

THE VARIABILITY OF TURKEY LIVESTOCK PRICE AND ITS RELATION WITH THE PRICE OF CHICKENS, PORK AND BEEF IN 2006-2015

Katarzyna Utnik-Banaś (ORCID: 0000-0002-5008-9301)

Faculty of Agriculture and Economics
University of Agriculture in Krakow, Poland
e-mail: rrbanas@cyf-kr.edu.pl

Abstract: The work determines the range of variability in the price of turkey livestock and its relation to prices of chickens, pork and beef in 2006-2015. In 2006-2011, the variability coefficient for turkey livestock was 5 to 10%, whereas in 2012-2015 it dropped below 5%. The prices were most stable out of prices of chickens, pork or beef. The biggest influence on the variability of the turkey livestock price was the long-term trend and cyclic fluctuations (82% of the total variability on average). Seasonal fluctuations had lower amplitude (between 7 and 4%) than in the case of prices of pork and chickens, and their input in the total variability amounted to 14% on average. The price of turkey livestock presented the strongest correlation with the price of beef ($r=0,851$) and chickens (0,837), and was the least correlated with pork (0,681). In 2006-2015 the price of turkey livestock increased by 68%, beef by 57%, chickens by 29% and pork by 13%.

Keywords: turkeys, price, variability, time series, seasonality, cyclic fluctuations

INTRODUCTION

In the dynamically developing poultry business, turkeys are placed second (after broilers) in the poultry species structure. The production of turkeys was 450 thousand tons (in live weight) in 2015, constituting 15.4% of the total poultry livestock and increased by 15.4% in comparison to the previous year [Biegański 2016]. A big increase in the production of turkeys in last years has been positively influenced by, among others, a stable level of buying-in prices of livestock [Świetlik 2016].

The price variability is a key aspect of price risk for all market members: producers, processors, as well as consumers [Figiel et al. 2012]. The price levels of agricultural raw materials are mainly influenced by: the biological-technical character of agricultural production, low short-term elasticity of supply, inter-market relations and relations to world prices [Hamulczuk and Stańko 2011]. Price variability is inevitable, however, it is crucial to know the causes lying behind the variability, which may allow foreseeing or preventing sudden changes in price levels. Characteristic elements of the price variability in agriculture include annual seasonal fluctuations or longer, periodically repetitive cyclic fluctuations. Best known are pig cycles in pork production [Szymańska 2012]. Despite numerous studies and a relatively well described mechanism, the occurrence of “pig cycles” has not been eliminated. The level of prices in livestock production is also influenced by the presence of supplementarity and relations between prices of pork, poultry and beef [Rembeza 2007]. In literature on price variability of different kind of livestock or meat [Hamulczuk 2009, Idzik 2009, Olszańska 2012] poultry is generally treated without a division into species: chickens, turkeys, geese and ducks. Given the big share of turkeys in the structure of the produced poultry [Dybowski 2014] and sizeable differences in supply-and-need conditions, it is essential to know more about elements shaping the level of turkey livestock prices.

The aim of the paper is to present the type and the range of variability of turkey livestock prices and their relations with livestock prices for chickens, pork and beef in 2006-2015.

RESEARCH MATERIAL AND METHODS

The research material was monthly time series for prices of turkeys, broilers, pork and beef livestock in 2006-2015. The prices of turkeys and chickens came from the Integrated System of Agricultural Market Information [2016], whereas the prices of pork and beef livestock were obtained from the Central Statistical Office [Prices of agricultural products 2006-2015].

The range of price variability in a year was presented with a variability coefficient, minimal value and maximal value (interval), maximal monthly change in price (increase or decrease) and the change in price indicator (in %). The analysis of the price variability for turkey livestock was conducted with a price time series decomposition. A time series includes the following elements [Dittmann 2008]:

- Developmental tendency – trend (T) – it shows the long-term tendency for one-way changes (increase or decrease) of the price. It is understood as the effect of the influence of a constant set of factors,
- Cyclic fluctuations (C) – they are formed as long-term, rhythmically repetitive price fluctuations around the developmental tendency in time intervals longer than one year,

- Seasonal fluctuations (S) – are price fluctuations of the observed variable (price) around the developmental tendency and repeat in a time interval not longer than one year.
- Random fluctuations – random element – (I).

