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TESTING THE GRANGER CAUSALITY FOR COMMODITY MUTUAL FUNDS IN POLAND AND COMMODITY PRICES

Monika Krawiec
Department of Econometrics and Statistics
Warsaw University of Life Sciences
e-mail: krawiec.monika@gmail.com

Summary: The recent increase in commodity price levels has resulted in the launch of a number of new commodity funds also in Poland. Since these funds do not have long quotation records, the study designed to answer the question whether changes in prices of commodities on world markets Granger-cause changes in quotations of participation units in specialized commodity funds in Poland, must have been limited to a 3-year-period. It includes 8 commodity funds, 11 commodities and 2 stock indices. Their log-returns constitute the base for calculating some descriptive statistics, testing for normality and stationarity. In order to achieve the goal of the research the Granger causality test is adopted. Its results exhibit Granger causality between commodity returns and majority of commodity fund returns, whereas in only few cases there is Granger causality running from stock indices returns to commodity funds returns.

Keywords: commodity prices, commodity mutual funds, Granger causality

INTRODUCTION

Commodities have attracted considerable interest as a financial investment in recent years. Moreover, motivations and strategies of participants have made commodity markets more like financial markets. Commodities used to be viewed as a separate asset class, but this class is of specific character. It encompasses a wide range of products. Due to Eller and Sagerer [2008] commodities can be categorized in two ways: hard and soft. Hard commodities can further be subdivided into energy (fossil and nuclear energy: crude oil, uranium, natural gas, coal; and alternative energy: solar, wind, water, biomass, geothermic, fuel cells) and metals (precious metals: gold, platinum, silver, palladium; base metals:

aluminum, copper, lead, nickel, zinc and ferrous metals: iron, still). There are three subsegments within soft commodities: food and consumer products (wheat: corn, rice, barley; oilseeds: soybeans, palm oil; semiluxury: coffee, cacao, tea, tobacco, sugar orange juice), industrial agro-raw materials (cotton, wool, timber, rubber), animal agro-raw materials (feeder cattle, live cattle, lean hogs). In the result of such a diversity, prices (returns) of one type of commodity may have little correlation with prices (returns) of another type of commodity, while by definition an asset class consists of similar assets that show a homogeneous risk-return profile (a high internal correlation) and heterogeneous risk-return profile towards other asset classes (a low external correlation) [Fabozzi at al. 2008]. Therefore, it is important to evaluate commodities individually, or on a sector basis when analyzing investments in commodities.

There are several types of commodity investments. The most important are: direct investment in physical good, indirect investment in stocks of natural resource companies or commodity mutual funds, an investment in commodity futures, or an investment in structured products on commodity futures indices [Fabozzi at al. 2008]. Although institutional investors still dominate commodity trading in individual commodities, retail investors also may invest in individual commodities through a broker or through commodity mutual funds. There are some clear advantages of using mutual funds to participate in commodity markets: diversification, professional management and low minimum requirements. On the contrary, fees that should be paid may be considered disadvantages. A couple of different types of commodity mutual funds are available to investors. The first type of these funds, called natural resource funds, invest in both commodity-producing and commodity-related stocks. Then sector-specific mutual funds track their specific underlying commodity. There are also mutual funds that invest in commodity futures. In most cases, these funds passively track and invest in a commodity futures index [Balarie 2007].

In Poland many commodity funds have emerged within last three – four years, so in most cases their track records do not go beyond three years. That is why the research presented in the paper is limited to few selected funds only and to the period of time from 2009 to 2011. The paper is aimed at answering the question whether changes in prices of commodities on world markets Granger-cause changes in quotations of participation units in specialized commodity funds operating in Poland.

EMPIRICAL DATA AND RESEARCH METHODS

Empirical data used for the purpose of the analysis covers a 3-year-period from January 2009 to December 2011. That are daily participation unit quotations of selected commodity mutual funds operating on the Polish market and prices of the most important commodities traded on world exchanges. The time horizon was limited due to data availability. Detailed analysis of available data allowed

selecting the following eight funds: Idea Surowce Plus (*Idea Raw Materials Plus*[1]), Investor Gold Otwarty (*Investor Gold Open*), Investor Agrobiznes (*Investor Agribusiness*), Skarbiec Rynków Surowcowych (*Treasury of Raw Materials Markets*), BPH Globalny Żywności i Surowców (*BPH Global of Food and Raw Materials*), Pioneer Surowców i Energii (*Pioneer of Raw Materials and Energy*), PZU Energia Medycyna Ekologia (*PZU Energy Medicine Ecology*), Opera Substantia.pl. As far as real commodities are concerned, the analysis covered grain, energy, base and precious metals. Table 1 presents commodities under consideration. Additionally, two indices representing British and U.S. stock markets were included in the research. They are respectively: FTSE 100 and S&P 500.

