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Vegetables Price Volatility in Poland – Onion and Carrot Case

Abstract. There are the producers who takes the weakest position on the agricultural market. Their activity is especially exposed to the risk factors. Price volatility which stays behind the price risk is one of the most important threats for producers' incomes. Economic stability is a base for investment and development. That is why the price volatility is worth to having a look at. There are two species examined in this paper: onion and carrot. Both have a significant share in Polish vegetable production. Onion crops are mostly exported but carrot is being sold on the domestic market. Apart from the sales market there was no significant difference in analyzed period between farm-gate price volatility for both species. The measured volatility was getting lower in consecutive years of analyzed period; only in years of unfavorable weather conditions there were some growth. The analyze was conducted with usage of descriptive statistic on the logarithmic rates of return.

Key words: price volatility, seasonal fluctuations, standard deviation, producer export price, onion, carrot

JEL Classification: Q11, Q13, Q14, Q17

Introduction

Agricultural production belongs to the industry branches especially exposed to the risk factors. Alongside by inner risk factors, that are able to be controlled, there is a group of external factors which stays out of control or estimation. The ongoing globalization process has strengthened linkages and dependencies between the national markets. Nowadays the problems, which emerge in other, often distant countries, may be reflected on Polish domestic market; so the prices that purchases producer for vegetable depend on the other markets situation like never before. What else influences on the price level, that producer receive for vegetable, is the situation on other related markets. For example high prices of leeks cause their substitution by onion (f. e. in soup mixtures).

The information that is important for a production management concerns, most of all, relative prices (what means that commodity prices are comparable with the others) (Friedman, 1994). The vegetable producers have to make their decisions in relation to current prices. But the problem is, they don't know the future market circumstances, when the production process will end. The prices reveal their work by encouraging farmers to increase production volume, when become higher, and equally to backtrack on those species, which make a loss because of an unsatisfied price. Can one really contemporary observe an escalation of this unfavorable phenomenon of increasing price volatility on the vegetable market in Poland? When the seasonal price changes are well known and surprises no one, than the unexpected changes have negative influence on the income situation of Polish producers, and other market players, as well. The higher is the price volatility, the

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higher are costs of price risk management (as higher insurance costs, deposit security in forward transactions, and so on). Higher costs of risk management result in growth of production costs, and similarly higher food prices (Figiel, 2012). That is why this problem is worth to be analyzed.

The main goal set in this paper was to evaluate if the price volatility for farm-gate vegetable prices grows, in terms of trade liberalization. There were two species compared and characterized by different ways of usage. First of them – onion - is mostly exported, the second – carrot – is mostly consumed on the domestic market. Consequently the farm gate onion prices should be characterized by higher influence of external factors, which reflect in growth of unanticipated price volatility. The carrot price should be more stable since there is less number of factors – mostly domestic, which influence on its value.

Literature overview

The price system is one of the best ways to connect sellers and buyers with each other. This mechanism does not even require any personal contact between them, as Milton Friedman noticed. Prices which derive from free trade are able to coordinate actions of many people, who care only for their own business; it is also the main reason of growing wealth of each of the market players. The price mechanism works so good and efficiently, that we often do not think of it (Friedman, 1994). What is important for a proper work of this mechanism is a free market. In such environment, the prices act in three directions: as a data medium, as a tool for income distribution, and finally prices lead towards the cheapest production method. All these three functions are closely related (Friedman, 1994). Unfortunately the pure price mechanism seems not to work properly under the horticulture market conditions.

In food sector the economic power of various market players groups is different. There are farmers who are the weakest ones; each of them represents small supply, and what is worse, often act separately (Rembisz, 2007). Furthermore, horticultural production is highly vulnerable to weather conditions, which stay mostly out of control. That is one of the reasons why farmers' incomes in Poland are unstable and lower than in non-agricultural sectors. This problem is widely analyzed by many scientists (Czyżewski, Poczta, Rembisz). As a solution which makes disparities between incomes level lower, the national support instruments are advised. It disturbs, to a certain extent, in the work of price mechanism, but is meaningful; it facilitates to equal income levels (it has many other advantages, but being beyond this paper scope). In other words, it is a cost of sustain farmers' incomes on the social acceptable level, but also weakens the efficiency of farming.

