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MILK PRICE VOLATILITY IN POLAND

Piotr Bórawski
Department of Agribusiness and Environmental Economics, Warmia and Mazury University in Olsztyn, Poland

ABSTRACT

The objective of this paper is to investigate milk price volatility in Poland from 1993-2004. The basis of analysis data used is from Central Statistical Office (GUS). Future changes in milk prices were predicted using Hurst coefficient. The economic transition process created large differences in milk prices. The collected data enabled to use ADF test which aim was to check integration level of milk price. Moreover, the milk price rank was estimated on the basis of ARMA model. The scientific analysis enabled to measure seasonality and to forecast milk prices.

Key words: milk price, minimum and maximum prices, Hurst coefficient, ADF test, ARMA model.

INTRODUCTION

Agriculture commodity prices, generally changed in the transition process. Free market economy caused different profitability relations. It is pointed out in the statistics that average production costs are not covered by low agriculture commodities prices, while the price of production means generally increased [4].

Milk and products made of it is very important because albumen is necessary to appropriate human organism growth and consumers are particularly vulnerable to unforeseen price changes and food accessibility [1]. A significant number of Polish milk producers are still two cows owners. Such small producers will not manage to fulfil EU standards. But, on the other hand, many positive changes are also observed in the Polish milk sector. For example, the quality of milk has improved, the small farm's number decreased and most big milk producers have adjusted their buildings to meet EU standards. The number of Polish milk processing enterprises which fulfilled EU sanitary and veterinary obligations increased from 215 in September 2004 to 219 in March 2005 (which determined 70%) [12].

As Bradley and other (2005) point out in 2004, Poland was the biggest milk producer among new EU member countries. But authors also add that production farms produced about 23% of total milk production in the country. The share of Poland in cows' milk production was 2.3% in the world and 8.7% in European Union in 2004. Poland is on 11th place in world milk production. The milk production per capita was 311 kg in 2003 [16]. Polish agriculture milk products compete effectively on EU markets. It is because of better quality milk and higher production. For instance, the production of milk in Warmia and Mazury increased from 358 litres per cow in 2000 to 4353 litres per cow in 2003 year [12].

The average milk production in Poland was 4204 litres per cow in 2004. But, the cows' number in physical heads decreased in private farms from 22 in 1996 to 19 in 2004. The milk production decreased from 766 litres per 1 ha of agriculture land in 2003 to 743 litres in 2004 [16].

The process of milk price volatility depends also on periodicity of the milk acquisition. As Iwan points out in the years 1996-2005 during December-February, less milk was delivered to processing enterprises than in months June-July [6]. But the amplitude of milk delivery to the processing enterprises each years is decreasing, which is connected with milk process concentration and better quality milk. Milk production varies from region to region, for example, the milk purchased in market production, is increasing at the fastest rate in podlaskie province. Moreover the milk prices are differential regionally. The highest milk prices are in podlaskiw province (98.79 PLN/100 litters) and warminsko-mazurskiw (91 PLN/100 litters), whereas the lowest in podkarpackiw (70.68 PLN/100 l) [12].

The average prices of cows' milk received by farmers on market-places increased from 0.51 PLN in 1995 to 1.09 in 2004 [16].

AIM AND METHODOLOGY

The aim of this paper is to investigate milk price volatility in the transition process in Poland.

The sample contains 144 observations from January 1993 to December 2004. Price volatility is estimated using average prices, minimal process, maximal prices and coefficient of variation (standard deviation divided by average prices) [5]. Apart from basic price coefficients this paper presents also milk price histogram, skewedness and kurtosis results [8].

Moreover, it was possible to calculate the Hurst coefficient [7,10,13].

