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COMPARISON OF PRICE AND YIELD VARIABILITY IN POLAND

PORÓWNANIE ZMIENNOŚCI PLONÓW I CEN W POLSCE

Key words: yield risk, price risk, aggregation level

Słowa kluczowe: ryzyko plonów, ryzyko cenowe, poziom agregacji

Abstract. The paper is dedicated to the relationship of data aggregation level and variability of yields and prices of major crop plants. For that purpose yields and prices of the major crop plants in Poland are analysed i.e.: winter wheat, triticale, rye, barley, rape and sugar beet. The research are based on data from Polish FADN from years 2004-2009. The samples' size ranged from 531 to 2893 for yields and from 183 to 1139 for prices, depending on the plant crop. In the paper six levels of data aggregation are examined, that is: farm, district, powiat, voivodship, region and country. It was found out that the degree of yield variability reduction (observed with data aggregation) is crop specific. For the price variability it is also true but to less extent. On general the reduction observed for the yield variability was much bigger than for the price variability. In the case of rape the reduction observed on the country level for yield variability was ten times higher than for the price variability.

Introduction

Price risk and yield risk are the most significant risks in the agriculture sector. In the analysis of risk in agriculture much greater attention is given to price risk than to yield risk. The reason for that is twofold: the availability of data and magnitude of variability on the national level of data aggregation. The prices time series are fairly easy to obtain and, due to the high spatial correlation, it is believed that the national level of aggregation does not matter. In the case of yield time series it is generally not true.

In previous work of the author [Kobus 2009] it was shown that the standard deviation for wheat yield (after eliminating the influence of the trend) takes values from 2 decitons (dt) per hectare in Podkarpackie to 5.4 dt/ha in Lubuskie. It shows that even on NUTS 2 level there exists considerable unevenness of yield risk, which prevents using highly aggregated data for modelling plant production risk on the farm level.

Another reason for neglecting yield risk in quantitative analysis of risk in agriculture in favour of price risk is magnitude of variability. In the case of major crop plants variability of prices, measured by the variation coefficient on national level, is roughly 3 times higher than variability of yields. It suggests that yield risk can be, without great loose to quality, omitted in modelling distribution of income from plant production. On the other hand it should be taken into consideration that there is a long way from the national to the farm level of data aggregation. Consequently, depending on the degree of spatial correlation, proportion of variability measures for yields and prices can be very different on the farm level.

The main aim of this paper is to find out how the level of data aggregation influence values of variability measures for major crop plants in Poland. And how the level of data aggregation change proportion of those measures for yields and prices.

Data and applied methods

The main source of data was Polish Farm Accountancy Data Network (FADN), which has the second largest sample in the FADN (over 11 thousand farms). Another source of data were Central Statistical Office of Poland [Rocznik Statystyczny... 2010].

The process of data selection was as follows: the samples for years 2004-2009 were screened for farms which were present in the samples for all years, then from that pool a separate selection was carried out for each crop. The criterion for selection was availability of yields for specific crop plant for each year. The same was done separately for prices, but in the case of prices the criterion was availability of transaction data for each year. This is the reason for different sizes of samples presented in Table 1.

Table 1. The sizes of samples for each plant researched
Tabela 1. Rozmiary prób dla poszczególnych roślin uprawnych

Crop plant/Roślina uprawna	Sample size/Rozmiar próby	
	yields/plony	prices/ceny
Winter wheat/Pszemica ozima	2748	1139
Triticale/Pszemzyto	2893	190
Rye/Żyto	1627	183
Barley/Jęczmień	2033	296
Rape (with turnip rape)/Rzepak (razem z rzepikiem)	741	645
Sugar beet/Burak cukrowy	874	820

Source: own study
 Źródło: opracowanie własne

Table 2. Mean standard deviations for yields and prices
Tabela 2. Odchylenia standardowe dla plonów i cen