Weak crops result in prices spike; outstanding crops cause the prices drop. By a low demand flexibility the move of supply curve may result in high price volatility, while sales volume remains constant (as for the equilibrium state). Hamulczuk and the others (2016) noticed that the main food price change factor, in short periods, is supply determinant. Regarding the fact that increase of food consumption is limited, the demand for vegetables is in the long period inelastic. The price volatility of demand is, however, able to growth mainly due to substitution possibility (Hamulczuk, 2016). In short periods the supply of vegetables is possible not to be flexible. It results from the fact that there is no possibility to gain production volume after it has started. In terms of relatively inflexible food demand even a slight change in the supply curve results in significant change of equilibrium price.

At the same time growth of need for vegetables (food) is inelastic (Hamulczuk, 2016). Different flexibility in supply and demand on the horticulture market results in discrepancies in parameters in market game is known as cobweb effect; it leads to slump on the horticulture market (Rembisz, 2007). In general increasing price volatility translates into greater price risk exposure (Figiel, 2012). It reveals by the uncertainty as for the income and the economic situation general. This influences market decisions, investments, and operational costs of units from whole agricultural sector. Higher price volatility boosts price risk management costs for example higher insurance contributions, higher deposit security in futures contracts (Figiel, 2012). That is why the knowledge of methods of measurement and analyze of price volatility and related price risk gain on importance.

What is also important is the fact, that the vegetable sector in Poland, in comparison with fruit sector, is by a long run more fragmented. The horizontal cooperation between producers is weak. That is one of the reasons why producers are more vulnerable to negative market changes (Nosecka, 2017). It is the organization ratio what, beside of the market parameters interactions, is crucial for proficient function of the horticulture sector (Rembisz, 2007).

Data and methods

Farm-gate prices are an outcome of several factors. One of them – trend-cycle is an relatively constant value. The second – seasonal fluctuations - are well known already. All the market players expect some variability as price drop when supply rises, and price increases in terms of higher demand. What also shapes the price value is its volatility. The volatility is unable to be calculated, but still it can be assessed. The higher the volatility is, the more uncertain and risky is the economic environment for producers. Their decisions might be inefficient, as well as management costs gets higher.

For the evaluation of price volatility there were the time series of export prices paid producers for carrot and onion taken. These species were chosen due to their significance in Polish vegetable production. Onion share in the structure of the vegetable production has been varying in 2004-2016 at 14-15% level; a bit higher has been the carrot share – 18-19% (Nosecka, 2017). What differs these two species is their share in the Polish vegetable export. Depending on the year 19-25% onion crops has been exported, but only 2-5% carrot. Greater importance of export in onion crops disposal should result in bigger influence of external factors which can shape prices on Polish domestic market. That is why the onion price volatility is expected to be higher than the carrot one (carrot is mostly sold on inner market).

As a first step all the time series were logarithm, afterward logarithmic rates of return were calculated, according to the equation:

$$r_t = \ln(p_t) - \ln(p_{t-1}).$$

Where r_t is the rate of return and p_t denotes value of price variable in period t. It resulted in trend elimination. For the assessment of the stationarity there was the Augmented Dickey-Fuller (ADF) test used. The ADF test is one that tests for a unit root in a time series sample. By the null hypothesis assumes that a unit root is present in a time series sample. The alternative hypothesis accepts stationarity or trend-stationarity. The

ADF statistic, used in the test, is a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit root at some level of confidence

There was the following model used to verify null hypothesis:

$$\Delta Y_t = \alpha + \delta Y_{t-1} + \gamma_1 Y_{t-1} + \gamma_2 Y_{t-2} + \cdots + \gamma_k Y_{t-k} + \varepsilon_t$$

In case of no basis to reject H_0 the nonstationary is concluded. The whole procedure needs to be repeated then, for the first differences series. Instead of Y_t the ΔY_t is taken, and instead of ΔY_{t-1} second differences. If first differences are stationary (H_0 is rejected) then one can assume that the series is integrated in the first level. Seasonality effect was identified using dummy variables (0,1). Saved residuals were a subject of further analysis with use of descriptive statistic. In this part the assessment of the volatility change was conducted by calculation of an average, median, standard deviation and annualized standard deviation with 52 weeks window length.

Analyzed period covers consecutive weeks of years 2004-2016. The data were gathered in Horticulture Economics Department, Institute of Agricultural and Food Economics - NRI.

The analyze contained in this paper was conducted in order to evaluate the farm-gate price volatility. The scope covered onion and carrot prices. Onion represents high share of export in the crops management, and in case of carrot the domestic demand is in prevalence. The aim of this paper is to answer the question: If the choice of species to be produced may affect further income stabilization.