Table 1. List of commodities included in the research.

Commodity	Market	Quotation unit
Corn	Chicago	USD/100 bushels
Soybean	Chicago	USD/100 bushels
Wheat	Chicago	USD/100 bushels
Crude oil	London	USD/barrel
Copper	London	USD/ton
Aluminum	London	USD/ton
Lead	London	USD/ton
Nickel	London	USD/ton
Gold	London	USD/ounce
Silver	London	USD/ounce
Platinum	London	USD/ounce

Source: own elaboration

In the first step of research rate of return series were calculated by taking the natural log of the ratio of two consecutive prices, i.e. $r_t = \ln(P_t / P_{t-1})$, where P_t is the price at time *t* and P_{t-1} is the price in the previous period. These rate of return series became the base to evaluate basic descriptive statistics for considered assets. Then, normality of distributions was tested. In the literature, there are discussed several tests of normality. Here, Shapiro-Wilk and Jarque-Bera tests were adopted. In order to answer the question whether changes in prices of basic commodities forecast changes in quotations of selected commodity mutual funds in Poland, Granger causality test was applied.

Granger causality[2] explains whether *x* causes *y,* that is how much of current *y* can be explained by past values of *y* and then see whether adding lagged values of *x* can improve the explanation. In this respect, *y* is said to be Granger-caused by *x* if *x* helps in the prediction of *y* - equivalently, if the coefficients on the lagged *x's*

[1] The names translated by the author are not official English names of the funds.
[2] Some econometricians prefer terms: precedence or predictive causality [Gujarati 2003].

are statistically significant. A bilateral causation is frequently the case: *x* Granger-causes *y* and *y* Granger-causes *x* [Ortiz at al. 2007].

The Granger test aims at comparing the following unrestricted model:

$$y_t = \sum_{k=1}^{m} \lambda_k d_k + \sum_{i=1}^{p} \alpha_i y_{t-i} + \sum_{j=1}^{q} \beta_j x_{t-j} + \varepsilon_t \quad (1)$$

to the model with restrictions:

$$y_t = \sum_{k=1}^{m} \lambda_k d_k + \sum_{i=1}^{p} \alpha_i y_{t-i} + \varepsilon_t \,, \quad (2)$$

where:

λ_k, α_i, β_j - model parameters,

y_t - variable value at time *t*,

ε_t - error term,

d_k - deterministic variables.

If $\beta_1 = \beta_2 = ... = \beta_q = 0$, *x* does not Granger-cause *y*. The test statistic may be of the following form:

$$W = \frac{SSE^* - SSE}{SSE} \cdot T \,, \quad (3)$$

where:

W – Wald statistic,

*SSE** – error sum of squares for equation (2),

SSE – error sum of squares for equation (1),

T – number of observations.

The above Wald statistic is asymptotically distributed as a χ^2 with degrees of freedom equal to *q* and should be applied to large samples only[3].

RESEARCH RESULTS

On the base of 739 quotations of considered funds, commodities and indices, there were calculated logarithmic returns used to evaluate basic characteristics given in table 2. They are: minimal and maximal observed value, expected rate of return (mean), standard deviation, standardized skewness and kurtosis. Values of Pearson correlation coefficients for pairs of selected assets are reported in table 3, where bold type denotes values that did not differ significantly from zero at 0,05 level. There are used the following acronyms: Idea S.P. – Idea Surowce Plus, Inv. G. – Investor Gold, Inv. A. – Investor Agrobiznes, Skarbiec – Skarbiec Rynków Surowcowych, BPH – BPH Globalny Żywności i Surowców,

[3] For more detailed information on testing Granger causality see for example Greene [2000], Maddala [2001], Ramanathan [2002] or Gujarati [2003].

Pioneer – Pioneer Surowców i Energii, PZU – PZU Energia Medycyna Ekologia, Opera – Opera Substantia.pl.

