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EXTREME PRICE RISK ON THE MARKET OF RAPESEEDS AND PROCESSED RAPESEED PRODUCTS IN POLAND[1]

EKSTREMALNE RYZYKO CENOWE NA RYNKU RZEPAKU I PRODUKTÓW PRZEROBU RZEPAKU W POLSCE

Key words: rapeseeds, rapeseed meal, rapeseed oilcake, rapeseed oil, extreme values theory, extreme price risk

Słowa kluczowe: rzepak, śruta rzepakowa, makuch rzepakowy, olej rzepakowy, teoria wartości ekstremalnych, ekstremalne ryzyko cenowe

Abstract. We can observe increasing volatility in rapeseed prices caused by the progressing process of globalisation in the turnover and processing of this raw material. It increases the exposure of rapeseed-producing entities and rapeseed-processing enterprises to price risk. The aim of this study is to assess the extreme price risk on the market of rapeseeds and processed rapeseed products in Poland. The study was based on average weekly rapeseed purchase prices and sales prices of refined rapeseed oil, rapeseed meal and rapeseed oilcake from 3 January 2005 and 19 April 2015. Extreme risk was measured with two measures: value at risk and expected shortfall. Extreme value theory was also applied. The research findings point to differences in the level of risk on the market of rapeseeds and processed rapeseed products.

Introduction

The deficit of domestic protein feeds causes a situation where about 75% of high protein materials for feeds are imported. Soybean extraction meal made from genetically modified soy cultivars is predominant. Due to this fact and considerable fluctuations in the prices of soybean extraction meal as well as owing to the fact that breeders want to reduce the costs of pork production there are attempts to find other, cheaper sources of vegetable protein to feed monogastric animals [Sobotka 2004]. Among domestic vegetable protein feeds rapeseed extraction meal and rapeseed oilcake, which are by-products of rapeseeds processing, deserve attention. Apart from that, the significance of domestic raw materials may increase after 1 January 2017, when feeding animals with genetically modified feeds and genetically modified organisms used as feeds will be forbidden [Dz.U. nr 144, poz. 1045, z późn. zm.]. As a result, we can expect that when the law prohibiting the use of GMO feeds becomes effective, the prices of poultry meat, pork, milk and eggs will rise by a dozen or several dozen per cent. Therefore, it is necessary to search for alternatives to soy and find other high protein feed components, which would be comparable to soy not only in terms of quality but also cost-effectiveness [Just, Śmiglak-Krajewska 2013].

As different sources report, rapeseed meal contains 33-38% of total protein, whereas rapeseed oilcake contains 28-32% of total protein [Krasucki, Grela 2004, Brzóska et al. 2010, Kalembasa, Adamiak 2010, Dzwonkowski, Hryszko 2011, Kowalska, Bielański 2011]. Rapeseed feeds are very good for pigs and cattle, but their application for feeding poultry may be limited. Rapeseed feeds contain less lysine amino acid than soy meal and the digestibility of both exogenous amino acids is lower than in soy [Brzóska 2009].

In 2014 the area of rapeseeds plantations (including agrimony) in Poland was 941.6 thousand ha and it was 2.3% greater than in the previous year. The average yield of rapeseeds and agrimony

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was estimated at 34.3 dt/ha, so it was 5.2 dt/ha (17.9%) greater than in 2013. The crop of rapeseeds and agrimony was estimated at more than 3.2 million tonnes. It was over 0.5 million tonnes (20.5%) greater than in 2013 and over 1.1 million tonnes (more than a half) greater than the average yield between 2006 and 2010. The highest crop was noted in Lower Silesian Province (431.1 thousand tonnes), Greater Poland Province (422.9 thousand tonnes), West Pomeranian Province (416.6 thousand tonnes) and Kuyavian-Pomeranian Province (400.4 thousand tonnes). The lowest crop was in Świętokrzyskie Province (25.3 thousand tonnes) and Lesser Poland Province (25.5 thousand tonnes) [*Wynikowy szacunek*… 2014].