The collected empirical material enabled to test the null hypothesis H0 that the variable is integrated in level 1 (the root is equal one). When the null hypothesis is rejected than the alternative hypothesis H1 that the rank is stationary should be accepted. The most appropriate possibility to calculate the level of integration is DF test (unit-root test). The test is based on equation estimation [3]:

$$\Delta yt=\delta yt-1+Et$$

If the δ is minus than p is smaller than one. The DF test enables to verify the detrimental δ in regression by using the smallest squared method. The null hypothesis rejection δ=0 for alternative hypothesis: δ<0 implicate that p<1 and "yt" is integrated in zero degree. If the value of t-statistic is smaller than the lower critical value, the hypothesis is rejected, on behalf of alternative hypothesis about stationary. The DF test has one drawback that it does not contain possibility of autocorrelation general process appearance E. When the component Et indicates autocorrelation it is necessary to use ADF test (Augmented Dickey-Fuller test) which is the most effective tool in practice.

$$\Delta yt = \delta yt - 1 + \sum_{l=1}^{k} \delta \Delta yt - 1 + Et$$

The stationary rank was described by ARMA model [8]. The model helped to verify the seasonal integration. All calculations were done in GRETL programme.

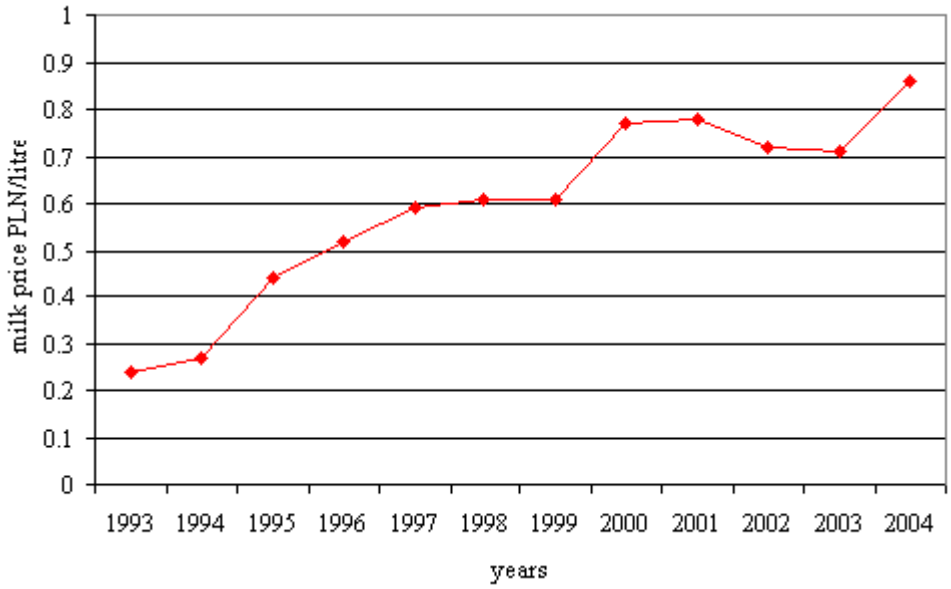
$$Yt = B1Yt - 1 + B2Yt - 2 + ... + BpYt - p + Et + \theta 1Et - 1 + \theta 2Et - 2 + ... + \theta qEt - q$$

where:
B – is the delay operator
Y – analyzed variable
E – varied component
θ – auto regression parameters

RESULTS

Average milk price results are reported in figure 1. The most profitable average milk prices in Poland were in 2004. During last 12 years, average milk price increased almost 300 per cent. But this was not a stable trend. The average milk price declined in the years 2002 and 2003 while it increased in 2004. The increasing milk price situation was an effect on EU enlargement process. A new demand for milk and other agriculture products was created by increasing export of this commodity to European Union countries. The export increased in 2004 about 52% in comparison to previous year and reached the level of 2050 mln litres in raw milk [12].

Fig. 1. Average milk prices in Poland (PLN)



Source: own calculation on the basis of Central Statistical Office data (GUS)

The minimum and maximum milk price analysis, delivers some very interesting information. Generally speaking, minimum prices of milk were characteristic during the sunniest months. As one might expect, during twelve years the lowest milk prices were stated in July (tab. 1). It was the result of higher milk production during the summer months and higher quality grass for feeding.

On the other hand, the maximum milk prices were found in winter months. In December, on nine occasions, the milk prices were the highest during the years 1993-2004. In contrast to the sunniest months, the high milk prices in December were the effect of smaller milk production.