Table 2. Basic characteristics of logarithmic returns obtained for considered funds, commodities and indices

Asset	Measure					
	Min	Max	Mean	Std. dev	Skewness	Kurtosis
Idea S.P.	-0,096730	0,070640	0,000428	0,014817	-10,3025	38,1232
Inv. G.	-0,051150	0,049379	0,000686	0,011878	0,20447	11,8165
Inv. A.	-0,053621	0,068783	0,000635	0,013058	0,82464	16,8944
Skarbiec	-0,038541	0,043882	0,000386	0,010408	-3,07389	5,49695
BPH	-0,040019	0,033717	0,000438	0,009768	-4,06107	7,04804
Pioneer	-0,049117	0,044161	0,000401	0,010514	-3,82182	7,71023
PZU	-0,042707	0,054525	0,000458	0,007975	10,7311	45,9956
Opera	-0,051630	0,037463	0,000359	0,010066	-2,30547	16,6512
Corn	-0,115546	0,137018	0,000593	0,022537	1,81614	21,1521
Soybean	-0,152513	0,098032	0,000268	0,048913	-9,31619	54,0986
Wheat	-0,100961	0,105094	0,000076	0,024964	1,95568	9,2183
Crude oil	-0,102654	0,097422	0,001097	0,023063	-1,65075	14,1904
Copper	-0,067093	0,072772	0,001206	0,020287	-1,0011	3,51007
Aluminum	-0,067416	0,076781	0,000356	0,017342	0,748382	7,35606
Lead	-0,112239	0,074306	0,000822	0,025613	-2,3836	3,96401
Nickel	-0,128184	0,089312	0,000525	0,024616	-5,15834	13,1328
Gold	-0,058162	0,068414	0,000809	0,012391	-2,57375	16,8555
Silver	-0,186926	0,173643	0,001266	0,028767	-4,66857	34,3526
Platinum	-0,062060	0,053382	0,000550	0,014347	-4,52693	9,96508
FTSE 100	-0,055630	0,050323	0,000270	0,013354	-3,0988	11,3616
S&P 500	-0,0675201	0,060650	0,000416	0,013866	-3,65389	15,5705

Source: own calculations

Analysis of results, given in table 2, allows to state that in the studied period all considered funds and commodities produced low expected rates of return. In the case of funds, the highest observed rate of return was that generated by Investor Gold (0,07%), and the one of Investor Agrobiznes (0,06%). Values obtained for almost all other funds were fluctuating around 0,04%. In the commodity group, silver and copper produced the highest rates of return equal to 0,13 and 0,12%. Although these results are almost two times higher than the best result obtained for funds, it is worth to notice that the lowest rate of return observed in the group of funds (for Opera Substantia.pl) was actually higher than the worst result among commodities, generated by wheat. Rates of return calculated for stock indices equaled respectively: 0,03% for FTSE 100 and 0,04% for S&P 500. Standard deviations calculated for funds in most cases were close to 1% and were comparable to values of the measure obtained for gold, platinum and stock indices,

whereas soybean exhibited the highest standard deviation. In all cases there was observed heightened kurtosis and for majority of investigated assets we had negative skewness (three funds: Investor Gold, Investor Agrobiznes, PZU Energia Medycyna Ekologia and three commodities: corn, wheat, aluminum had positive skewness).

Table 3. Coefficients of correlation between selected assets

Asset	Idea S.P.	Inv. G.	Inv. A.	Skarbiec	BPH	Pioneer	PZU	Opera
Corn	0,2009	**0,0014**	0,0888	0,2204	0,3023	0,2666	**0,0171**	0,3031
Soybean	0,2125	**-0,0197**	**0,0672**	0,1988	0,3105	0,2585	**-0,0360**	0,2453
Wheat	0,1375	0,1195	**0,0532**	0,2619	0,3389	**0,0416**	**0,0516**	0,1505
Crude oil	0,1567	**0,0636**	0,2060	0,4670	0,4158	**0,0113**	0,0834	0,1177
Copper	0,5548	0,1073	0,2036	0,4708	0,3877	0,2665	**0,0305**	0,3418
Aluminum	-0,5364	**0,0200**	0,1544	0,3780	0,3283	0,2735	**-0,0204**	0,3689
Lead	0,5417	0,1052	0,1633	0,4165	0,3435	0,2832	**0,0129**	0,3355
Nickel	0,5068	**0,0564**	0,1575	0,4309	0,3665	0,2150	**-0,0276**	0,3240
Gold	0,1578	0,5549	**0,0180**	0,3322	0,2750	0,1604	**-0,0384**	0,2484
Silver	0,3847	0,3473	0,1303	0,4148	0,3558	0,3572	**-0,0304**	0,4197
Platinum	0,4593	0,2961	0,2015	0,4791	0,3820	0,3452	**-0,0111**	0,4248
FTSE 100	0,5123	-0,0818	0,2658	0,1304	**0,0711**	0,5605	**-0,0267**	0,2719
S&P 500	0,6764	**-0,0252**	0,2950	0,2559	0,1985	0,4414	**-0,0204**	0,3714