Given the mutual relation between the long-term trend (T) and cyclic fluctuations (C) formed by similar factors, the elements of the time series are treated in the paper as a whole trend-cycle element ($T_t C_t$). To describe the time series for turkey livestock prices, a multiplicative model was used in the form of the following formula [Stańko 2013]:

$$Y_t = T_t C_t S_t I_t$$

where:

- Y_t – livestock price in time t ,
- $T_t C_t$ – long-term trend and cyclic fluctuations,
- S_t – seasonal fluctuations,
- I_t – random fluctuations.

The Census II/X11 [Idzik 2009] method was used to determine the seasonality of indicators. The advantage of Census II/X11 is, among others, the ability to calculate seasonal fluctuations for each year separately, which allows for an analysis of possible changes in seasonality models in longer periods of time. In order to check the relevance of the seasonality indicators, a variance analysis was carried out for indicator values in particular months using the F test.

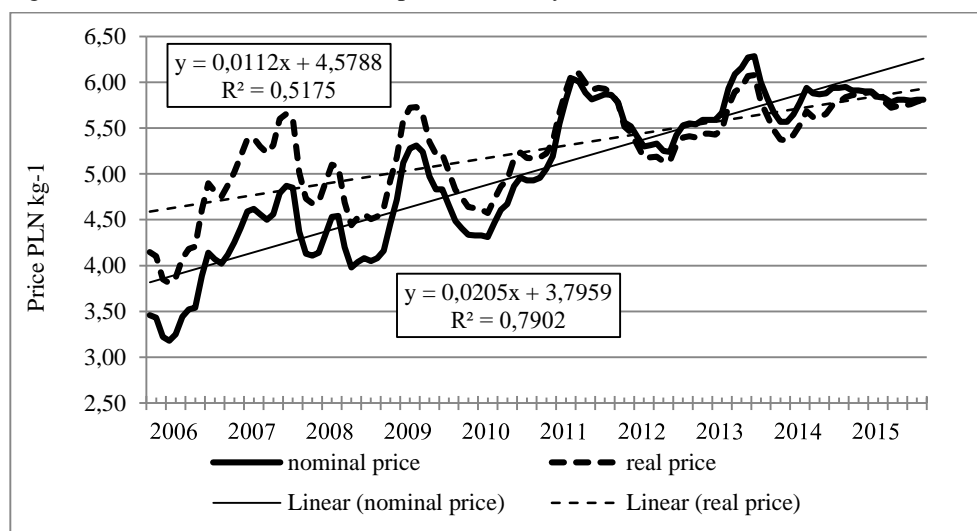
The influence of particular components of the time series, such as: seasonality (S), random fluctuation (I) and developmental tendency (TC) on the general variability of broiler livestock prices was determined in relation to the duration of changes. To this end, the share of variances for particular components of the series in the total price variance was analyzed. The calculations were carried out with a forecasting and time series analysis packet included in the computer program Statistica 9.0 [Kot et al. 2011].

RESULTS

Over ten years, the nominal price of turkey livestock increased from 3.46 PLN/kg in January 2006 to 5.81 PLN/kg in December 2015 (Figure 1). The biggest increase (9.8%) took place in 2006, in which the price rose from 3.54 PLN/kg in August to 3.89 PLN/kg in September. The biggest drop, however, took place in 2007, in which the price decreased from 4.85 PLN/kg to 4.37 PLN/kg in December.

In 2006-2011 the price variability coefficient in a year was ranging between 4.5 and 9.6%, whereas in 2012 prices in a year were subjected to lower fluctuations, and the variability coefficient was under 5% (Table 1).