For many years oil plant meals have been predominant in the structure of consumption of high protein feed materials in Poland. Among them soybean meal is the most important, as its share in the consumption reached 55-65% in the last three seasons. Rapeseed meal is the secondv most popular (its share reached 20-24%) and sunflower meal is the third most common (with a share of 14-20%) [*Rynek pasz*... 2014].

According to the data of the Polish Association of Oil Producers, the organisation which associates about 90% of domestic oil-processing companies, in 2014 the member-companies processed more than 2.4 million tonnes of rapeseeds (9% more than in the previous year). They produced about 1.03 million tonnes of crude rapeseed oil and 1.3 million tonnes of rapeseed extraction meal and 53 thousand tonnes of rapeseed oilcake [www.kzprirb.pl].

In the last ten years the economic significance of rapeseeds has increased considerably, as compared with other industrial plants. Rape is exclusively a commodity crop and it is not used for farms' own needs. Therefore, the rapeseeds price level and stability have considerable influence on farms' income. Increased variability of prices of some agricultural raw materials, including rapeseeds, was caused by progressing globalisation in the turnover and processing of these materials [Jerzak, Łąkowski 2013]. From January 2005 to mid-April 2015 the average purchase price on the domestic rapeseed market ranged from 768.04 zlotys per tonne in late July 2005 to 2107 zlotys per tonne in May 2012. Then it dropped to 1519 zlotys per tonne in the second half of April 2015 [www.minrol.gov.pl]. At that time there were strong fluctuations in the prices of rapeseeds and processed rapeseed products. Changes in price trends on the rapeseeds market fundamentally influence the stability of economic conditions for entities producing rapeseeds and enterprises processing this raw material. Market price fluctuations increase these entities' exposure to price risk and thus they affect the stability of their income. In order to manage these entities' risk effectively it is necessary to measure the rapeseeds price risk appropriately, including analysis of extreme price variation. Therefore, the aim of this study was to assess extreme price risk on the market of rapeseeds and processed rapeseed products in Poland. Quantile risk measures (value at risk, expected shortfall) calculated by means of the extreme value theory were used to measure the extreme risk. Publications [Morgan et al. 2012; Van Oordt et al. 2013] provide descriptions of research where the extreme value theory was used to measure risk on the markets of agricultural commodities.

Research material and methodology

The research was based on series of average weekly rapeseeds purchase prices and sales prices of refined rapeseed oil, rapeseed meal and rapeseed oilcake in Poland from 3 January 2005 to 19 April 2015. The prices were noted in the Integrated Agricultural Market Information System, which is managed by the Department of Agricultural Markets, Ministry of Agriculture and Rural Development [www.minrol.gov.pl]. The prices of individual products were used to calculate weekly logarithmic increases in percentage (rates of return) from the formula: $r_t = 100 \ln (P_t/P_{t-1})$, where P_t is the commodity average price in period t. In total, 535 growths were calculated.

The extreme value theory was used for estimation of the extreme price risk for individual commodities. Two quantile risk measures were determined: value at risk and expected shortfall. In addition, the calculated values at risk were compared with the values obtained after the application of normal distribution and empirical distribution.

Downside risk measures are used to measure risk in the negative concept and they measure the potential loss. Value at Risk (*VaR*) is the most common downside risk measure. It refers to the amount of loss of the investment value (financial instrument, commodity or entire portfolio), where the probability that it will take place or be exceeded in a set period of time equals a predefined toleration level. Formally *VaR* is expressed with the following formula [Jajuga et al. 2001]:

$$P(P_t \leq P_{t-1} - VaR) = \alpha \tag{1}$$

where: P_t – the value of investment, financial instrument or commodity in time t, α – the set toleration level.