Source: own calculations

On the base of data reported in table 3 one may notice that the highest positive correlations were observed for the following pairs: Pioneer Surowców I Energii – FTSE 100, Investor Gold – Gold, Idea Surowce Plus – Copper, Idea Surowce Plus – Lead. In most cases funds returns were positively correlated with FTSE 100 and S&P 500 returns. The only exception with statistically significant negative correlation was Investor Gold. Generally, the highest negative correlation (statistically significant) was observed for the pair: Idea Surowce Plus – aluminum.

Although on the base of data, presented in table 2, one could not expect investigated time series to fit normal distribution, Shapiro-Wilk and Jarque-Bera tests were applied to verify formally whether considered logarithmic returns were normally distributed. The results obtained are reported in table 4. In parentheses there are also displayed p-values. One can state that distributions of logarithmic returns of all considered assets did not follow normal distribution. The only exception was copper. In its case Shapiro-Wilk test suggests not to reject at 0,5% the null hypothesis that variable under consideration is normally distributed.

Table 4. Results of testing normality of logarithmic returns

Asset	Statistic		Asset	Statistic	
	Shapiro-Wilk	Jarque-Bera		Shapiro-Wilk	Jarque-Bera
Idea S.P.	0,923 (0,000)	1536,090 (0,000)	Crude oil	0,966 (0,000)	200,101 (0,000)
Inv. G.	0,973 (0,000)	136,734 (0,000)	Copper	0,994 (0,006)	12,841 (0,002)
Inv. A.	0,961 (0,000)	280,74 (0,000)	Aluminum	0,990 (0,000)	53,284 (0,000)
Skarbiec	0,988 (0,000)	38,730 (0,000)	Lead	0,993 (0,000)	20,808 (0,000)
BPH	0,983 (0,000)	64,802 (0,000)	Nickel	0,974 (0,000)	195,469 (0,000)
Pioneer	0,985 (0,000)	72,506 (0,000)	Gold	0,967 (0,000)	285,370 (0,000)
PZU	0,886 (0,000)	2197,165 (0,000)	Silver	0,941 (0,000)	1182,830 (0,000)
Opera	0,958 (0,000)	277,332 (0,000)	Platinum	0,977 (0,000)	117,485 (0,000)
Corn	0,963 (0,000)	442,776 (0,000)	FTSE 100	0,972 (0,000)	135,896 (0,000)
Soybean	0,924 (0,000)	2968,810 (0,000)	S&P 500	0,954 (0,000)	251,080 (0,000)
Wheat	0,980 (0,000)	86,819 (0,000)	x	x	x

Source: own calculations

In the next step of the research, Granger causality test was applied in order to answer the question whether changes in prices of commodities on world markets Granger-cause changes in quotations of participation units in specialized commodity funds operating in Poland. As in the Granger procedure variables are assumed to be stationary, augmented Dickey-Fuller (ADF) test was used to verify the stationarity of investigated time series. Its results are presented in table 5. Since they let us conclude that all considered time series were stationary, the following series of hypotheses were formulated and verified:

H_0: *changes in prices of commodity X do not Granger-cause changes in quotations of fund Y.*

As the Granger causality test depends critically on the number of lags, the test was applied using several lags (k=1, 2,…, 5). Results (values of Wald statistic) are reported in tables 6 – 8, where arrows point to the direction of causality and the bold type implies there is presence of Granger causality at 0,05 significance level. In most cases the lag length did not influence test results.