Figure. 1. Level of real and nominal prices of turkey livestock in 2006-2015



Source: own study based on: Integrated System of Agricultural Market Information, 2016

Table 1. Variability of nominal prices of broiler livestock in 2006-2015

Year	Nominal price							
	Average	min	max	Variability coefficient%	Max monthly %		Index of change	
	PLN kg ⁻¹				decrease	increase	yearly	2006=1
2006	3.60	3.18	4.14	9.56	-6.12	9.89	1.16	1.16
2007	4.54	4.12	4.87	5.08	-9.90	5.04	1.06	1.26
2008	4.19	3.98	4.54	4.46	-7.49	4.83	0.99	1.18
2009	4.84	4.16	5.31	7.50	-5.15	8.47	1.08	1.30
2010	4.60	4.31	4.96	5.78	-1.77	4.20	1.12	1.42
2011	5.66	4.96	6.04	6.69	-2.00	6.90	1.18	1.69
2012	5.43	5.24	5.78	2.95	-3.81	3.44	0.96	1.60
2013	5.88	5.54	6.29	4.79	-4.55	4.59	1.05	1.68
2014	5.80	5.57	5.95	2.57	-2.58	2.82	1.05	1.72
2015	5.84	5.78	5.91	0.83	-1.02	0.52	0.98	1.68

Source: own study based on: Integrated System of Agricultural Market Information, 2016

Real prices in 2006 were 20% higher than nominal prices. The difference was gradually decreasing, and in 2012-2014 real prices were 2-4% lower than nominal prices. The long-term linear trend of real prices (having eliminated the influence of inflation) in 2006-2015 indicates their decrease by 0.011 PLN/ month ($R^2 = 0.52$) on average.

Maximal monthly changes in prices of turkey livestock did not exceed 10% and were comparable to maximal monthly decreases (increase) in prices of broilers (Table 1). The price of beef livestock in a monthly horizon of changes were more steady (maximal decrease in prices -6.8%, increase +8.4%), whereas monthly changes in prices of pork were much bigger than turkey livestock and were between -11.6% to 16.2% (Table 2). In the yearly horizon of changes in prices of turkey livestock (-4 to 18%) were also comparable to changes in prices of chickens and much lower than changes in prices of pork, which reached -18 to +50% in a year. Throughout ten years (2006-2015) (nominal) prices of livestock increased for: turkeys by 68%, beef by 57%, chickens by 29% and pork by 13%. Prices of the compared livestock kinds were significantly related with prices of turkey livestock being most correlated with the price of beef ($r = 0.851$) and chickens (0.837), and least with pork (0.681).

Table 2. Changes in prices of turkey, chicken, pork and beef livestock in 2006-2015

Horizon of changes	Maximal change	Livestock price			
		Turkeys	Chickens	Pork	Beef
Monthly	increase %	-9.9	-9.0	-11.6	-6.8
	decrease %	9.9	10.6	16.2	8.4
Yearly ¹⁾	increase %	96	93	82	93
	decrease %	118	115	150	121
change indicator 2006-2015 ²⁾ %		168	129	113	157
Correlation coefficient ³⁾		1	0.837	0.689	0.851

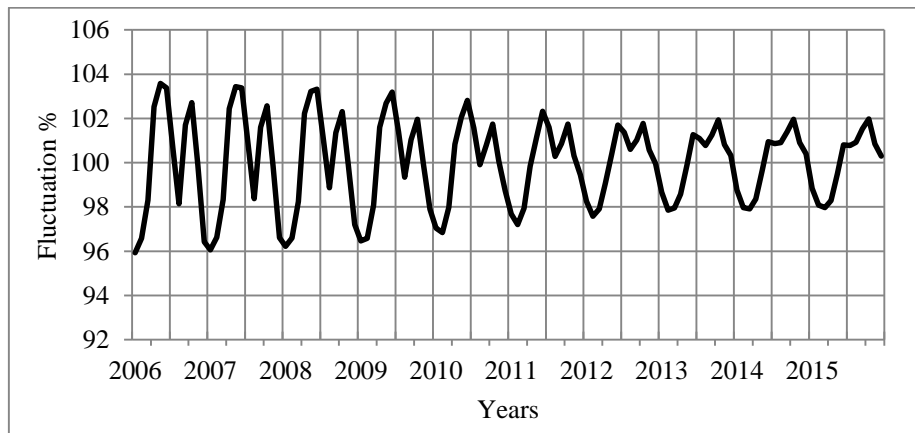
¹⁾ previous year = 100%; ²⁾ 2006 = 100%; ³⁾ correlation with the price of turkey livestock $p < 0.001$;