The loss can also be expressed as percentage, which allows us to compare risk. If r_t is the percentage logarithmic rate of return on the financial instrument or commodity in time t, *VaR* is defined with the following formula:

$$P(r_t \leq -VaR) = \alpha \tag{2}$$

VaR for the toleration level α for the long position in the financial instrument or commodity making a loss when the price of this instrument or commodity decreases is the opposite number to the quantile of distribution of the rate of return:

$$VaR_{\alpha,t+1} = -F_{r_t}^{-1}(\alpha) \tag{3}$$

where $F_{r_t}^{-1}(\alpha)$ is the α-quantile of distribution of the rate of return r_t. *VaR* for the short position in the financial instrument or commodity making a loss when the price of this instrument or commodity increases is the $1-\alpha$-quantile of distribution of the rate of return r_t :

$$VaR_{1-\alpha,t+1} = F_{r_t}^{-1}(1-\alpha) \tag{4}$$

Value at risk does not show how great the loss can be if it exceeds the value at risk. Expected Shortfall (*ES*) is the measure of risk which provides information about the volume of loss. The *ES* measure is defined as the expected shortfall value on condition that the loss is greater than the value at risk.

The Extreme Values Theory (EVT) provides tools to measure extreme risk. There are two approaches to extreme value modelling in this theory. The first approach is based on the Block Maxima Model (BMM), which enables estimation of the distribution of extremes. The other approach is used more often and it is based on the Peaks over Threshold Model (POT), which enables estimation of the tail of distribution of returns. The tail of distribution of returns is modelled by means of Generalised Pareto Distribution (GPD), whereas the beginning of the tail is defined by determination of the threshold value.

In the peak over threshold model [McNeil 1999, Morgan et al. 2012] the starting point for considerations is the conditional distribution of peak-over-threshold values u of random variable X, which is defined with the following formula:

$$F_u(x) = P(X - u \leq x | X > u) = \frac{F(x+u) - F(u)}{1 - F(u)} \tag{5}$$

where F is the unknown cumulative distribution function of random variable X.

According to the Pickands-Balkema-de Haan theorem, cumulative distribution function F_u is characterised by threshold distribution if value u is high enough. It is generalised Pareto distribution with the following cumulative distribution function:

$$G_{\xi,\beta}(x) = \begin{cases} 1 - (1 + \xi x / \beta)^{-1/\xi}, & \xi \neq 0 \\ 1 - \exp(-x / \beta), & \xi = 0 \end{cases} \tag{6}$$

where: $\beta > 0$, $x \geq 0$, for $\xi \geq 0$ and $0 \leq x \leq -\beta / \xi$ for $\xi < 0$.

There are two parameters in this distribution: β – the scale parameter and ξ – the shape parameter, which is responsible for the tail thickness.

Positive values of parameter ξ result in the presence of thick (heavy) tails, which involves higher probability of occurrence of extreme returns. On the other hand, negative values of parameter ξ result in thinner tails than in the normal distribution. The parameters of the Pareto cumulative distribution function are estimated with the maximum likelihood method. This estimation requires the choice of the threshold value *u,* which affects the estimator values obtained. If threshold value *u* is too high, few observations will exceed threshold *u*. This will result in high variation. If threshold value *u* is too low, the estimators will be excessively burdened. Formulas (5)-(6) are used to calculate the cumulative distribution function of variable *X*:

$$F(x) = \left(1 - F(u)\right)G_{\xi,\beta}(x-u) + F(u), \ x > u \tag{7}$$

Then the $F(u)$ value must be replaced by the empirical estimator $\hat{F}(u) = 1 - N_u / n$, where *n* is the number of observations, and N_u is the number of peaks over threshold *u*. As a result, the following estimator of cumulative distribution function *F* is obtained:

$$\hat{F}(x) = 1 - \frac{N_u}{n}\left(1 + \hat{\xi}\,\frac{(x-u)}{\hat{\beta}}\right)^{-1/\hat{\xi}} \tag{8}$$

When *x* is calculated from the equation (8), *VaR* for the short position can be expressed with the following formula:

$$VaR_{1-\alpha} = u + \frac{\hat{\beta}}{\hat{\xi}}\left(\left(\frac{n}{N_u}\alpha\right)^{-\hat{\xi}} - 1\right) \tag{9}$$

where α is the toleration level for *VaR.* In order to calculate the *VaR* for the long position, it is necessary to multiply rates of return by minus one.