Aggregation level/ Poziom agregacji	Mean SD/ Średnie SD [dt/ha]	Reduction degree/ Stożenie redukcji [%]	Mean SD/ Średnie SD [dt/ha]	Reduction degree/ Stożenie redukcji [%]
	yield/plon		price/cena	
Wheat/Pszemica				
Farm/Gospodarstwo rolne	8.9	0	14.0	0
District/Gmina	7.4	17	13.2	6
Powiat/Powiat	6.3	29	12.6	10
Voivodship/Województwo	5.4	40	12.0	14
Region/Region	4.9	45	11.9	15
Country/Kraj	4.8	47	11.8	16
Triticale/Pszemzyto				
Farm/Gospodarstwo rolne	8.2	0	14.2	0
District/Gmina	6.6	19	13.9	2
Powiat/Powiat	5.6	31	13.4	5
Voivodship/Województwo	4.9	40	11.7	17
Region/Region	4.6	43	11.6	18
Country/Kraj	4.5	45	11.5	19
Rape (with turnip rape)/Rzepak (razem z rzepikiem)				
Farm/Gospodarstwo rolne	6.1	0	17.3	0
District/Gmina	5.2	15	17.0	2
Powiat/Powiat	4.2	32	16.7	4
Voivodship/Województwo	2.7	55	16.3	6
Region/Region	2.4	61	16.3	6
Country/Kraj	2.3	63	16.2	6
Sugar beet/Burak cukrowy				
Farm/Gospodarstwo rolne	83.4	0	3.8	0
District/Gmina	70.3	16	3.6	6
Powiat/Powiat	59.6	29	3.5	10
Voivodship/Województwo	50.8	39	3.4	13
Region/Region	46.8	44	3.2	17
Country/Kraj	44.7	46	3.1	20

Source: own study
 Źródło: opracowanie własne

In this paper six levels of data aggregation are examined, that is: farm, district, powiat¹, voivodship, region and country. The average total area (in thous. ha) of the mentioned data aggregation levels are respectively (starting from district): 14.8, 99.6, 1954.2, 7817.0 and 31,267.9. Arable land constituted almost 39% of the total area in year 2008 [Rocznik Statystyczny... 2010]. In the same year the average used arable land of the farm in Polish FADN sample was 12.76 ha, which is much higher than the average arable land of the farm in Poland reported by Central Statistical Office. The reason for this is the fact that the Polish FADN sample is constructed to be representative of farms of economic size of at least 2 ESU.

For all territorial units, on each level of aggregation, prices and yields' standard deviations were calculated according to the following formula:

$$S_{a_i} = \sqrt{\frac{\sum_{i=1}^6 [(Y_{a_i,i} - \bar{Y}_{a_i})]^2}{6-1}} \quad (1)$$

where: $Y_{a_i,i}$ is a weighted average yield (or price) from all farms in the administrative unit a_i , the subscript i denotes a level of aggregation from the level 0 (no aggregation) to the level 5 with data aggregated for the whole country.

The yields and prices used for calculating the standard deviations were not detrended deliberately, although in another paper of the author [Kobus 2010] detrending was recommended. The reason for that were the relatively short time series, which involved a risk of serious overfitting, especially on a low level of aggregation. As a consequence, it could conceal the relation between the level of aggregation and yield or price risk.

To isolate the above mentioned relation from all factors which influence yield and price variability, except the level of aggregation, weighted averages of standard deviations were calculated. The areas of administrative units were used as weights for yields and for prices the sales size.

¹ Powiat is the second level of local government administration in Poland.

Results

The values of standard deviations of yields and prices are presented in Table 2. It may be observed that for all crop plants, considered in this analysis, values of variability measures are getting lower with an increase of data aggregation level.

To better assess similarities between the various crop plants the degree of reduction of standard deviation values from the farm level was also calculated, according to the following formula:

$$RD_i = (1 - \frac{S_i}{S_0}) \times 100\% \quad (2)$$

where RD_i is the reduction degree on the level i , S_i is the mean standard deviation on that level and S_0 is the mean standard deviation on the farm level of data aggregation.

When looking at the reduction of yields variability on the country level it may be observed that for all crop plants, except rape, there is similar reduction, i.e.: between 42% and 50%. It means that yield variability measured by standard deviations is almost twice higher at the farm level than at the country level; in case of rape it is three times higher. On the other hand the reduction observed for price variability on the country level is much lower and is ranging from typically between 15% and 20%. What is interesting rape is again an exception, but contrary to yields this time the reduction is smaller.

Direct comparison of standard deviation between different species and especially between yields and prices could be misleading. Comparison of variation coefficients is much more informative.