Table 5. ADF test results for logarithmic returns of separate assets and indices

Asset	Tau statistic	Asset	Tau statistic
Idea S.P.	-17,3809 (0,000)	Crude oil	-20,1048 (0,000)
Inv. G.	-19,4703 (0,000)	Copper	-19,5733 (0,000)
Inv. A.	-21,2287 (0,000)	Aluminum	-19,9100 (0,000)
Skarbiec	-19,5318 (0,000)	Lead	-18,5830 (0,000)
BPH	-19,0382 (0,000)	Nickel	-18,6120 (0,000)
Pioneer	-19,6300 (0,000)	Gold	-20,0223 (0,000)
PZU	-20,1434 (0,000)	Silver	-20,7975 (0,000)
Opera	-19,2349 (0,000)	Platinum	-18,6534 (0,000)
Corn	-19,8693 (0,000)	FTSE 100	-19,4881 (0,000)
Soybean	-19,9067 (0,000)	S&P 500	-18,8919 (0,000)
Wheat	-19,7206 (0,000)	x	x

Source: own calculations

On the base of results displayed in tables 6 – 8 one may notice Granger causality flowing from corn, soybean, wheat, crude oil, copper, aluminum, lead, nickel, gold, silver, and platinum returns to the Idea Surowce Plus returns, while there was no causal relationship between FTSE 100 index returns and returns of the fund. Regardless the lag length, there was causality running from gold and FTSE 100 returns to Investor Gold returns. Changes in soybean, crude oil, copper, aluminum and nickel prices Granger-caused changes in Investor Agrobizness quotations. Analogous relationship was also observed for S&P 500 index and Investor Agrobiznes fund.

The study also detected the causal relationship running from corn, soybean, wheat and crude oil returns to Skarbiec Rynków Surowcowych returns. Then, there were also exhibited causal relationships between returns from all assets and Pioneer Surowców i Energii, except FTSE 100. On the contrary, changes in prices of two commodities only: wheat and crude oil Granger-caused changes in quotations of BPH Globalny Surowców i Żywności. Moreover, there was no evidence of causality between any commodity or index and PZU Energia Medycyna Ekologia returns (the fund returns were also uncorrelated with returns from almost all assets except crude oil).

Table 6. Granger causality test results for Idea Surowce Plus, Investor Gold and Investor Agrobiznes

Relationship	*k*=1	*k*=2	*k*=3	*k*=4	*k*=5
Corn→Idea S.P.	**22,68**	**25,80**	**26,10**	**26,57**	**26,77**
Soybean→Idea S.P.	**37,33**	**38,86**	**37,95**	**39,03**	**39,39**
Wheat→Idea S.P.	**46,63**	**52,17**	**50,57**	**53,67**	**53,95**
Crude oil→Idea S.P.	**188,45**	**195,97**	**193,21**	**204,26**	**211,43**
Copper→Idea S.P.	**65,22**	**70,70**	**76,37**	**79,95**	**81,23**
Aluminum→Idea S.P.	**52,19**	**62,01**	**63,21**	**64,16**	**64,16**
Lead→Idea S.P.	**47,98**	**51,67**	**51,93**	**53,05**	**58,74**
Nickel→Idea S.P.	**59,04**	**64,80**	**63,87**	**68,48**	**71,56**
Gold→Idea S.P.	**18,62**	**19,01**	**19,67**	**20,96**	**24,74**
Silver→Idea S.P.	**8,19**	**8,03**	**10,69**	**11,31**	**14,17**
Platinum→Idea S.P.	**42,35**	**38,78**	**44,27**	**47,55**	**49,38**
FTSE 100→Idea S.P.	2,35	4,87	5,41	6,24	6,72
S&P500→Idea S.P.	0,36	3,51	7,40	**11,05**	**11,34**
Corn→Inv. G.	0,49	0,63	1,05	1,15	1,97
Soybean→Inv. G.	0,10	0,70	0,59	0,65	0,81
Wheat→Inv. G.	**5,71**	5,86	5,62	**10,30**	10,42
Crude oil→Inv. G.	0,41	3,96	6,44	6,75	6,82
Copper→Inv. G.	2,26	3,05	3,14	3,38	4,64
Aluminum→Inv. G.	**4,17**	4,33	4,98	7,40	9,49
Lead→Inv. G.	0,50	4,70	1,55	4,04	4,53
Nickel→Inv. G.	**6,57**	**7,15**	6,98	7,69	7,50
Gold→Inv. G.	**11,21**	**19,47**	**19,56**	**20,01**	**20,46**
Silver→Inv. G.	0,59	0,90	4,05	5,21	7,37
Platinum→Inv. G.	1,58	2,79	4,51	4,86	5,30
FTSE 100→Inv. G.	**7,57**	**13,05**	**12,92**	**13,03**	**13,85**
S&P 500→Inv. G.	1,05	1,63	2,13	2,74	4,44
Corn→Inv. A.	**4,37**	4,91	4,72	4,63	5,33
Soybean→Inv. A.	**8,57**	**8,41**	**8,49**	8,53	9,55
Wheat→Inv. A.	**6,57**	**9,21**	5,90	9,20	9,54
Crude oil→Inv. A.	**23,27**	**24,89**	**28,33**	**31,45**	**41,32**
Copper→Inv. A.	**12,98**	**13,88**	**14,56**	**14,29**	8,67
Aluminum→Inv. A.	**7,69**	**7,74**	**7,92**	8,17	9,16
Lead→Inv. A.	**5,01**	5,07	5,06	5,28	5,66
Nickel→Inv. A.	**18,31**	**17,80**	**16,37**	**15,21**	**14,90**
Gold→Inv. A.	0,26	0,72	1,72	1,79	1,84
Silver→Inv. A.	0,18	0,17	0,28	0,26	0,63
Platinum→Iv. A.	**4,02**	5,49	6,74	7,28	8,41
FTSE 100→Inv. A.	3,57	**6,53**	6,24	5,88	7,22
S&P 500→Inv. A.	**14,38**	**20,89**	**19,64**	**19,21**	**22,17**