The peak over threshold model enables determination of the expected shortfall for the short position by means of the following formula [McNeil 1999; Morgan et al. 2012]:

$$ES_{1-\alpha} = \frac{VaR_{1-\alpha}}{1-\hat{\xi}} + \frac{\hat{\beta} - \hat{\xi}u}{1-\hat{\xi}} \tag{10}$$

Research results

Table 1 shows the descriptive statistics of percentage series of logarithmic increases in prices of rapeseeds and processed rapeseed products as well as the Jarque-Bera test values. The arithmetic means of logarithmic increases in prices of rapeseeds and processed rapeseed products are close to zero and they do not differ significantly from zero at a 5% significance level (test *t*). The logarithmic increases in rapeseed meal prices are characterized by the greatest volatility, which was measured with the range and standard deviation. This points to the high dynamics of these prices.

Table 1. Descriptive statistics of logarithmic increases in prices and the value of the Jarque-Bera test (J-B) for rapeseeds and processed rapeseed products
Tabela 1. Statystyki opisowe logarytmicznych przyrostów cen oraz wartość testu Jarque'a-Bery (J-B) dla rzepaku i produktów jego przerobu

Statistics/*Statystka*	Rapeseeds/ *Nasiona rzepaku*	Refined oil/ *Olej rafinowany*	Rapeseed meal/ *Śruta rzepakowa*	Rapeseed oilcake/ *Makuch rzepakowy*
Maximum/*Maksimum*	21.12	23.62	20.79	24.92
Minimum/*Minimum*	-16.27	-26.65	-28.71	- 16.68
Mean/Średnia	0.0905	0.0326	0.1713	0.1687
Standard deviation/ *Odchylenie standardowe*	3.68	3.73	6.00	3.81
Skewness/*Skośność*	0.44	-0.16	-0.20	0.50
Kurtosis/*Kurtoza*	8.87	12.75	5.02	10.01
J-B	786.37	2120.45	94.88	1117.65

Source: own study
Źródło: opracowanie własne

The standard deviation values for logarithmic increases in the prices of other commodities were similar. At the next stage the research will check whether extreme price risk levels are similar, too. The skewness is not statistically significant at a 5% significance level for logarithmic increases in prices of rapeseed oil and rape meal (D'Agostino test). There is positive skewness for logarithmic increases in prices of rapeseeds and rape oilcake. For all of the series of logarithmic increases in prices the kurtosis is significantly greater than three at a 5% significance level (Anscombe-Glynn test). This means that the distributions of increases in prices of all the commodities under study are characterised by thick tails, so the occurrence of extreme values in increase series is more frequent than in the normal distribution. The hypothesis about normality of the distributions of logarithmic increases in prices under study was rejected upon the Jarque-Bera test. As results from the study, it is necessary to model logarithmic increases in commodity prices with distributions allowing for thick tails and skewness.

Table 2 shows estimates of the parameters of the generalised Pareto distribution for the left and right tail of the distribution for logarithmic increases in prices of rapeseeds and processed rapeseed products, including standard errors. The calculations were made for the 90% threshold, which means that the highest 10% of positive and negative logarithmic price increases was regarded as extreme observations. The parameter estimates in the generalised Pareto distribution for logarithmic increases in the price of commodities under study were burdened with relatively gross errors. As far as logarithmic increases in the prices of rapeseeds and rapeseed oilcake are concerned, the shape parameter values for the right tail are greater than the values for the left tail. This means that the right tails of distributions of logarithmic increases in the prices of these commodities are thicker than the left tails and the occurrence of extreme loss is more likely to appear in the short rather than long position. On the other hand, as far as rapeseed oil and rapeseed meal are concerned, the left tails of distributions of logarithmic price increases are thicker than the right tails. The thickest left tail can be observed in the distribution of logarithmic increases in rapeseed oil prices. On the other hand, the heaviest right tails can be seen in the distributions of logarithmic increases in the prices of rapeseed oil and rapeseed oilcake. This may result in a higher level of extreme price risk on the market of these products. The values of parameter estimates largely depend on the assumed threshold value in the peak over threshold model.

