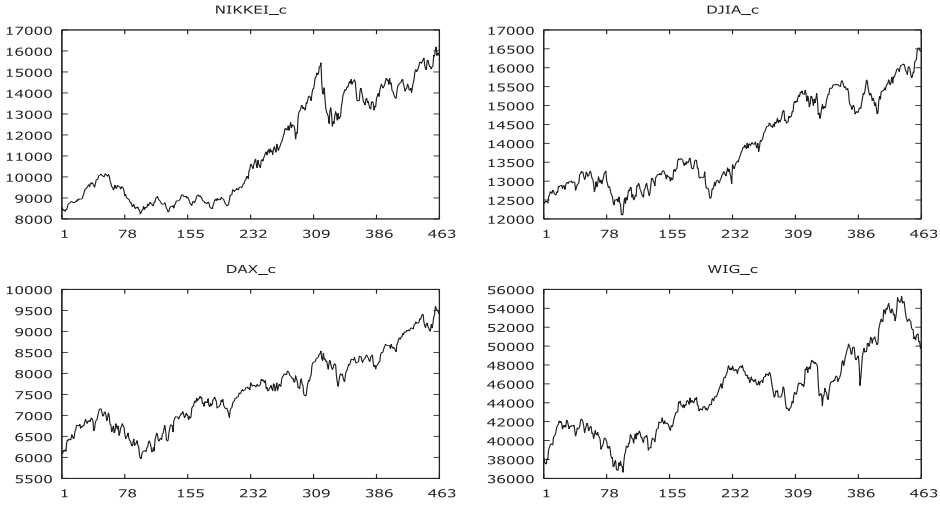
4. Data

In this study we use logarithmic rates of return calculated by equation (1) based on daily quotations of WIG, NIKKEI, DJIA and DAX indexes in the period 04.01.2012–10.01.2014, N = 463. The source of these data is Stooq.pl database.

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \times 100 \tag{1}$$

Where P_t is price of X index in *t*-period.

CHART 1: *Line charts of daily index closing prices* (NIKKEI, DJIA, DAX, WIG) *in the period 04.01.2012–10.01.2014*

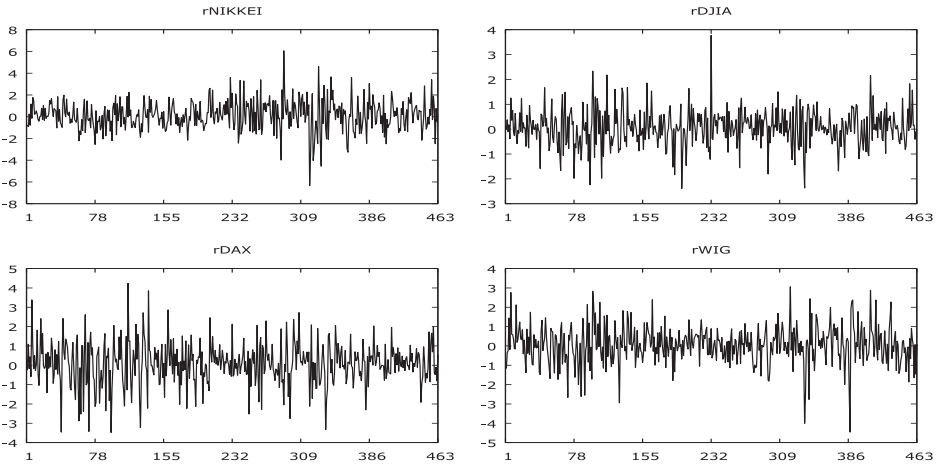


S o u r c e: own study in Gretl.

In the analyzed period, the indices showed an upward trend. In the same periods, their behavior was quite similar so we expect a highly positive correlation coefficients between the prices time series (Chart 1). In the case of returns there can be observed: phenomenon to the average return, volatility, and the variance clustering in time (Chart 2). On the Polish and German markets volatility appeared relatively more often over-average than on the other two markets.

co-movements of stock markets in Hungary, Poland and the Czech Republic, International Journal of Finance and Economics 2001/6, pp. 28–29.

CHART 2: *Line charts index daily rates of returns* (NIKKEI, DJIA, DAX, WIG) *in the period 04.01.2012–10.01.2014*



S o u r c e: own study in Gretl.