Source: own calculations

Table 7. Granger causality test results for Skarbiec Rynków Surowcowych, Pioneer Surowców i Energii and BPH Globalny Żywności i Surowców

Relationship	*k*=1	*k*=2	*k*=3	*k*=4	*k*=5
Corn→Skarbiec	**7,55**	**11,80**	**13,04**	**13,13**	**12,20**
Soybean→Skarbiec	**16,81**	**22,88**	**23,05**	**23,53**	**24,35**
Wheat→Skarbiec	**9,37**	**11,18**	**16,48**	**18,48**	**18,48**
Crude oil→Skarbiec	**59,06**	**67,48**	**69,66**	**73,05**	**80,80**
Copper→Skarbiec	1,48	3,14	**9,75**	**10,18**	9,63
Aluminum→Skarbiec	0,44	2,24	3,49	4,61	4,33
Lead→Skarbiec	0,41	1,78	3,09	3,64	4,66
Nickel→Skarbiec	0,65	1,71	1,65	2,70	2,96
Gold→ Skarbiec	3,36	3,53	4,29	5,49	5,79
Silver→Skarbiec	0,11	1,34	2,09	4,37	4,27
Platinum→Skarbiec	0,07	0,78	1,09	2,91	3,33
FTSE 100→Skarbiec	0,004	2,87	3,51	4,23	7,24
S&P 500→Skarbiec	0,90	1,67	3,23	3,40	3,53
Corn→Pioneer	**49,01**	**52,84**	**53,34**	**55,98**	**56,04**
Soybean→Pioneer	**81,26**	**90,81**	**90,67**	**92,62**	**91,05**
Wheat→Pioneer	**167,14**	**165,73**	**162,75**	**169,11**	**169,15**
Crude oil→Pioneer.	**506,24**	**532,75**	**522,94**	**535,61**	**597,82**
Copper→Pioneer	**165,73**	**177,57**	**192,61**	**194,10**	**195,08**
Aluminum→Pioneer	**106,35**	**108,94**	**111,55**	**111,21**	**111,92**
Lead→Pioneer	**113,86**	**119,76**	**125,26**	**127,06**	**125,99**
Nickel→ Pioneer	**155,39**	**154,89**	**150,44**	**151,90**	**155,21**
Gold→Pioneer	**111,84**	**114,41**	**117,77**	**120,20**	**129,00**
Silver→Pioneer	**96,38**	**101,25**	**105,18**	**105,01**	**109,89**
Platinum→Pioneer	**164,47**	**166,02**	**183,45**	**185,53**	**188,58**
FTSE 100→Pioneer	2,75	2,85	3,52	4,26	4,73
S&P500→Pioneer	**29,90**	**46,27**	**45,01**	**44,53**	**44,78**
Corn→BPH	2,10	**7,30**	**8,95**	8,95	9,22
Soybean→BPH	0,68	5,64	5,97	5,95	6,99
Wheat→BPH	**9,63**	**10,95**	**14,90**	**16,16**	**17,27**
Crude oil→BPH	**27,28**	**33,38**	**34,24**	**34,87**	**36,34**
Copper→BPH	2,18	3,62	3,60	6,99	6,07
Aluminum→BPH	0,78	1,89	2,03	5,75	4,93
Lead→BPH	2,22	4,94	4,92	5,43	5,22
Nickel→BPH	0,27	1,02	1,73	5,96	4,99
Gold→BPH	3,31	2,99	2,97	5,16	5,04
Silver→BPH	0,37	0,76	1,27	3,25	3,65
Platinum→BPH	1,60	2,33	3,20	5,64	4,85
FTSE 100→BPH	0,48	0,70	1,96	4,79	6,11
S&P 500→BPH	1,72	1,80	2,20	2,89	3,51

