Empirical Analysis of Potential Oligopsony Power and Production Technology in the Ukrainian Milk Processing Industry under Conditions of Economic Transition

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Abstract— **The objective of this study is to provide an empirical analysis of potential market power of the Ukrainian milk processing industry in the market for raw milk. The article is based on the New Empirical Industrial Organization (NEIO) approach and pays special attention to the production technology of the sector. In NEIO studies of market power in the food processing industry the production technology is typically assumed to be of a neoclassical type with simple properties like, e.g., constant returns to scale. Properties of this kind, however, are likely not to prevail in most transition countries of Eastern Europe because of serious distortions in factor usage mainly due to institutional deficiencies. Therefore, the analysis of this study is based on the more general representation of the production technology by a translog production function. The econometric model used to measure the degree of oligopsony power of the Ukrainian milk processing industry is estimated on the basis of monthly data. The model did not produce any evidence suggesting the exercise of market power by the milk-processing industry in the estimation period from January 1996 to December 2003. This empirical result is consistent with the low operating rate of the Ukrainian milk processing industry and relatively small concentration ratio at the national level. However, it may be appropriate to conduct similar analyses on a regional level, since the concentration of milk processing plants and the structure of agricultural farms in the regions of Ukraine are quite different.**

Keywords— **milk processing industry, new empirical industrial organization (NEIO), oligopsony power, production technology, transition economy, Ukraine.**

I. INTRODUCTION

Transition from the planned to the market economy involved profound changes in Ukrainian economy. Before the liberalization of prices in 1992, milk processing in Ukraine was concentrated in regionally distributed large state milk processing factories. Until today, the distribution of the milk processing plants reflects the principles of a planned economy in that there is still one processing plant in almost every administrative rayon of Ukraine. Nevertheless, to a certain degree there is concentration of the milk processing industry in some regions, which suggests a strong market position for the milk processors with the exertion of market power vis-à-vis the raw milk producers. According to Bojarunets (2002) in 2002 the largest milk processing enterprise in Ukraine had a market share of 12 %. In 2001 the largest four enterprises had a share of 28 %, whereas the largest ten controlled about 50 % of the market. The rest is shared by about 350-400 enterprises. In the meantime, the state milk processing factories have been privatized. However, the emerging privatization forms were heterogeneous. That is why different kinds of market conduct and, consequently, market performance can be expected, depending on ownership and incentive structures involved.

Furthermore, there is some evidence of limited market transparency and an influence of regional administrative authorities on regional trade with raw milk via regional trade restrictions. In such conditions milk processing enterprises were able to gain a regional monopsony or oligopsony position on the raw milk market. In addition, in 2002 the Antimonopoly Committee of Ukraine detected price cartels among milk processing enterprises in some administrative regions of Ukraine.

These observations suggest that there may be exercise of market power on the part of the milk processing industry in the Ukrainian market for raw milk. On the other hand, although to some extent there is concentration of enterprises in some regions, overall concentration on the national level is low. Moreover, annual milk deliveries from producers to processing factories over the first years of transition declined from 15 to about 4 million t. The capacity utilization in the industry has declined considerably during the 1990s and has reached a level as low as about 10 per cent at the end of the decade. This suggests, contrary to the aforementioned observations, that there should be fierce competition among milk processing enterprises for raw milk.

The objective of this study is to provide an econometric analysis of potential market power of the Ukrainian milk processing industry on the market for raw milk. The analysis is based on the New Empirical Industrial Organization (NEIO) approach (see e.g. Bresnahan, 1989, Sexton and Lavoie, 2001, and Wohlgenant, 2001) and pays special attention to the production technology of the sector. In NEIO studies of market power in the food processing industry the production technology is typically assumed to be of a neoclassical type which may be a suitable assumption for mature market economies like the US or in Western Europe. However, neoclassical production functions do not seem to be appropriate in the case of the Ukrainian milk processing industry, which, during the transition period, suffered from a severe crisis affecting production relationships in the industry in several respects.