The analysis of average milk price changes shows, that the highest increase was observed in 1995 (60.58%) in comparison to 1994. On the other hand, the highest decrease of average milk prices was observed in 2002 (-7.56%) in comparison to 2001. Milk prices are managed by supply and demand on market and increase when the demand is higher and the production is lower. When the demand is lower and the production is higher the milk prices generally decrees.

Table 1. Minimum and maximum milk prices in Poland

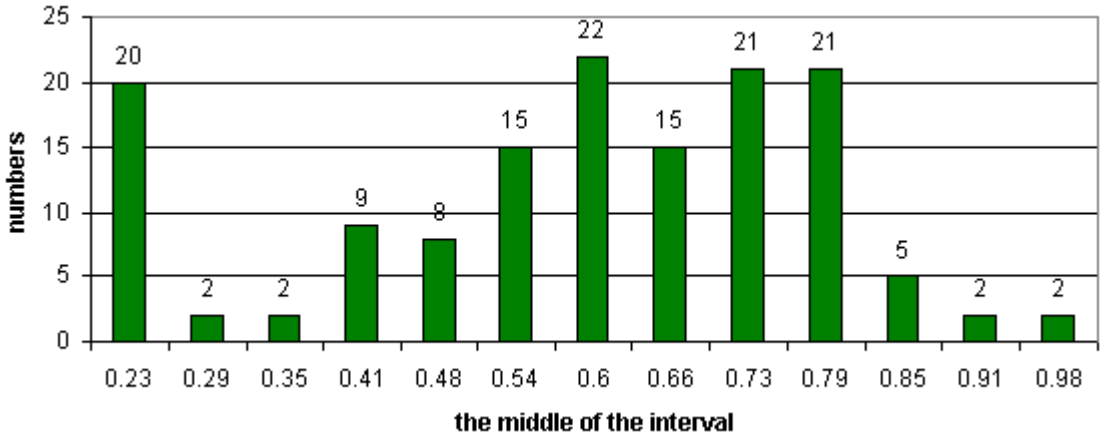
Years	Min.	Month	Max.	Month	Average price increase/decrease in comparison to previous year
1993	0.23	May-October	0.24	November-April	-
1994	0.25	January-July	S0.37	December	+16.59
1995	0.39	January	0.51	December	+60.58
1996	0.49	August	0.56	December	+17.05
1997	0.56	July	0.64	December	+13.59
1998	0.57	July	0.65	March	+4.44
1999	0.57	July	0.71	December	-0.02
2000	0.75	July	0.84	December	+26.81
2001	0.74	August	0.82	February	+0.94
2002	0.66	July-August	0.81	January	-7.56
2003	0.67	July	0.74	December	-2.38
2004	0.79	January	0.98	December	+22.20

Source: own calculation on the basis of Central Statistical Office data (GUS)

The most average monthly numerous milk price interval in Poland was (0.57-0.64 PLN/l). During last 12 years 22 Polish milk prices were included in this interval (fig. 2). Next milk intervals were 0.7-0.76 PLN/litre and 0.76-0.83 PLN/litre (each 21 times during 144 monthly observations).

The least numerous milk price interval were between 0.26-0.32; 0.32-0.39; 0.88-0.95 and above 0.95 PLN/litre (fig. 2). Relatively numerous milk price interval was below 0.26 PLN\litre (20 times during last ten years). The most common explanation for these results is that the Polish milk prices were not stable during the transition period.

Fig. 2. The milk price histogram



Source: own calculation on the basis of Central Statistical Office data (GUS)

Milk price volatility was calculated on the basis of descriptive statistics in Table 1. Over the period 1993-2004 average Polish milk price analyzed during monthly measurements was 0.59 PLN/litre. The obtained result enables to ascertain, that Polish milk price did not change normally. The results of the first column of the table 1 suggest that the changes in Polish milk prices during last twelve years can be described as varied processes.

The statistic analysis which results in forecasting experience enabled to calculate the Hurst coefficient (H). When H is higher the risk level is smaller [13]. If H is between (0.5-1) the elaborated rank is persistent. It is characterized by long memory effect. When the H coefficient is between (0-0.5) the correlation is minus. The market will probably change the movement direction. For H=0.5 the variables are not dependent. The H coefficient calculated in the survey was very high. The test suggests that in 94% chance this rise rank will be preserved in the future. This prognosis seems to be rather optimistic for Polish milk producers.