5. Methods

The study begins with an analysis of the correlation between indices and their rates of return respectively. Then analysis of the autocorrelation function ACF and PACF for identification autoregression[9] in time series was conducted. In order to determine whether, and if so, what is the direction of the interaction between variables, analysis of Granger causality[10] using stationary rates of return[11] was checked. This was followed by estimating VAR and VECM models[12], to determine whether there are compounds having a long-term effect between the indexes, and what is the impact of impulses from other developed stock on Polish stock exchange. We use methodology proposed by Johansen and Engle

[9] **G. Ljung**, **G. Box**, *On a Measure of a Lack of Fit in Time Series Models*, Biometrika 1978/65/2, pp. 299–303.

[10] **C. Granger**, *Investigating Casual Relations by Econometric Models and Cross-Spectral Methods*, Econometrica 1969/37, p. 424.

[11] **P. Phillips**, **P. Perron**, *Testing for a unit root in time series regression*, Biometrika 1988/75/2, pp. 335–346.

[12] **E. Kusideł**, *Modele wektorowo-autoregresyjne VAR. Metodologia i zastosowania*, in: **B. Suchecki** (ed.), *Dane panelowe i modelowanie wielowymiarowe w badaniach ekonomicznych*, Wydawnictwo Absolwent, Łódź 2000, pp. 27–34.

and Granger[13] in order to identify the integrating relationship. We also developed analysis of the effectiveness of 6 investment strategies based on the assumption of the presence of causality and correlation between the indices prices in group of considered stock exchanges.

TABLE 1: *Pearson correlation coefficients between* NIKKEI, DJIA, DAX, WIG *daily close prices in the period 04.01.2012–10.01.2014*

NIKKEI_c	DJIA_c	DAX_c	WIG_c	
1	0,9716	0,9197	0,8207	NIKKEI_c
	1	0,9511	0,8563	DJIA_c
		1	0,9523	DAX_c
			1	WIG_c

S o u r c e: own study.

TABLE 2: *Pearson correlation coefficients between* NIKKEI, DJIA, DAX, WIG *daily rates of returns in the period 04.01.2012–10.01.2014*

r_NIKKEI_c	r_DJIA_c	r_DAX_c	r_WIG_c	
1	0,0740	0,1915	0,1643	r_NIKKEI_c
	1	0,5786	0,3854	r_DJIA_c
		1	0,6056	r_DAX_c
			1	r_WIG_c

S o u r c e: own study.

TABLE 3: *Descriptive statistics for* NIKKEI, DJIA, DAX, WIG *daily rates of returns in the period 04.01.2012–10.01.2014*

Variable	Mean	Min.	Max.	St. Dev.	Skewness	Kurtosis
r_NIKKEI_c	0,0013	–0,0634	0,0607	0,0135	–0,06	2,09
r_DJIA_c	0,0006	–0,0239	0,0377	0,0073	0,11	2,04
r_DAX_c	0,0009	–0,0348	0,0424	0,0109	–0,16	1,38
r_WIG_c	0,0006	–0,0446	0,0306	0,0097	–0,29	1,94

S o u r c e: own study.

[13] **R. Engle**, **C. Granger**, *Cointegration and Error Correction: Representation, Estimation and Testing*, Econometrica 1987/55/2, pp. 251–276; **S. Johansen**, *Statistical Analysis of Cointegration Vectors*, Journal of Economic Dynamics and Control 1988/12, pp. 231–254.

High positive correlation coefficients between the price indices show the coexistence of similar changes in these markets (Table 1). The strength of correlation returns is significantly lower. While in correlation coefficient between DJIA and NIKKEI rates of return is not statistically significant, 1 period lagged NIKKEI rate of return confirms a moderate correlation (0.4561) with DJIA. The rates of return on the US market are somewhat correlated strongly with German stock market rather than the Polish one. At the same time, there is a moderately positive correlation (Table 2) between DAX and WIG rates of return. It should be noted that during the reporting period, the average rate of return did not differ significantly from 0, but the value of the coefficient of variation indicates that the WSE was characterized by relatively highest volatility. Distribution of returns is characterized by leptokurtosis and statistically significant asymmetry in the case of returns on WIG (Table 3).

TABLE 4: *Descriptive statistics for Pearson correlation coefficients for* NIKKEI, DJIA, DAX, WIG *daily rates of return based on 20-daymoving average in the period 04.01.2012–10.01.2014*

Correlation	Mean	Median	Min.	Max.	St. Dev.	Skewness	Kurtosis
JAP_USA	0,07	0,12	–0,58	0,57	0,26	–0,42	–0,56
JAP_GER	0,22	0,25	–0,65	0,69	0,25	–0,88	1,16
JAP_PL	0,19	0,19	–0,56	0,78	0,26	–0,53	–0,01
USA_NIEM	0,58	0,64	–0,07	0,89	0,22	–1,13	0,57
USA_PL	0,39	0,41	–0,54	0,74	0,23	–0,91	1,58
NIEM_PL	0,62	0,67	–0,31	0,89	0,18	–1,97	5,95

S o u r c e: own study.