First, in the dairy sector, the volume of raw milk delivered fell between 1991 and 1999 by around 80 %, which meant, as was mentioned above, that at the end of the 1990s the operating rate of dairies was only just above 10 %. Second, some of the privatisation rules were burdensome, because the privatisation legislation obliged enterprises to make extensive social guarantees to employees. In the dairy sector this meant that the adjustment of the number of jobs to the decline of production was slow. Moreover, privatized dairies were prohibited from changing their production programmes for a period of 10 years. Third, according to Schwagulyak-Shostak (1999), during the energy crisis of the 1990s regional energy companies cut off electric power to residential and industrial users for many hours daily. Consequently, as in other industrial sectors as well, the technological process in the dairy sector was frequently disrupted. In view of these restrictions with presumably severe impacts on production relationships in the Ukrainian milk processing industry a more general description of the production technology is needed than can be provided by a neoclassical production function. Therefore, the description of the milk processing technology in the structural model used in this study for testing for buyer market power is based on a translog production function, which imposes much less a priori restrictions on the technology than neoclassical functions. In addition, the model consists of the first-order condition for profit maximizing demand for raw milk in the sector and the supply function for raw milk.

Our paper is organized as follows. In the next section we present the theoretical model of oligopsony power followed by its econometric specification in Section 3. The estimation results are discussed in Section 4. In the last section we summarize the results and give some conclusions.

II. STRUCTURAL MODEL OF OLIGOPSONY MARKET POWER

We assume that the milk processing industry produces a homogeneous product Y using one agricultural input (raw milk M) and several non-agricultural inputs ($\mathbf{N}$). The production function of the milk processing industry is

$$Y = f\left(M, \mathbf{N}\right). \qquad (1)$$

The farming sector produces raw milk and supplies it to the milk processing industry. The supply equation for raw milk in inverse form can be represented by

$$W_M = g(M, \mathbf{S}), \qquad (2)$$

where W_M is the price of raw milk and $\mathbf{S}$ is a vector of supply shifters. Given this representation of the production function (1) and the raw milk supply function (2), the profit equation for the milk processing industry can be written as:

$$\Pi = P \cdot f(M, \mathbf{N}) - W_M \cdot M - \mathbf{W_N} \cdot \mathbf{N}, \qquad (3)$$

where P is the output price of the milk processing industry and $\mathbf{W_N}$ is a vector of prices of non-agricultural inputs.

The first-order condition for profit maximization that allows for imperfect competition (oligopsony power) in the raw milk market is:

$$W_M \left(1 + \frac{\Theta}{\varepsilon}\right) = P \cdot f_M, \qquad (4)$$

where Θ is a parameter indexing the degree of market power, f_M is the marginal product of raw milk and $\varepsilon = (\partial M/\partial W_M)(W_M/M)$ is the market price elasticity of supply of raw milk. If $\Theta = 0$, then the market for raw milk is perfectly competitive and the aggregate value marginal product of raw milk equals the market price of raw milk. If $\Theta = 1$, then the market for raw milk is monopsonistic or the dairies act like a monopsony (cartel) and the marginal factor cost is equated to the value marginal product for profit maximization. Intermediate values of Θ imply the presence of an oligopsonistic market structure, in which case the interpretation of the first-order condition is that the 'perceived' marginal factor cost equals the aggregate value marginal product of raw milk. Using industry data over time the parameter Θ reflecting the degree of oligopsony power in the milk processing industry can be estimated on the basis of a structural model including equations (2) and (4). However, because of peculiarities of the production technology in the Ukrainian milk processing industry during the transition period from a planned economy to a market oriented economy, it was considered a necessary extension of the model to estimate production function (1) with the two behavioural functions.

III. ECONOMETRIC SPECIFICATION OF THE MARKET STRUCTURE MODEL

As was argued above, a flexible representation of the production technology of the Ukrainian milk processing industry is needed. In this study we use a transcendental logarithmic (translog) production function (Christensen, Jorgenson and Lau, 1973), which imposes much less a priori restrictions on the production technology than neoclassical variants. Considering the cost structure of the milk processing industry we concentrate on the most important factors of production in terms of cost components and assume that the milk processing industry uses only four factors, namely raw milk (M), labour (L), capital (K) and energy (E). Using a simplified notation (X) for all factor quantities or volumes, the production function can be written as:

$$\begin{aligned}\ln Y = \ln\alpha_0 + \sum_{j=1}^{4}\alpha_j \ln X_j + \\ \frac{1}{2}\sum_{j=1}^{4}\sum_{l=1}^{4}\alpha_{jl}\ln X_j \ln X_l + \\ \gamma_T T + \frac{1}{2}\gamma_{TT}T^2 + \sum_{j=1}^{4}\gamma_{jT}\ln X_j T,\end{aligned} \qquad (5)$$

where $\alpha_{jl} = \alpha_{lj}\,(j \neq l)$ and $X_j, X_l = M, L, K, E$. The time trend variable T is a proxy for technical change in the milk processing industry. The marginal product of raw milk is given by:

$$f_M = \left(\alpha_M + \sum_{l=1}^{4}\alpha_{Ml}\ln X_l + \gamma_{MT}T\right)\frac{Y}{M}. \qquad (6)$$