Results

Before Polish accession to the EU the influence of international trade on vegetable prices was negligible. The prices and their volatility were highly dependable upon crops and domestic demand. The spike of the export share in production disposal has started to rise in the post accession period, since the linkages between Polish and other markets have got tighter (Hamulczuk, 2016).

Price value is an outcome of several components which stay in mutual relations. Some of them are regular and predictable, so also well-known for the market players. It is trend-cycle which shows general direction of the change and can linger at least few years. The second factor, seasonal fluctuations, is related to the production process which in horticulture depends on plant vegetation. Also price seasonal volatility is already well known phenomenon even for producers. It is characterized by shorter, few months lasting periods. Producers can minimalize its action for example by storing crops in cold stores waiting for a satisfying price offer. The final factor which is the most important reason (in this case) of income instability is random fluctuations known as white noise. This factor is unfortunately unpredictable. Random fluctuations reflect among other things the situation in other countries, on other markets, not directly linked with the Polish onion and carrot market. According to global trends of food prices growth there were expectations for noticeable upward trend in price levels of both species. Preliminary analyze of gathered prices does not however confirm this general trend on Polish market.

The very first step in the evaluation if the prices have been changing during analyzed period, was their stationarity assessment. There were two tests: ADF and KPSS used.

Table 1. The results of ADF and KPSS tests

	ADF				KPSS	
	a-1 estimated value	Tau statistic	p value	lag	Critical value	Test value
	level of variable					
onion	-0,041269	-3,44791	0,009458	6	0,348	0,840505
carrot	-0,109036	-6,13234	5,717e-008	2	0,348	1,25995
	first difference of variable					
onion	-1,24083	-14,2593	6,446e-033	6	0,348	0,0302
carrot	-0,12219	-6,4911	6,469e-008	2	0,348	0,0081

Source: own study on the basis of Horticulture Economics Department of Institute of Agricultural and Food Economics – NRI records.

The ADF test did not allow to accept H0 which says that the time series is nonstationary because of unit root occurrence. However KPSS test revealed nonstationary of time series both onion and carrot prices on the 0-variable level (test statistics were higher than critical value). Both tests for the first difference of variables, showed stationarity in both cases (see table 1). By the reason of this fact, further volatility analyze was conducted with the use of price logarithms differences, what let to expurgate the seasonal influence.
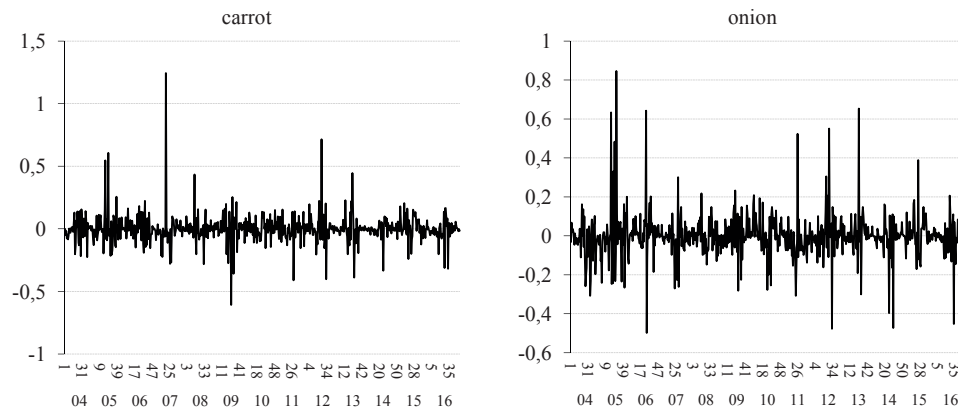

Fig. 1. Price residuals volatility of carrot and onion

Source: own study on the basis of Horticulture Economics Department of Institute of Agricultural and Food Economics – NRI records.

The charts of residuals for both carrot and onion show no trends; on the basis of visual evaluation one can state their randomness. The volatility of onion prices is however higher than carrot, but on the other hand, there is no visible growth of volatility. Due to the fact, that the median value (in tables 2 and 3) is mostly close to zero, one can confirm randomness of residuals. Standard deviation shows concentration of observations value round an average.

Table 2. Descriptive statistics of the stochastic component of logarithmic increments of weekly onion prices

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
average	-0,03	0,01	0,02	-0,01	0,00	0,01	0,01	-0,03	0,01	0,01	-0,01	0,01	-0,01
median	-0,02	0,00	0,02	0,00	0,00	0,00	0,00	-0,01	0,00	0,00	0,00	0,00	0,00
standard deviation	0,12	0,22	0,13	0,09	0,07	0,10	0,10	0,12	0,14	0,13	0,11	0,09	0,11
annualized deviation	0,85	1,62	0,96	0,65	0,52	0,73	0,69	0,86	1,00	0,91	0,81	0,68	0,77

Source: own study.