The descriptive statistics shows that the price distribution for milk in Poland was negatively skewed. The asymmetry in milk distribution can be described as left-sided.

The kurtosis analysis point out that the value of variable is less concentrated than in normal distribution (-0.64).

The milk prices coefficient of variation was 33%, what suggests significant changes in the analyzed period.

The milk prices coefficient of variation was 33%, what suggests significant changes in the analyzed period.

The collected empirical materials enabled a dominant to be calculated, which was the most frequent price in empirical distribution. The dominant price value was calculated on the basis of Sobczyk's equation [17]:

$$D = x_{D+} \frac{n_D - n_{D-1}}{(n_D - n_{D-1}) + (n_D - n_{D+1})} i_D$$

where: D is dominant, xD is the lower class frontier with dominant, nD- is the number of observations in dominant class, nD-1 is the interval number forgoing the dominant interval, nD+1 is the interval number following the dominant interval, iD is the dominant interval spread.

$$D = 0.574 + \frac{(22-15)}{(22-15) + (22-15)} 0.1 = 0.674$$

The dominant value achieved from the analysis was 0.674 PLN, what enables to conclude that the dominant was higher about 193 percentage points the minimal milk price value and lower about 31.2% from the maximal milk price value.

Table 2. Descriptive statistics

Specification	Milk
Mean	0.59
Median	0.61
Minimal	0.23
Maximal	0.98
Standard deviation	0.19
Coefficient of variation	0.33
Skewedness	-0.50
Kurtosis	-0.64
Chi-squared	18.61
p	0.00
Hurst coefficient (H)	0.94

Source: own calculation on the basis of Central Statistical Office data (GUS)

The empirical results show that the hypothesis H0 is hardly rejected. The milk price rank can be classified as stationary because the stat value is smaller than the lower critical value (2.37-2.68 from ADF table test) (tab. 3). When the null hypothesis is rejected there is no need to verify the alternative hypothesis H1.

Table 3. ADF Test

Variable	Coefficient	STD Error	T Stat	P value
Milk price	0.002	0.002	1.207	0.942

Source: own calculation on the basis of Central Statistical Office data (GUS)

The ARMA model was accepted to next analysis which was based on seasonality estimation. In the first step after the ADF test estimation, the stationary process is differentiate [8]. The results are presented in table 4. The variables of AR (1) and AR (2) are the parameters of autocorrelation for the first and the second milk rank time. The data show, that all parameters are stationary essential (p value <0,00001). It means that the milk price in one month dependent on milk price from previous month.