Substituting equation (6) into (4) yields the first-order condition for profit maximization with respect to raw milk that allows for imperfect competition in this market:

$$W_M = \frac{\left(\alpha_M + \sum_{l=1}^{4}\alpha_{Ml}\ln X_l + \gamma_{MT}T\right)\frac{Y}{M}P}{\left(1+\frac{\Theta}{\varepsilon}\right)}. \qquad (7)$$

According to Bresnahan (1982) and Lau (1982) for identification of market power the inverse supply function (2) must have specific properties: It (a) must be at least of the second degree in M, (b) must be non-separable and (c) has no constant elasticity with respect to M. In previous studies we used the following truncated second-order approximation to a general logarithmic raw milk supply function (2):

$$\begin{aligned}\ln M = \beta_0 + \sum_j \beta_j \ln W_j + \phi_C \ln C + \delta_T T + \\ \frac{1}{2}\delta_{TT}T^2 + \sum_{jT}\delta_{jT}\ln W_j T + \varphi_{CT}\ln C\, T,\end{aligned} \qquad (8)$$

where $W_j\,(j = M, D, B, F)$ is respectively the price at which milk is supplied (W_M), the direct marketing price for milk that is sold directly to consumers (W_D), the price received for beef cattle (W_B) and the price of mixed feeds (W_F). C is the number of milking cows as quasi-fixed factor and T is a linear time trend to account for autonomous change (technical change and other unaccounted for factors affecting short-run supply response over time).

From (8), the price elasticity of raw milk supply takes the form $\beta_M + \delta_{MT} T$. Therefore, the first order condition (7) can be rewritten as:

$$W_M = \frac{\left(\alpha_M + \sum_{l=1}^{4} \alpha_{Ml} \ln X_l + \gamma_{MT} T\right) \frac{Y}{M} P}{1 + \frac{\Theta}{\beta_M + \delta_{MT} T}} \qquad (9)$$

By making use of the monthly time-series data, the parameter of oligopsony power Θ can be tested econometrically based on the simultaneous estimation of the raw milk supply function (8), the production function (5) and the first order condition (9). Since equation (9) is nonlinear in parameters the model represents a nonlinear simultaneous equation system. For the econometric specification additive disturbance terms were added which were assumed to have zero mean, constant variance, and to be independently and normally distributed. For comparison a second specification of the model, excluding the production function, was formulated in addition. Both models were estimated using nonlinear three-stage least squares (see Amemiya, 1977).

The data used in estimation were obtained from the State Committee of Statistics of Ukraine. The data set includes 96 monthly time-series observations, from January 1996 to December 2003, which were adjusted for seasonal variation. The choice of the sample period was dictated by data availability. Seasonal adjustment was performed using the X11 procedure of the statistical software package SAS (SAS, 1985). For ease of interpretation of estimation results, the data were transformed into deviations from their geometric mean. A detailed description of the data is given in Perekhozhuk (2007).

IV. ESTIMATION RESULTS AND SPECIFICATION TESTING

Two alternative specifications of the market structure model were considered. Model I consist of two simultaneous equations: the supply function (8) and the first order condition (9). In Model II these equations are supplemented by the production function (5). Since the price of raw milk (W_M), the quantity of raw milk (M) and the aggregate output quantity of the milk processing industry (Y) are endogenous, instrumental variables had to be defined. All exogenous variables in the system were used as instruments. The estimations were carried out using the SAS statistical software (SAS, 1985)

For a general comparison of the estimated market structure models Table 1 lists some coefficients of statistical inference. The fit of both models is quite good. The adjusted R-square between observed and predicted values obtained for the equations of the supply function in both models is very similar and amounts to 0.91. The addition of the production function to the model results in an increase of the R-square in the equation for the first-order condition. An evaluation of serial correlation of the error terms is difficult, because the Durbin-Watson test statistic, like the t-ratios reported below, can only be interpreted in an approximate way due to the nonlinearity of the estimation method (White, 1992).