Comparing values from Tables 3 and 4 may be observed that on general variation coefficients for prices are bigger than for yields. However, the differences are much more bigger on the national level

Table 3. Variation coefficients and averages for yields
Tabela 3. Współczynniki zmienności i średnie dla plonów

Aggregation level/ Poziom agregacji	Variation coefficients/Współczynniki zmienności [%]					
	winter wheat/ pszenica ozima	triticale/ pszenżyto	rye/ żyto	barley/ jęczmień	rape/ rzepak	sugar beet/ burak cukrowy
Farm/Gospodarstwo rolne	16.6	18.8	22.6	21.8	18.8	16.8
District/Gmina	13.8	15.2	19.5	18.9	16.0	14.1
Powiat/Powiat	11.7	13.0	16.5	16.6	12.8	12.0
Voivodship/Województwo	10.0	11.2	13.2	13.9	8.4	10.2
Region/Region	9.1	10.7	12.0	12.1	7.4	9.4
Country/Kraj	8.8	10.4	11.7	10.9	6.9	9.0
Average yield/Średni plon	53.9	43.4	29.2	38.9	32.5	498.1

Source: own study

Źródło: opracowanie własne

Table 4. Variation coefficients and averages for prices
Tabela 4. Współczynniki zmienności i średnie dla cen

Aggregation level/ Poziom agregacji	Variation coefficients/Współczynniki zmienności [%]					
	winter wheat/ pszenica ozima	triticale/ pszenżyto	rye/ żyto	barley/ jęczmień	rape/ rzepak	sugar beet/ burak cukrowy
Farm/Gospodarstwo rolne	28.0	32.0	37.3	27.9	18.1	29.3
District/Gmina	26.3	31.3	36.7	27.5	17.7	27.6
Powiat/Powiat	25.1	30.3	35.9	26.9	17.4	26.3
Voivodship/Województwo	23.9	26.4	32.0	25.4	17.0	25.6
Region/Region	23.7	26.1	31.7	24.9	16.9	24.4
Country/Kraj	23.5	25.9	31.6	24.7	16.9	23.3
Average yield/Średni plon	50.1	44.4	38.5	49.4	95.9	13.1

Source: own study

Źródło: opracowanie własne

then on the farm level. On the national level variation coefficients for prices are almost 3 times bigger than variation coefficients for yields. Whereas, on the farm level variation coefficients for prices are, on average, only 50% bigger than for variation coefficients for yields, and in same case are almost equal.

It suggest than on farm level yield variability is almost as important as price variability and, therefore, cannot be neglected in analysis of variability of farmers' income from plant production.

Conclusions

The reduction of yields variability is similar, on the country level, for all crop plants, except rape, i.e.: between 42 and 50%. It means that yield variability measured by standard deviations is almost twice higher at the farm level than at the country level.

The reduction observed for price variability on the country level is much lower than for yields and is ranging typically between 15 and 20%. It confirms that national or regional times series of prices, contrary to yields time series, could be used in risk analysis on the farm level.

The disproportion of variability, measured by variability coefficient, observed on country level of data aggregation is much lower on farm level. On the national level variation coefficients for prices are almost 3 times bigger than variation coefficients for yields. While, on the farm level variation coefficients for prices are, on average, only 50% bigger than for variation coefficients for yields.

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Streszczenie

W artykule badano związek między poziomem agregacji danych a zmiennością plonów i cen podstawowych roślin uprawnych w Polsce. W tym celu poddano analizie plony i ceny podstawowych roślin uprawnych, tzn. pszenicy ozimej, pszenżyta, żyta, jęczmienia, rzepaku i buraków cukrowych. W badaniach wykorzystano dane gromadzone przez polski FADN pochodzących z lat 2004-2009. Rozmiary prób, w zależności od rośliny wynosiły od 531 do 2893 dla plonów i od 183 do 1139 dla cen. W pracy analizowano 6 poziomów agregacji danych, tzn.: gospodarstwo rolne, gmina, powiat, województwo, region i kraj. W pracy wykazano, że stopień redukcji zmienności plonu obserwowanej na wyższych poziomach agregacji danych zależy od gatunku rośliny uprawnej. W przypadku zmienności cen występowała również zależność od gatunku rośliny uprawnej – jednak w mniejszym stopniu. Przeciętnie redukcja zmienności obserwowana w przypadku plonów była o wiele większa niż w przypadku cen. Ekstremalnym przypadkiem był rzepak, gdzie redukcja zmienności obserwowana na poziomie kraju była 10-krotnie większa dla plonów niż dla cen.

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