The correlations coefficients between rates of return as seen from the empirical data are not time-invariant. In order to show how these coefficients vitiate in terms of strength and direction, correlation moving averages were calculated for 20 consecutive trading days for rates of return, on which the descriptive statistics were showed in Table 4. The selection of the time window was arbitrary and dictated by short-recurring investment themes. The average correlation coefficients are similar to those obtained in Table 1. Particularly noteworthy is the fact that there is short-term negative correlation between the returns of the indices, the emerging possibility of carrying out specific investment strategies. It should be also noted that the correlation between the US stock market as well as German and Polish are among the most stable in time. The fact that distributions are asymmetric has significance for assumptions of investment strategies.

TABLE 5: *Selecting number of lags in VAR model*y_t = [rDJIA, rNIKKEI, rDAX, rWIG]'

Information criteria	Lags	
	1	2
const		
AIC	10,285532	10,258088*
BIC	10,466044*	10,583008
HQC	10,356633*	10,386069
Without const		
AIC	10,26098	10,233162*
BIC	10,404675*	10,520552
HQC	10,317564*	10,34633

S o u r c e: own study.

TABLE 6: *Granger causuality analysisa* = 0,1

Causuality direction	Lags	F-statistic	p-value
rDJIAc –> rWIGc	1	8,6701	0,0033
rDJIAc –> rDAXc	4	8,5987	0,0000
rDJIAc –> rNIKKEIc	1	118,2564	0,0931
rNIKKEIc –> rWIGc	1	2,2694	0,1041
rNIKKEIc –> rDAXc	2	0,9055	0,3416
rNIKKEIc –> rDJIAc	1	2,8221	0,0932
rDAXc –> rWIGc	1	0,9906	0,3199
rDAXc –> rNIKKEIc	1	14,8249	0,0001
rDAXc –> rDJIAc	4	2,5492	0,0381

S o u r c e: own study.

According to the definition of Granger causality (x_t is the cause y_t if the current y_t values can be predicted with greater accuracy by past values of x_t, than in any other way, ceteris paribus) the exclusion rates of return on the DJIA will make forecasting properties of VAR model worse both in the equation explaining the evolution of rates of return on the Polish, German and Japanese indices. At the same time, causality is observed from Japan to German stock exchange. Causality between DAX and NIKKEI and DAX and DJIA rates of return are bi-directional. In addition, the analysis of Cholesky decomposition of variance allows you to

reorder the variables from the least susceptible to the influence of others to the most vulnerable in the following order (rDJIA, rNIKKEI, rDAX, rWIG).

TABLE 7: *Cointegration tests for* l_NIKKEI, l_WIG, l_DJIA, l_DAX, *and 2 lags*

Rank	Eigenvalues	Trace statistic	p-vale	Test Lmax	p-value
0	0,056827	49,129	0,0361	27,029	0,0559
1	0,033336	22,100	0,3023	15,664	0,2552
2	0,013467	6,4358	0,6487	6,2638	0,5865

S o u r c e: own study in JMulti.

Long-term relationship equation between WIG and DJIA:

$$\Delta lWIG_c = -0{,}0147ECM_{t-1} + 0{,}0476 \times \Delta lWIG_{c\,t-1} + 0{,}193 \times \Delta lDJIA_{c\,t-1} + 0{,}059 \qquad (2)$$

Coefficient $\alpha = -0{,}0147$ informs that less than 1,5% of the variation of the logarithm deviations of closing prices of WIG index in long-term relationship with the DJIA rates closure is reduced in one day. Long-term dependency exists and is statistically significant as evidenced by the module higher than the critical value of the Student's t-statistics. The parameter of the delayed index value is statistically insignificant WIG_c which means that the previous increment the index has no effect on the current gain ($0{,}944 < t^*$). The parameter of the delayed increase in $DJIA_{c,t-1}$ is statistically significant, which means that the growth of $DJIA_c$ results in the increases of WIG_c the next day. Thus the rate of return on index WIG is impacted by the closing of the DJIA on the previous day. These results are consistent with those obtained by other researchers, among others[14]. Whereas the observed relationship, 6 specific investment strategies were formulated, which recommend long or short position in financial instrument (when certain conditions in the markets having a potential impact on the analyzed are present) (Table 8). The results suggest that on the basis of the presented strategy it is not possible to make a profit (apart from any costs of: data access, brokerage and other factors affecting their profitability) at least in 50 per cent of cases. At the same time, they encourage further research with the use of other groups of financial instruments, time ranges and intervals.