Table 1 Statistical inference of N3SLS estimation of market structure models

Model	Equation	DF Model	R^2	$\overline{R^2}$	DW	Objective Value
Model I	$\ln M$	12	0.9205	0.9101	1.2820	1.4642
	W_M	8	0.9778	0.9760	1.4730	
Model II	$\ln M$	12	0.9200	0.9095	1.2637	2.2949
	W_M	5	0.9835	0.9828	1.0358	
	$\ln Y$	18	0.9550	0.9452	1.8677	

Source: Own calculations using data from the State Committee of Statistics of Ukraine and statistical software SAS (SAS, 1985).

Moreover, the values of the Durbin-Watson statistic lie in the inconclusive range. It is common practice to use the minimized values of the objective function in the NL3SLS estimation as an additional criterion for comparison of estimated models. In our case, this criterion shows a slightly better performance of Model I, but comparison is not straightforward because the estimated models are different in terms of the number of equations.

The parameter estimates for both models are reported in Table 2. The estimates of the parameter of the first-order condition measuring the degree of oligopsony power in the milk processing industry is of primary interest. In both models the estimated parameter Θ is close to zero and statistically insignificant. While the negative value of Θ is not theoretically possible, it ranges in the 95 % confidence interval from -0.0026 to 0.0014 for the first model and from -0.0162 to 0.0069 for the second model. With a Wald χ^2 statistic of 0.31 and 0.63 for Model I and Model II, respectively, the hypothesis that the milk processing industry is a price-taker in the farm milk market is not rejected at the 25 % level $\left(\chi^2_{1;\,0.25} = 1.32\right)$ for the second model and even at the 50 % level $\left(\chi^2_{1;\,0.50} = 0.46\right)$ for first model, respectively. In view of the market structure at the national level and the low rate of capacity utilization of the milk processing industry this finding is probably plausible. According to our calculations based on plant level data of the Ukrainian milk processing industry (cf. Perekhozhuk, 2007), the Herfindahl-Hirschman coefficient is small and amounts to 0.007 for the period of 2001 to 2004.

For the milk supply equation, 8 of the 13 parameters yield t-statistics[1] indicating statistical significance at the 5 % level or less. Moreover, the parameters of the supply functions are very robust to change in the model specification. In fact, most parameters are almost identical and change only to the second decimal. The parameters β_M and δ_{MT} are highly significant at any reasonable level of significance and are shared by two of the simultaneous equations (supply function and FOC) to be estimated. Consequently, the linear time trend variable T enters interactively with supply-side exogenous variables, so that the supply curve rotates each successive time periods – a necessary condition for identifying the market power parameter according to Bresnahan (1982) and Lau (1982). A Wald test of the joint hypothesis that the coefficients of the five time trend interaction terms were collectively zero is rejected with a Wald χ^2 statistic of 110.02 for the first model and 122.79 for the second model at the 1 % significance level $\left(\chi^2_{5;\,0.01} = 15{,}09\right)$.

Since all variables were measured as deviations from their geometric mean the parameters $\beta_j\left(j = M, D, B, F\right)$ of the estimated supply function represent the price elasticities of farm milk supply, ϕ_C is the supply elasticity of quasi-fixed inputs represented by the number of milking cows and parameter δ_T is the monthly rate of autonomous change in farm milk supply.

[1] All test statistics and standard errors reported in this article are asymptotic.