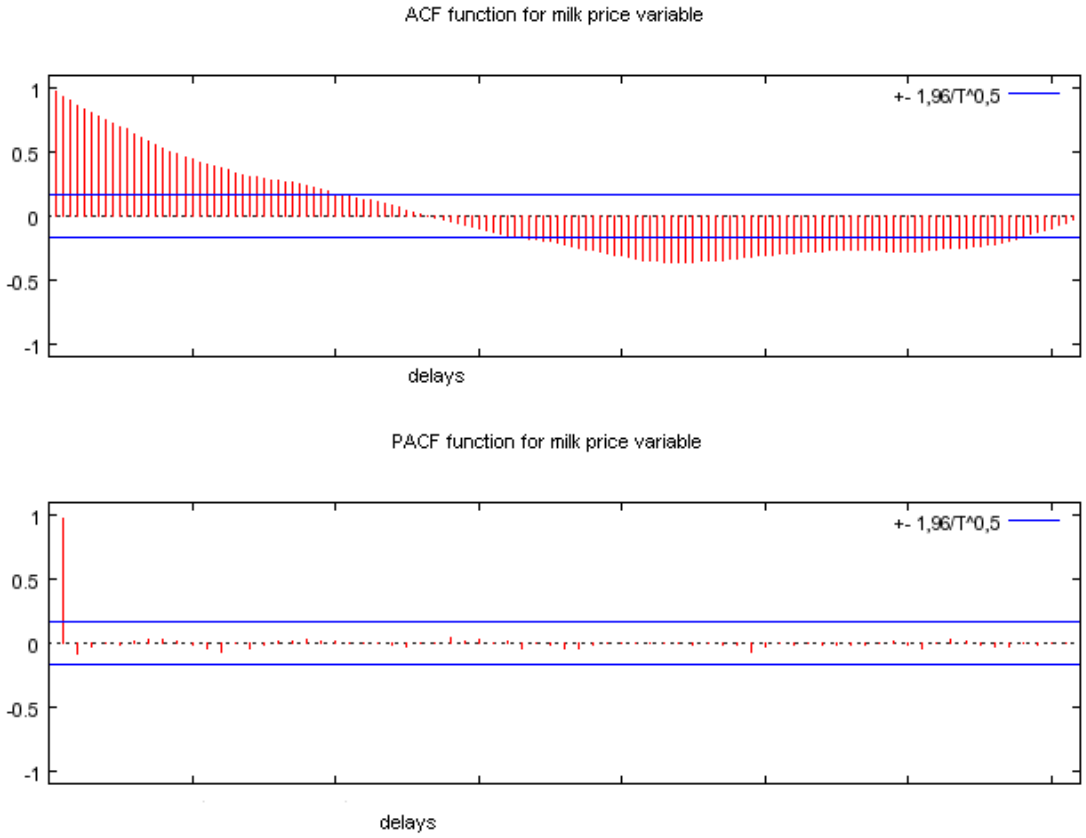
Table 4. Model ARMA estimation

Variable	Coefficient	Standard error	T stat	P value
AR (1)	1.00778	0.0024	419.117	< 0.00001 ***
AR (2)	0.58168	0.00609	9.5467	< 0.00001 ***

Source: own calculation on the basis of Central Statistical Office data (GUS)

The other step of the analysis was to verify the characteristic of the rest by using autocorrelation function (ACF) and partial autocorrelation (PACF). The analysis shows that the values are different from zero because some of them exceed the fat lines. The hypothesis concerning zero values of the rest is rejected.

Fig. 3. ACF and PACF function for milk price variable



Source: own calculation on the basis of Central Statistical Office data (GUS)

The prognosis achieved by ARMA model was not fully the same as real prices (tab. 5). The error for ARMA prognosis was not higher than 5 per cent in 12 months of 2004. In seven months price prognosis were lower in comparison to real milk price (January, March, May, June, July, September, November, December). Only in one month (August) the prognosis of milk prices were the same. In other months the prognosis was higher than the real milk prices (February, April, July, October). Similar results were achieved by Dudek [14], where the errors for poultry prices calculated in the model ARIMA were lower than average arithmetic value for error prognosis (6,28%) [15]. The model of ARMA because of its low errors can be used to milk price prognosis in a long time.

Table 5. Milk price prognosis

Observations	Milk price	Prognosis	Error for ARMA
2004:01	0.794	0.752	4.8
2004:02	0.789	0.825	4.6
2004:03	0.800	0.790	1.3
2004:04	0.809	0.812	0.4
2004:05	0.822	0.814	1.0
2004:06	0.840	0.833	0.8
2004:07	0.861	0.850	1.3
2004:08	0.874	0.874	0.0
2004:09	0.890	0.881	1.0
2004:10	0.923	0.902	2.3
2004:11	0.957	0.942	1.6
2004:12	0.982	0.973	0.9

Source: own calculation on the basis of Central Statistical Office data (GUS)

CONCLUSIONS

The milk price depends, mainly on supply and demand. Higher than average milk price were observed in winter months, when the production was decreasing. In the contrary, the milk price decrease in the summer months when the milk production increase.

Only three times during the twelve year period, did the average milk price decrease (1999, 2002, 2003) whereas in nine years it increased. Polish milk prices were significantly increasing in the analyzed period. The process of milk price increases started in 1993 and is still ongoing.

The descriptive statistics also delivers different results. The implication of the theoretical Hurst coefficient model of price volatility is that the Polish milk price increase tendency will probably stay in market (H=0.94).

The ADF test analysis show that Polish milk rank can be classified as stationary.