[14] **G. Przekota**, *op. cit.*, p. 143.

TABLE 8: *Characteristics of investment strategies; o-opening price, closing price of c, L-Buy, S-Sell*

Lp.	Strategy	Strategy description
I	USA → Poland	$DJIA\_o_t - DJIA\_c_{(t-1)} >= 0 \rightarrow rWIG_t > 0$ => L WIG; otherwise: S;
II	USA → Poland	$r\_DJIA\_c_t > 0$ => $rWIG_{t+1} > 0 \rightarrow$ L WIG; otherwise: S;
III	Japan → Germany	rNIKKEIc(t–1) > = 0 → L: DAX; otherwise: S;
IV	USA → Germany	$rDJIA\_{t} > 0$ => $rDAX_{t+1} > 0 \rightarrow$ L DAX; otherwise: S;
V	Japan → Poland	$rNIKKEI_t > 0$=> $rWIG_t > 0 \rightarrow$ L WIG; otherwise: S;
VI	Japan and USA → Poland	($rNIKKEI_t > 0$ or $r\_DJIA_{t-1} >= 0 \rightarrow r\_WIG_t > 0$ => L WIG; otherwise: S;

S o u r c e: own study.

TABLE 9: *The results of investment strategies for* NIKKEI, DJIA, DAX, WIG *in the period 04.01.2012–10.01.2014*

Strategy	Deal	Effectiveness [%]
I	Long	25,1
	Short	27,3
II	Long	31,0
	Short	24,0
III	Long	31,2
	Short	30,1
IV	Long	19,7
	Short	36,7
V	Long	31,4
	Short	31,4
VI	Long	39,0
	Short	30,8

S o u r c e: own study.

6. Conclusions

The estimated models show that there exists long-term dependence between Polish and American stock exchange as well as the occurrence of flow of impulses between-market in the short term. The confrontation of empirical research with other cases in literature shows that the choice of indices and research periods may imply the opposite findings. The models and strategies presented are not an excellent tool for predicting rates of return and achieving extraordinary profits. The investor's ability to respond to the changing situation should not only concern

domestic capital market, but also the world's leading stock exchanges. It was found that the changes on capital market in Poland (which is a developing market) compared to the markets in developed countries are slightly easier to predict. At the same time carrying out a similar study of the effects of rates of return on the American, Japanese, Polish and German stock exchanges suggest rather comparable usefulness of the proposed strategy. Formal verification of predictability of changes in the prices of financial instruments require the involvement of a wider range of statistical and econometric tools as well as technical analysis.

The results suggest that, from the Polish capital market point of view, changes on global stock markets are not inert. It has been shown that the correlation of returns from the instruments whose prices are almost collinear has a moderately strong positive correlation, which changes over time, not only in terms of strength but also direction, which creates additional risk as well as investment opportunities. This leads to further research, particularly with the use of econometric tools such as DCC-GARCH models that takes into account the dynamics of the correlation, variance and clustering phenomenon, whose presence has been confirmed.

References

Augustyński Iwo, *Wpływ giełd światowych na główne indeksy giełdowe w Polsce*, Finansowy Kwartalnik Internetowy „e-Finanse 2011/7/ 1, www.e-finanse.com

Będkowska-Sójka Barbara (2010), *Intraday CAC40, DAX20 and WIG20 returns when the American macro news is announced*, Bank i Kredyt 2010/41/2.

Bhargava Rohit, **Bose Ann**, **Dubofsky David**, *Exploiting International Stock Market Correlations with Open-End International Mutual Funds*, Journal of Business; Finance, and Accounting 1998/25.

Bogle John, *The Battle for the Soul of Capitalism*, Yale University Press, New Haven 2005.

Brzeszczyński Janusz, **Kelm Robert**, *Ekonometryczne modele rynków finansowych; Modele kursów giełdowych i kursów walutowych*, Wydawnictwo WIG-Press, Warszawa 2002.

Czupryna Marcin, *O współzależności giełd na przykładzie giełdy polskiej i niemieckiej*, Annales Universitatis Mariae Curie-Skłodowska 2013/XLVII/3.

Dudek Aleksandra, *Wpływ sytuacji na amerykańskiej giełdzie papierów wartościowych na zachowania inwestorów w Polsce – analiza ekonometryczna*, in: Danuta Kopycińska (ed.), *Ekonomiczne problemy funkcjonowania współczesnego świata*, Wydawnictwo Print Group, Szczecin 2009.