Table 2 Parameter estimates of N3SLS estimation of market structure models

Para-meter	Model I			Model II		
	Estimate	St. Error	t-Ratio	Estimate	St. Error	t-Ratio
β_0	-0.1012	0.0118	-8.6	-0.0961	0.0111	-8.65
β_M	0.4473	0.1695	2.64	0.4577	0.1597	2.87
β_D	-0.2056	0.1299	-1.58	-0.2809	0.1184	-2.37
β_B	0.3225	0.1444	2.23	0.3177	0.1361	2.33
β_F	-0.4411	0.1611	-2.74	-0.3479	0.1508	-2.31
ϕ_C	0.0474	0.6708	0.07	-0.304	0.5952	-0.51
δ_T	0.0017	0.0014	1.23	0.0006	0.0014	0.45
δ_{TT}	-0.0005	0.0001	-4.34	-0.0004	0.0001	-3.76
δ_{MT}	0.0137	0.0052	2.64	0.0091	0.0032	2.84
δ_{DT}	0.0041	0.0045	0.91	0.0048	0.0039	1.24
δ_{BT}	0.0147	0.0057	2.57	0.0105	0.0054	1.94
δ_{FT}	0.0151	0.0054	2.78	0.0146	0.0052	2.8
φ_{CT}	-0.0222	0.0253	-0.88	-0.0346	0.0239	-1.45
α_0	-	-	-	0.0005	0.0092	0.05
α_M	1.0017	0.0035	289.13	0.9854	0.0186	52.95
α_L	-	-	-	0.4012	0.4316	0.93
α_K	-	-	-	-0.1347	0.1604	-0.84
α_E	-	-	-	0.1539	0.0457	3.36
γ_T	-	-	-	-0.0006	0.0009	-0.67
α_{MM}	0.7041	0.0833	8.46	0.4864	0.0714	6.81
α_{LL}	-	-	-	-78.4429	45.5951	-1.72
α_{KK}	-	-	-	-7.4964	2.2046	-3.4
α_{EE}	-	-	-	0.6884	0.6686	1.03
γ_{TT}	-	-	-	0	0.0001	-0.38
α_{ML}	-1.9953	0.3794	-5.26	-2.033	0.3271	-6.21
α_{MK}	-0.1318	0.1116	-1.18	-0.2419	0.0934	-2.59
α_{ME}	-0.4346	0.0698	-6.23	-0.3357	0.0478	-7.02
γ_{MT}	-0.0014	0.0004	-3.3	-0.0012	0.0004	-3.1
α_{LK}	-	-	-	20.3873	8.6496	2.36
α_{LE}	-	-	-	6.2458	3.0236	2.07
γ_{LT}	-	-	-	0.0067	0.0394	0.17
α_{KE}	-	-	-	0.5115	0.9027	0.57
γ_{KT}	-	-	-	-0.0107	0.0127	-0.85
γ_{ET}	-	-	-	0.0099	0.0044	2.24
Θ	-0.0006	0.001	-0.56	-0.0047	0.0059	-0.79

Source: See Table 1.

The own-price and cross-price elasticities of farm milk supply evaluated at the sample mean are less than one in absolute terms, they have the expected signs and are compatible with economic theory. The estimated own price elasticity of farm milk supply $\left(\beta_M\right)$ is 0.45 and highly significant at the 1 % level of significance for both models. The sign structure of the cross-price elasticities of farm milk supply is of considerable interest. The farm milk delivered to the milk processing industry is a substitute for the farm milk that was sold directly to consumers and a complement of beef cattle. The price elasticity of mixed feeds (β_F) is negative and statistically significant at least at the 2.5 % level. A Wald test of the hypothesis that the own- and cross-price elasticities of farm milk supply evaluated at the sample mean add up to zero (homogeneity of degree zero of the supply function in prices) is not rejected for both models with a Wald χ^2 statistic of 0.80 and 1.19 even at the 25 % level $\left(\chi^2_{1;\,0.25} = 1.32\right)$. On the other hand, the supply elasticity of quasi-fixed inputs (ϕ_C) is statistically insignificant. Therefore, this variable does not seem to have an impact on the raw milk supply delivered to the milk processing industry. Furthermore, our empirical findings show that the rate of autonomous change in the farm milk supply (δ_T) amounts to 2.1 % annually (Model I) but is statistically insignificant.

By virtue of the fact that all variables were measured as deviations from their geometric mean the estimated parameters of the translog production function α_j $(j = M, L, K, E)$ represent partial production elasticities of the inputs and γ_T is the rate of technical change in the milk processing industry. The estimation results of the first model show that the estimated production elasticity of raw milk (α_M) is statistically highly significant but its unusually high point estimate seems to be counter-intuitive at first sight. This result is almost unchanged when, as in Model II, the complete production function (8) is estimated as part of the structural model. In Model II, the estimated production elasticities of labour (α_L) and capital (α_K) are statistically insignificant. Therefore, these elasticities might as well be zero. Moreover, the estimate for capital has to be interpreted with great care, since the monthly data for capital services had to be generated by interpolation, which suggests that the time series for this production factor used in estimation might not be very reliable. Therefore, no economic interpretation will be given for this elasticity. Only the production elasticity of energy is estimated with an order of magnitude which corresponds more or less to expectations and it is, moreover, statistically significant at least at the 1 % level. Finally, the estimated rate of technical change (γ_T) is close to zero and statistically insignificant.