The measures of extreme price risk were determined for market entities occupying the long and short position on the market of rapeseeds and processed rapeseed products, i.e. for the left and right tails of distributions of logarithmic increases in the prices of these commodities. The measures were estimated with 535 logarithmic increases in the product prices. The calculations were made at the following four toleration levels: 0.005, 0.01, 0.025 and 0.05.

The first stage of the research involved checking the influence of the choice of the threshold value in the peak over threshold model on the values of extreme risk measures. *VaR* and *ES* were

Table 2. Estimates of the parameters of the generalized Pareto distribution with standard errors in brackets
Tabela 2. Oszacowania parametrów uogólnionego rozkładu Pareto z błędami standardowymi w nawiasach

Commodity/*Towar*	Left tail/*Lewy ogon*			Right tail/*Prawy ogon*		
	u	$\hat{\xi}$	$\hat{\beta}$	u	$\hat{\xi}$	$\hat{\beta}$
Rapeseeds/ *Nasiona rzepaku*	-3.5326	-0.0391	3.1662	3.2951	0.0884	3.3763
		(0.1636)	(0.6736)		(0.1937)	(0.7985)
Refined oil/ *Olej rafinowany*	-3.6512	0.3634	1.8136	3.5437	0.1754	2.5739
		(0.2047)	(0.4368)		(0.1705)	(0.5581)
Rapeseed meal/ *Śruta rzepakowa*	-6.9778	-0.0152	4.1969	6.7963	-0.2627	5.3369
		(0.1328)	(0.7979)		(0.1449)	(1.0433)
Rapeseed oilcake/ *Makuch rzepakowy*	-3.7432	0.0257	2.9694	3.6426	0.1706	3.0009
		(0.1747)	(0.6574)		(0.1837)	(0.6826)

Source: own study
Źródło: opracowanie własne

Table 3. Estimates of the value at risk and expected shortfall for the generalized Pareto distribution (GP) at a toleration level of 0.01 for rapeseeds – calculations for different threshold values
Tabela 3. Oszacowania wartości zagrożonej i oczekiwanego niedoboru dla uogólnionego rozkładu Pareto (GP) na poziomie tolerancji 0,01 dla rzepaku wyznaczone dla różnych wartości progowych

Measure/ *Miara*	*VaR_GP*		*ES_GP*	
u [%]	left tail/ *lewy ogon*	right tail/ *prawy ogon*	left tail/ *lewy ogon*	right tail/ *prawy ogon*
88	10.53	11.92	13.34	17.96
89	10.56	11.91	13.27	17.10
90	10.62	11.96	13.20	16.42
91	10.50	12.07	13.37	16.03
92	10.60	12.22	13.24	15.85
93	10.38	12.43	13.64	15.77
94	10.43	12.40	13.50	15.78

Source: own study
Źródło: opracowanie własne

determined as quantile functions in the generalised Pareto distribution for rapeseeds and processed rapeseed products at a 0.01 toleration level and different thresholds assumed for tails in the distribution of logarithmic increases in the commodity prices ranging from 88% to 94%. Table 3 shows the *VaR* and *ES* estimates for rapeseeds. In order to calculate *VaR* and *ES* at 0.005, 0.01, 0.025 and 0.05 toleration levels it is necessary to choose a threshold value that is lower than 95%. The *VaR* and *ES* estimates for logarithmic increases in rapeseeds prices are close to the threshold values of 90%-94%. As far as the other products are concerned, stable risk estimates were also obtained for different threshold values. Therefore, the next stage of the research involved the determination of extreme risk measures for rapeseeds and processed rapeseed products as quantile functions in the generalised Pareto distribution, assuming a 90% threshold for the tails in the distribution of logarithmic increases in the commodity prices. Table 4 shows the *VaR* and *ES* estimates.