Source: own study based on: Integrated System of Agricultural Market Information. 2016. Prices of agricultural products 2006-2015 Central Statistical Office

The decomposition of the time series for prices of turkeys indicates regular seasonal and cyclic fluctuations as well as irregular random fluctuations. The steady seasonality test results proved that the seasonal variability of prices of turkeys is statistically significant ($p < 0.001$, statistics value $F = 9.769$). In the analyzed period there was a noticeable change in the model seasonality and a decrease in the amplitude of seasonal fluctuations. In 2006 turkey livestock was cheapest (96%) in winter months (December-February). Two periods of increase in the price were also characteristic: spring with its peak in May (103.6%) and

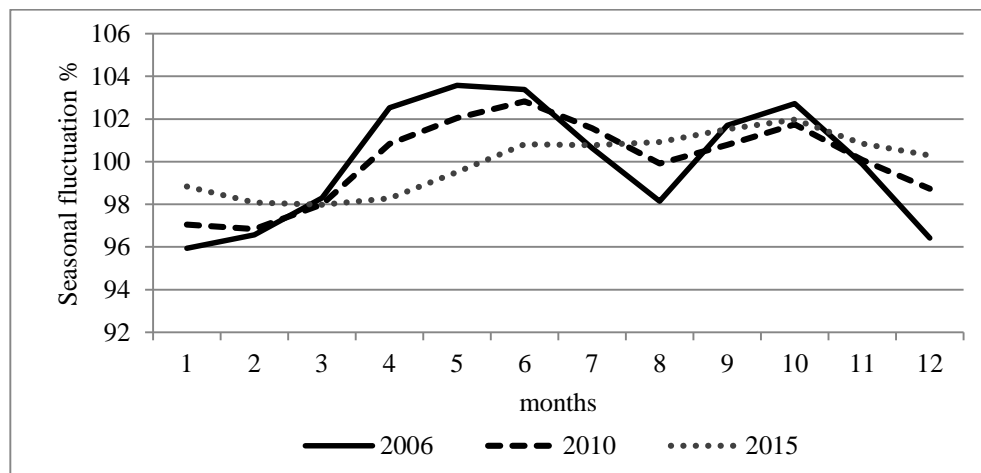
autumn with its slightly lower peak (102.7%) in October (Figures 2 and 3). The amplitude of seasonal fluctuations amounted to 7.7%.

Figure. 2. Seasonal fluctuation of real prices of turkey livestock in 2006-2015



Source: own study based on: Integrated System of Agricultural Market Information. 2016

Figure 3. Changes in the price seasonality model of turkey livestock in 2006-2015



Source: own study based on: Integrated System of Agricultural Market Information. 2016

In the following years, there was a gradual decrease in the fluctuation amplitude and the spring increase in prices. In 2015, lowest prices of turkey livestock (98% of the annual average) were in February and March, whereas the highest (102%) in October. The share of seasonal fluctuations in a monthly horizon amounted to 30% of the total price variability, in three-month horizon it was 22%, and the share dropped under 10% in a horizon longer than half a year (Table 3).