Source: own calculations

Table 8. Granger causality test results for PZU Energia Medycyna Ekologia and Opera Substantia.pl

Relationship	*k*=1	*k*=2	*k*=3	*k*=4	*k*=5
Corn→PZU	0,03	1,05	4,69	5,45	5,91
Soybean→PZU	0,01	0,02	0,08	1,73	1,53
Wheat→PZU	0,03	0,59	0,86	0,81	1,64
Crude oil→PZU	1,14	2,05	5,31	5,63	5,88
Copper→PZU	1,79	1,52	1,97	2,47	4,08
Aluminum→PZU	0,98	1,48	2,54	4,39	6,14
Lead→PZU	3,40	4,52	4,99	5,29	5,59
Nickel→PZU	0,33	0,35	0,49	0,97	5,09
Gold→PZU	1,29	1,59	2,88	3,19	5,69
Silver→PZU	1,36	2,08	2,07	2,43	2,54
Platinum→PZU	1,75	1,67	2,48	2,42	3,13
FTSE 100→PZU	0,003	2,62	3,02	6,48	6,64
S&P 500→PZU	0,15	2,46	0,14	4,61	4,69
Corn→Opera	**4,93**	5,68	6,43	6,49	8,70
Soybean→Opera	**12,24**	**13,69**	**13,36**	**15,43**	**17,65**
Wheat→ Opera	**50,59**	**54,07**	**52,73**	**55,66**	**57,69**
Crude oil→Opera	**161,38**	**168,95**	**162,75**	**165,30**	**163,56**
Copper→Opera	**7,94**	**11,57**	**20,56**	**22,75**	**24,38**
Aluminum→Opera	**12,84**	**20,20**	**23,33**	**23,67**	**23,14**
Lead→Opera	**12,00**	**14,40**	**15,28**	**15,36**	**17,77**
Nickel→Opera	**10,65**	**13,39**	**16,26**	**20,30**	**20,04**
Gold→Opera	**43,41**	**44,18**	**45,41**	**47,46**	**49,94**
Silver→Opera	**10,85**	**10,61**	**13,43**	**13,14**	**13,06**
Platinum→Opera	**15,89**	**17,24**	**21,78**	**23,66**	**23,70**
FTSE 100→Opera	0,64	1,63	2,07	2,11	2,22
S&P 500→Opera	0,07	4,10	4,44	5,68	7,40

Source: own calculations

Finally, the study revealed clear causality flowing from soybean, wheat, crude oil, copper, aluminum, lead, nickel, gold, silver and platinum returns to the Opera Substantia.pl returns.

CONCLUDING REMARKS

In recent years, passive investments in commodities provided high (equity-like) average returns, negative return correlations with traditional asset classes and some protection against inflation. One of the most attractive aspects of commodity investments today is that there is a bunch of alternative means of obtaining commodity returns including direct commodity investment through purchasing real commodities in spot markets or through commodity based futures and options,

direct equity investment and commodity based mutual funds. The paper focuses on the latter.

Although there are numerous commodity specialized funds functioning in Poland, only a few of them have been operating for more than three or four years. Thus the research presented in the paper had to be limited. It was aimed at answering the question whether changes in prices of commodities on world markets Granger-cause changes in quotations of participation units in specialized commodity funds operating in Poland.

The study covered the period from 2009 to 2011 and included eight commodity funds, eleven commodities and two stock indices. On the base of their logarithmic returns, there were calculated basic descriptive statistics and coefficients of correlations. Then tests for normality and stationarity were conducted. Finally, to achieve the purpose of the study, Granger causality test was used. In most cases results revealed Granger causality running from commodity returns to the funds returns, whereas in only few cases there were observed relationships between stock indices (FTSE 100 and S&P 500) returns and commodity funds returns. The results are generally consistent with investment policies of separate funds.

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