Although the production elasticities of raw milk and labour are hard to interpret at first sight, the results gain at least some plausibility when the institutional restrictions on the Ukrainian milk processing industry and its development in the 1990s as described in the first paragraph of this paper are taken into consideration. Concerning the input of labour, the estimated production elasticity suggests that the marginal product of labour in the industry is zero. This can be interpreted as evidence that the structural adjustment of the sector to the drastically reduced operating rate was insufficient from an economic perspective. As was mentioned above, for institutional reasons it was not possible to reduce the size of the workforce in the industry accordingly. On the other hand, the tremendously reduced delivery of raw milk, which caused the low operating rate, in combination with the unproportionately large workforce made raw milk an extremely scarce input, which manifests itself in an unusually high production elasticity.

V. SUMMARY AND CONCLUSIONS

The objective of this paper has been to measure the degree of oligopsony power for the Ukrainian milk processing industry. For this purpose, two structural econometric models were estimated. Special attention was paid to the production technology in the Ukrainian milk processing industry, which operates under different circumstances as in developed market economies. In this study the production technology is represented by a translog production function, which imposes much less a priori restrictions on the technology than neoclassical functions. The estimated production elasticity of raw milk is unusually high, the estimated production elasticity of labour is statistically insignificant, i.e. the marginal product of labour might as well as be zero. Given the low operating rate of the milk processing industry, the political requirements in the privatization process and the administrative intervention in the raw milk market during the transition, these findings are probably plausible.

The estimation results did not produce any evidence suggesting the exercise of market power by the milk processing industry in the estimation period from January 1996 to December 2003. This empirical result is consistent with the low operating rate of the Ukrainian milk processing industry and relatively small concentration ratio at the national level. However, it may be appropriate to conduct similar analyses on a regional level, since the concentration of milk processing enterprises and the structure of agricultural farms in the regions of Ukraine are quite different. While our estimate of the Herfindahl-Hirschman coefficient in the Ukrainian milk processing industry suggests that concentration is low at the national level, on the regional level there is evidence for higher concentration. Additional data on the plant level show that in 8 out of 25 regions the Herfindahl-Hirschman coefficient is larger than 0.2. Hence, it would be desirable to apply the structural econometric model also to regional data and to measure market power on a regional market level. The authors hope that this can be achieved in further analyses.

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REFERENCES

1. Amemiya T (1977) The Maximum Likelihood Estimator and the Nonlinear Three-Stage Least Squares Estimator in the General Nonlinear Simultaneous Equation Model. *Econometrica* 45: 955-968
2. Bojarunets A (2002). Market with a high fat content. *Companion* 13. [In Russian]
3. Bresnahan T F (1982) The oligopoly solution concept is identified. *Economics Letters* 10: 87-92
4. Bresnahan T F (1989) Empirical Studies of Industries with Market Power. In Schmalensee R, Willig R (eds), *Handbook of Industrial Organization* 2: 1011-1057. Amsterdam: Elsevier Science B.V.
5. Christensen L R, Jorgenson D W, Lau L J (1973) Transcendental Logarithmic Productions Frontiers. *The Review of Economics and Statistics* 55: 28-45
6. Lau L J (1982) On identifying the degree of competitiveness from industry price and output data. *Economics Letters* 10: 93-99
7. Perekhozhuk O (2007) Marktstruktur und Preisbildung auf dem ukrainischen Markt fuer Rohmilch, *Studies on the Agricultural and Food Sector in Central and Eastern Europe* 41, Halle (Saale): IAMO
8. SAS (1985) *SAS Institute*, Version 5. Cary, New Carolina
9. Schwagulyak-Shostak O (1999) Energy crisis and how to deal with it. *Galytski kontrakty* 50. [In Ukrainian]
10. Sexton R J, Lavoie N (2001) Food Processing and Distribution: an Industrial Organization Approach. In Gardner B, Rausser G (eds), *Handbook of Agricultural Economics* 1: 863-932. Amsterdam: Elsevier Science B.V.
11. White K J (1992) Durbin-Watson Test for Autocorrelation in Nonlinear Models. *The Review of Economics and Statistics* 74: 370-373
12. Wohlgenant M K (2001) Marketing Margins: Empirical Analysis. In Gardner B, Rausser G (eds), *Handbook of Agricultural Economics* 1: 933-970. Amsterdam: Elsevier Science B.V.

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