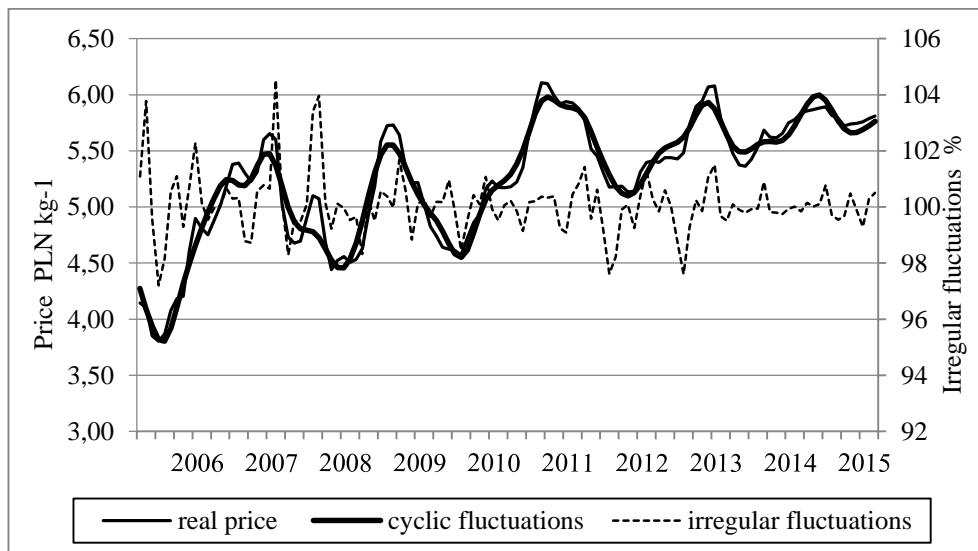
Changes in prices of turkey livestock in 2006 – 2015 were characterized by a noticeable cyclicity of 2 to 3 year-long cycles (Figure 4).

Table 3. Share of seasonal, cyclic and irregular changes in the total price variability of turkey livestock in 2006-2015

Horizon of changes (months)	Changes %		
	irregular	cyclic	seasonal
1	16.1	53.5	30.4
2	8.0	65.0	27.0
3	4.4	73.6	22.0
4	2.8	80.3	16.9
5	2.2	84.7	13.1
6	1.5	87.6	10.9
7	1.0	89.9	9.1
9	1.0	92.9	6.1
11	0.8	97.6	1.6
12	0.9	99.0	0.1
Average	3.9	82.4	13.7

Source: own study based on: Integrated System of Agricultural Market Information. 2016

Figure 4. Results of the decomposition of the time series for real prices of turkey livestock



Source: own study based on: Integrated System of Agricultural Market Information. 2016

Bottom turning-points occurred in: June 2006, August 2008, May 2010, August 2012 and March 2014. Top turning-points (peaks) occurred in: October

2006, June 2009, July 2011 and October 2013. The value of $MCD = 4.25$ indicates that after five months of one-way changes a new cycle occurs. Cyclic fluctuations constituted the major share in the total price variability of turkey livestock: in a month horizon of changes they amounted to 53.5% and in a 4 month period their share constituted 80% of the total variability (Table 3). Irregular fluctuations in a month horizon of changes amounted to 16% of the total variability, whereas in a three month horizon their share was under 5%. Annually, on average, cyclic fluctuations amounted to 82.4%, seasonal fluctuations 13.7% and random 3.9% of the total price variability for turkey livestock.

DISCUSSION

Price variability is characteristic of the free market, functioning based on the rule of balance between supply and demand [Figiel et al. 2012]. Significant price fluctuations frequent in agriculture are rooted in a relatively poorly flexible in price demand influenced by slow changes and practically fixed supply in short-term, often influenced by quite rapid changes. Figiel [2002] points out that the range of price fluctuations depends greatly on the price efficiency of a given market, expressed as the ability to set a price quickly, objectively reflecting the demand-and-supply situation both at the present moment and in future determined for the given market.

The price variability of turkey livestock expressed in the most general measurement, which is variability coefficient, was on average 5% in a year and was small in comparison to other livestock types. Rembeza [2007] states that in 1996-2007 the highest price variability was characteristic for beef livestock (around 19%), lower for pork (15%), and the lowest for poultry (10%).

The type of variability that is most associated with agriculture is seasonal fluctuations [Hamulczuk i Stańko 2011]. Price seasonality of turkeys is characterized by a small amplitude (5% in 2011), comparable to seasonal fluctuations of beef (7%), [Idzik 2009] and significantly lower than chickens (16% in 2011, [Utnik-Banaś 2011] or pork (18%) [Olszańska 2012]. The share of seasonal fluctuations in the total price variability of turkey or beef livestock (14%) is also small (14% on average) in comparison to chickens or pork, where the share of this type of variability amounts 36 and 46% respectively. In recent years (2010-2015) the seasonality model of turkey livestock prices has changed with its peak in autumn (October) and differs from the seasonality model of chickens, which peak in summer (August). The highest influence on the price variability of turkey livestock came from the long-term trend and cyclic fluctuations (82% of the total variability on average). As a comparison with other kinds of livestock, this type of price variability amounted to 75% for beef, 55% for chickens and 46% for pork. The influence of random fluctuations on the price variability of turkey livestock was much lower (4% on average) than for pork (8%), chickens (9%) and beef (11%). Figiel [2002] points out the fact that the decrease in random fluctuations of

prices having no justification in real supply-and-demand relations is characteristic of an increase in the price efficiency of a given market. The results of the paper indicate tighter relations between prices of turkey and beef livestock than chickens and pork.