Engle Robert, **Granger Clive**, *Cointegration and Error Correction: Representation, Estimation and Testing*, Econometrica 1987/55/2.

Fama Eugene, *Efficient Capital Markets: A review of Theory and Empirical Work*, Journal of Finance 1970/25.

Granger Clive, *Investigating Casual Relations by Econometric Models and Cross-Spectral Methods*, Econometrica 1969/37.

Greene Jason, **Hodges Charles**, *The dilution impact of daily fund flows on open-end mutual funds*, Journal of Financial Economics 2002/65.

Hanousek Jan, **Kocenda Evzen**, *Foreign News and Spillovers In Emerging European Stock Markets*, Review of International Economics 2011/19.

Horvath Roman, **Petrovski Dragan**, *International Stock Market Integration; Central and South Eastern Europe Compared*, IOS Working Papers 2012.

Johansen Søren, *Statistical Analysis of Cointegration Vectors*, Journal of Economic Dynamics and Control 1988/12.

Kanas Angelos, *Linkages between the US and European equity markets: further evidence from cointegration tests*, Applied Financial Economics 1988/8.

Kusideł Ewa, *Modele wektorowo-autoregresyjne VAR. Metodologia i zastosowania*, in: Bogdan Suchecki (ed.), *Dane panelowe i modelowanie wielowymiarowe w badaniach ekonomicznych*, Wydawnictwo Absolwent, Łódź 2000.

Li Hu, **Majerowska Ewa**, *Stock market integration: A multivariate GARCH analysis on Poland and Hungary*, Research in International Business and Finance 2008/24.

Ljung Greta, **Box Georg**, *On a Measure of a Lack of Fit in Time Series Models*, Biometrika 1978/65/2.

Lucey Brian, **Voronkova Svitlana**, *Linkages and relationships between Emerging European and Developed Stock Markets before and after the Russian Crisis of 1997–1998*, International Finance Review 2005/6.

Menzly Lior, **Ozbas Oguhzan**, *Market segmentation and cross-predictability of returns*, Journal of Finance 2010/65.

Mrzygłód Urszula, **Nowak Sabina**, *The Analysis of Selected European Stock Market Cointegration*, Journal of Emerging and Transition Countries 2009/2.

Phillips Peter, **Perron Pierre**, *Testing for a unit root in time series regression*, Biometrika 1988/75/2.

Stooq, Financial Website, www.stooq.pl; stan na 02.03.2014 r.

Przekota Grzegorz, *Analiza zależności między indeksami rynków akcji na giełdzie polskiej i amerykańskiej*, Badania Operacyjne i Decyzje 2007/3–4.

Scheicher Martin, *The co-movements of stock markets in Hungary, Poland and the Czech Republic*, International Journal of Finance and Economics 2001/6.

Syriopoulos Theodoros, *Dynamic Linkages between Emerging European and Developed Stock Markets: Has EMU Any Impact?*, International Review of Financial Analysis 2007/16.

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ZALEŻNOŚCI MIĘDZYRYNKOWE: ANALIZA WYBRANYCH STRATEGII INWESTYCYJNYCH

(Streszczenie)

Zależności między rynkami kapitałowymi stanowią ważny zarówno z teoretycznego, jak i praktycznego punktu widzenia obszar badawczy. Zagadnienie to rozpatrywane jest najczęściej na gruncie teorii efektywności rynku, możliwości skutecznej predykcji przyszłych cen instrumentów finansowych na podstawie danych historycznych.

W artykule postanowiono zweryfikować hipotezę zakładającą wyższą podatność i przewidywalność rynków kapitałowych w krajach rozwijających się jak Polska w porównaniu z krajami rozwiniętymi na tle sytuacji na największych światowych giełdach. Rozważaniu poddano wpływowość giełdy amerykańskiej (indeks DJIA) oraz japońskiej (indeks NIKKEI) na giełdę niemiecką (indeks DAX) oraz polską (indeks WIG). Badanie empiryczne za okres 2012–2014 obejmowało m.in. analizę korelacji, przyczynowości w sensie Grangera i kointegracji w celu określenia zależności krótkookresowych i długookresowych. Zaproponowano 6 strategii inwestycyjnych bazujących na współzależnościach międzyrynkowych i oceniono je efektywność pod kątem zdolności predykcyjnej, co stanowiło cel niniejszego artykułu.

Słowa kluczowe: zależności międzyrynkowe; strategie inwestycyjne