The tendency of milk price increases had a positive impact on farmers and milk processing enterprises economic situation improvement

Moreover, the ARMA model used for milk price forecasting can be used in practice because of its level of error is not so high and is lower than the average for such model.

REFERENCES

1. Barrett Christopher B., and D. E. Sahn. 2001. Food Policy in Crisis Management. Cornell University, working papers, (2005): 1.
2. Bradley J., Zaleski J., Tomaszewski P., 2005. Zdezagrowany sektor rolny (Raport nr 1) [Deagronomy rural sector], Wrocławska Agencja Rozwoju Regionalnego, s. 80. [in Polish].
3. Charemza W., Deadman D., 1997. Nowa ekonometria [New econometric]. PWE, ss. 292 [in Polish].
4. Evenson R. Technology and prices in agriculture. www. Fao. Org//docrep/. (2005).
5. Figiel Sz., and T. Scott. 1997. The Impact of Government Policies on the Relationship Between Polish and World Wheat Prices. Panos Varangis – World Bank.
6. Iwan B., 2005. Sezonowosc skupu mleka [The periodicity of the milk acquisition]. Roczniki Naukowe SERiA, Tom VII, z. 2, s. 79-83 [in Polish].
7. Jajuga K., and D. Papla.1997. Teoria chaosu a analizie finansowych szeregów czasowych – aspekty teoretyczne i badania empiryczne [The chaos theory in time financial ranks analysis – theoretical aspects and empiric researches]. V Ogólnopolskie Seminarium Naukowe, 9-11 wrzesnia, Toruń. [in Polish]
8. Kufel T., 2004. Ekonometria. Rozwiazywanie problemów z wykorzystaniem programu GRETL Econometry. [Problems solving with using GRETL programme]. PWN, Warszawa, ss.151. [in Polish].
9. Majewski J., 2005. Regionalne zróżnicowanie skupu mleka w Polsce oraz czynniki je determinujace [The factors determining regional differentiation of milk purchase in Poland]. Roczniki Naukowe SERiA, Tom 25, z. 5, s. 56-59.
10. Orzeczko W. 2005. Własnosci testów STUR w swietle metod z teorii chaosu [The STUR test chracteristics in the chaos theory methods light]. IX Ogólnopolskie Seminarium Naukowe, 6-8 wrzesnia, Toruń. [in Polish].
11. Rybicki G., 2005. Sytuacja na rynku mleczarskim po przystapieniu Polski do Unii Europejskiej [Situation on milk market after the accession of Poland to European Union], Tom. VII, z. 2, s. 194-198.
12. Rynek mleka (stan i perspektywy) [Milk market – estate and perspectives], IERiGŻ, ARR, MRiRW, kwiecień 2005 [in Polish]
13. Stawicki J., Janiak E.A., Muller-Fraczek E., 2005. Różnicowanie fraktalne szeregów czasowych – wykładnik Hursta i wymiar fraktalny [Fraktral differentiation of time ranks – Hurst coefficient and fraktral dimension]. V Ogólnopolskie Seminarium Naukowe, 9-11 wrzesnia, Toruń 1997. [in Polish].
14. Dudek H., 2005. Prognozowanie cen skupu mięsa drobiowego za pomocš sezonowego modelu ARIMA [Forecasting the poultry meat prices by using seasonal ARIMA model]. Roczniki Naukowe SERiA, Tom VII, zeszyt 5, Warszawa-Poznań, s. 119-25. [in Polish].
15. Stańko S., 1994. Prognozowanie w rolnictwie [Forecasting in agriculture]. Wyd. SGGW, Warszawa, 26-30 [in Polish].
16. Rocznik Statystyczny Rolnictwa i Obszarów Wiejskich 2005. [Statistical Yearbook of Agriculture and Rural Areas]. GUS, Warszawa, ss. 485. [in Polish].
17. Sobczyk M., 2005. Statystyka [Statistics]. Wyd. PWN, Warszawa, ss. 377. [in Polish].

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Piotr Bórawski
Department of Agribusiness and Environmental Economics,
Warmia and Mazury University in Olsztyn, Poland
Plac Łodzki 2, 10-957 Olsztyn, Poland
Phone: 48 89 523-33-13
email: pboraw@moskit.uwm.edu.pl