REFERENCES

- Biegański M. (2016) Produkcja indyków w Polsce w 2015r. *Polskie Drobiarstwo*, 4, 54-58.
- Ceny produktów rolnych (2006-2015) Główny Urząd Statystyczny, Warszawa.
- Dittmann P. (2008) Prognozowanie w przedsiębiorstwie. Metody i ich zastosowanie. Oficyna Wolters Kluwer Business, Kraków.
- Dybowski G. (2014) Podstawy konkurencyjności polskiej branży drobiarskiej. *Studia i Monografie*, 160. IERiGŻ-PIB. Warszawa.
- Figiel S. (2002) Cenowa efektywność rynku towarowego na przykładzie zbóż w Polsce. Wydawnictwo Uniwersytetu Warmińsko-Mazurskiego. Olsztyn.
- Figiel S., Hamulczuk M., Klimkowski C. (2012) Metodyczne aspekty analizy zmienności cen oraz pomiaru ryzyka cenowego na towarowych rynkach rolnych. *Komunikaty. Raporty. Ekspertyzy*, 559. IERiGŻ-PIB. Warszawa.
- Hamulczuk M. (2009) Analiza, prognozowanie i zarządzanie ryzykiem cenowym na podstawowych rynkach rolnych – możliwości stabilizowania dochodów producentów rolnych. IERiGŻ-PIB. Warszawa, 149. 1-68.
- Hamulczuk M., Stańko S. (2011) Prognozowanie cen surowców rolnych - uwarunkowania i metody. *Komunikaty. raporty. ekspertyzy nr 547*. IERiGŻ-PIB. Warszawa, 5 – 43.
- Idzik M. (2009) Analiza struktury szeregów czasowych cen produktów rolnych. [In:] *Zarządzanie ryzykiem cenowym a możliwości stabilizowania dochodów producentów rolnych – aspekty poznawcze i aplikacyjne*. Red. M. Hamulczuk. S. Stańko. IERiGŻ-PIB. Warszawa, 148. 15 – 47.
- Kot S. M., Jakubowski J., Sokołowski A. (2011) *Statystyka*. Difin, Warszawa, 335 – 357.
- Olszańska A. (2012) Rynek żywca w Polsce (1955–2010) – zmiany strukturalne. koncentracja produkcji i wahania podaży. *Monografie i opracowania nr 214*. Wyd. UE we Wrocławiu.
- Rembeza J. (2007) Transmisja cen na rynku mięsa. [W:] *Ewolucja rynku mięsnego i jej wpływ na proces transmisji cen*. IERiGŻ-PIB., 73, 183 – 213, Warszawa.
- Stańko S. (red.) (2013) *Prognozowanie w agrobiznesie. teoria i przykłady zastosowania*. Wydawnictwo SGGW. Warszawa.
- Szymańska E. (2012) Zmienność koniunktury na rynku trzody chlewnej w Polsce. *Roczn. Nauk. SERiA*. XIV/1, 524 – 528
- Świetlik K. (2016) Zmienność i zróżnicowanie cen żywca drobiowego w 2015r. *Polskie Drobiarstwo*, 4, 2-7.
- Utnik-Banaś K. (2012) Analiza szeregu czasowego cen żywca brojlerów w latach 1991–2011. *Metody Ilościowe w Badaniach Ekonomicznych*. Wydawnictwo SGGW. Warszawa. XIII/1, 224 – 233.
- Zintegrowany System Rolniczej Informacji Rynkowej (2016) <http://www.minrol.gov.pl/pol/Rynki-rolne> [12.04.2016]