The greatest price risk measured with value at risk and expected shortfall can be observed on the rapeseed meal market. A market entity occupying the long position on the market (producer) is exposed to the risk of 19% or greater loss resulting from the decrease in the rapeseed meal value within one week, at a probability of 0.005. As far as the other commodities are concerned, the loss could reach 12.5-13.5% or more. This means that losses at these or greater levels may occur once in four years. Rapeseeds are characterised by the lowest extreme price risk. The risk level on the rapeseeds and rapeseed oilcake markets, measured with *VaR* and *ES*, is greater in the short position, but only for low toleration levels. As far as rapeseed meal is concerned, at low toleration levels the *VaR* and *ES* values indicate greater risk for entities occupying the long position. As far as rapeseed oil is concerned, *VaR* estimates are similar for the long and short positions. However, if the *VaR* level is exceeded, the peak-over-threshold values will be greater for the long position and low toleration levels.

Table 4. Estimates of the value at risk and expected shortfall for the generalized Pareto distribution (GP)
Tabela 4. Oszacowania wartości zagrożonej i oczekiwanego niedoboru dla uogólnionego rozkładu Pareto (GP)

VaR_GP	Left tail/*Lewy ogon*				Right tail/*Prawy ogon*			
α	0.005	0.01	0.025	0.05	0.005	0.01	0.025	0.05
Rapeseeds/*Nasiona rzepaku*	12.51	10.62	7.94	5.76	14.89	11.96	8.33	5.75
Refined oil/*Olej rafinowany*	13.51	10.24	6.97	5.11	13.72	10.89	7.62	5.47
Rapeseed meal/Śruta *rzepakowa*	19.35	16.59	12.83	9.92	17.89	16.05	13.04	10.22
Rapeseed oilcake/*Makuch rzepakowy*	13.00	10.83	7.99	5.86	15.40	12.17	8.40	5.89
ES_GP	Left tail/*Lewy ogon*				Right tail/*Prawy ogon*			
α	0.005	0.01	0.025	0.05	0.005	0.01	0.025	0.05
Rapeseeds/*Nasiona rzepaku*	14.93	13.20	10.74	8.74	19.59	16.42	12.48	9.68
Refined oil/*Olej rafinowany*	21.71	16.66	11.63	8.76	18.96	15.54	11.59	9.00
Rapeseed meal/Śruta *rzepakowa*	23.18	20.50	16.86	14.04	19.80	18.35	15.97	13.74
Rapeseed oilcake/*Makuch rzepakowy*	16.18	13.99	11.11	8.96	21.24	17.40	12.94	9.96

Source: own study
Źródło: opracowanie własne

Table 5. Estimates of the value at risk for the normal distribution (NORM) and empirical distribution (EMP)
Tabela 5. Oszacowania wartości zagrożonej dla rozkładu normalnego (NORM) i empirycznego (EMP)

VaR_NORM	Left tail/*Lewy ogon*				Right tail/*Prawy ogon*			
α	0.005	0.01	0.025	0.05	0.005	0.01	0.025	0.05
Rapeseeds/*Nasiona rzepaku*	9.38	8.46	7.11	5.96	9.56	8.64	7.30	6.14
Refined oil/*Olej rafinowany*	9.57	8.64	7.28	6.10	9.64	8.71	7.34	6.17
Rapeseed meal/Śruta *rzepakowa*	15.28	13.78	11.58	9.69	15.62	14.12	11.93	10.04
Rapeseed oilcake/*Makuch rzepakowy*	9.65	8.70	7.30	6.10	9.99	9.04	7.64	6.44
VaR_EMP	Left tail/*Lewy ogon*				Right tail/*Prawy ogon*			
α	0.005	0.01	0.025	0.05	0.005	0.01	0.025	0.05
Rapeseeds/*Nasiona rzepaku*	12.82	11.50	7.62	5.52	13.84	12.48	8.87	5.34
Refined oil/*Olej rafinowany*	11.84	10.13	7.10	5.08	13.44	11.52	7.48	5.57
Rapeseed meal/Śruta *rzepakowa*	18.38	16.85	12.49	10.09	17.56	15.50	14.07	9.57
Rapeseed oilcake/*Makuch rzepakowy*	13.39	10.48	8.33	5.81	15.61	11.87	9.15	5.84