Table 3. Descriptive statistics of the stochastic component of logarithmic increments of weekly carrot prices

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
average	-0,01	0,01	0,00	0,00	0,00	0,00	0,01	-0,01	0,01	0,00	0,00	0,02	-0,01
median	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
standard deviation	0,09	0,19	0,10	0,22	0,11	0,15	0,07	0,10	0,16	0,13	0,08	0,07	0,08
annualized deviation	0,65	1,34	0,72	1,59	0,77	1,06	0,49	0,71	1,12	0,93	0,59	0,55	0,55

Source: own study.

The analyze of standard deviation in months let to have a closer look at the price volatility. As one could expect the standard deviation of onion prices has more diversified values in comparison with carrot one. It derives from higher influence of external markets where onion is exported. The highest volatility level in onion chart is observed after the Polish accession to the EU. This period was characterized by uncertainty, which came along with a new market circumstances. What may be confusing it was negligible reaction of price volatility in 2008 and 2009, when the global crisis had begun. Standard deviation was varying more in 2011-2013, when onion crops in Poland were weaker. What definitely cannot be observed it is the increase of volatility level of onion price during whole analyzed period.
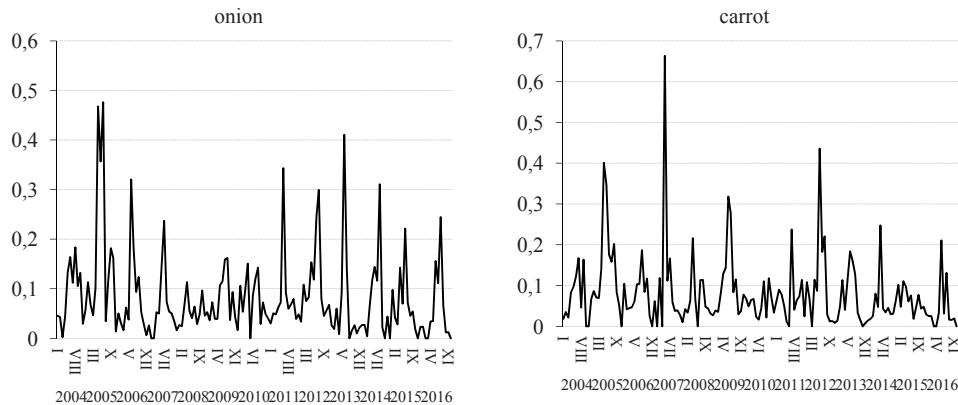

Fig. 2. Moving standard deviation for seasonally adjusted log returns of price series of carrot and onion in Poland (window length – 52 weeks)

Source: own study on the basis of Horticulture Economics Department of Institute of Agricultural and Food Economics – NRI records.

Because of the fact, that the biggest part of carrot production volume is located on the domestic market, unknown factors which influenced on the volatility ratio result more from the weather conditions. The extraordinary gain of standard deviation recorded in 2005 is explained however, just like onion, by structural and political circumstances. The most significant peak of standard deviation value was recorded on the beginning of 2007. It was caused by the lower, due to the drought, crops in 2006. Price volatility in 2006 was stable because of increased import which covered domestic demand. On the beginning of 2007 the cold storages were empty already and the market was waiting for a new crops of 2007. This complex situation made volatility soaring. The drought in 2011 stood for a common situation in 2012.

The common European market is the mature market with properly working economic mechanisms. These mechanisms have positive influence on the price stabilization. There is however, a question of further trade liberalization which can spoil equilibrium.

Summary

On the basis of the conducted analyze one is manage to state some influence of external situation on the onion price volatility. This influence on carrot prices is slightly weaker. For both species price volatility in 2004-2016 was the biggest in the period of Polish accession to the EU, when the market equilibrium which being then in force has been changed. The weather conditions is the most important factor which boosts the price uncertainty. For both onion and carrot one cannot state that price volatility during analyzed period has been increasing. The tighten cooperation between European markets results in drop of price volatility. During three last years of the analyze there was a plunge in the price volatility spotted. The price risk borne by producers gets slightly lower. It is a positive information also for government administration bodies because it means, that currently implemented policy is successful.

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