Source: own study
Źródło: opracowanie własne

At the next stage of the research the *VaR* estimates determined by means of the extreme values theory were compared with values at risk determined by means of the empirical distribution quantile and normal distribution quantile. Table 5 shows the values of these estimates.

The results of measurements of extreme price risk for rapeseeds and processed rapeseed products calculated by means of the generalised Pareto distribution were usually similar to the results obtained for the empirical distribution. On the other hand, the *VaR* values obtained by means of the normal distribution were lower than the values calculated by means of the empirical distribution for low toleration levels. These results indicate that the extreme price risk for rapeseeds and processed rapeseed products measured with normal distribution quantiles was underestimated. It is in agreement with previous observations concerning the properties of distributions of logarithmic increases in the prices of these commodities.

Conclusions

The aim of this article was to assess extreme price risk on the market of rapeseeds and processed rapeseed products in Poland. Extreme price risk was measured by means of two measures, i.e. value at risk and expected shortfall, and it was based on the extreme value theory. The values at risk obtained in the calculations were compared with the value at risk estimates obtained by means of the normal distribution and empirical distribution.

The research results point to the absence of normality in the distributions of logarithmic increases in the prices of rapeseeds and processed rapeseed products and the presence of thick tails. The results confirm the possibility of frequent occurrence of unfavourable, large price fluctuations. Therefore, it seems justified that distributions of logarithmic price increases should be modelled by means of the peaks over threshold model derived from the extreme value theory. The advantage of this approach is that it models only distribution tails rather than entire distributions and thus, it is possible to estimate distribution tails more precisely. These observations were confirmed by similar *VaR* estimates which were obtained after the application of the generalised Pareto distribution from the peak over threshold model and the empirical distribution. The extreme risk measures point to the presence of differences in the price risk level on the market of rapeseeds and processed rapeseed products. The highest extreme price risk can be observed on the rapeseed meal market. The market of the commodities under investigation was characterised by the presence of asymmetry in the risk taken by the long and short positions.

Further research should assess the quality of estimates of extreme price risk on the market of rapeseeds and processed rapeseed products. However, in order to make this assessment it is necessary to acquire sufficiently long series of prices of these commodities.

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Streszczenie

Obserwowany wzrost zmienności cen rzepaku wywołany m.in. postępującym procesem globalizacji obrotu i przerobu tego surowca, zwiększa ekspozycję podmiotów produkujących rzepak oraz przedsiębiorstw zajmujących się przetwarzaniem tego surowca na ryzyko cenowe. Celem pracy była ocena ekstremalnego ryzyka cenowego na rynku rzepaku i produktów jego przerobu w Polsce. Wykorzystano w tym celu średnie tygodniowe ceny skupu nasion rzepaku oraz ceny sprzedaży oleju rzepakowego rafinowanego, śruty rzepakowej oraz makuchu rzepakowego od 3 stycznia 2005 do 19 kwietnia 2015 roku. Ekstremalne ryzyko zmierzono za pomocą dwóch miar – wartości zagrożonej i oczekiwanego niedoboru, wykorzystując teorię wartości ekstremalnych. Wyniki badań wskazały na występowanie różnic w poziomie ryzyka na rynku rzepaku i produktów jego przerobu.

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