Competition or Market Power in the Ukrainian Meat Supply Chain?

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Abstract

The objective of this paper is to provide an analysis of potential market power in the Ukrainian meat supply chain. Many agricultural Economists find evidence of oligopsony power in the meat packing industry. These studies are typically done for industries in developed market economies and have largely focused on the US and European meat sectors. However, the meat sectors in transition countries, that are potentially different from the ones in developed economies, have been largely ignored by research. Yet, the issue of imperfect competition seems to be especially relevant to the meat sector in transition countries. With reference to the contribution by NEIO studies there was a market structure model constructed to measure the degree of oligopsony power in the Ukrainian meat supply chain. The estimation results of the market structure models did not produce any evidence suggesting the exercise of oligopsony power at the national level in the investigation period from January 1996 to June 2003.

Keywords: Competition, Market Power, Meat Processing Industry, New Empirical Industrial Organization (NEIO), Ukraine.

1.Introduction

Over the past 15 years, the meat supply chain in Ukraine, like many other sectors of the economy, has experienced drastic changes. During the transition from centrally planned to a market-oriented economy, first and foremost there has been a liberalization of prices of agricultural products and consumer goods. The liberalization of prices put an end to a state regulation of production, establishment of administrative prices and the centralized logistics enterprises. The second step of transition to market economy was a privatization of state and collective enterprises, firstly in agriculture, and later the state processing enterprises of agro-industrial complex, including the meat supply chain. Privatization put an end to state monopolies and gave birth to the development of competitive relations in the agro-industrial complex.

The producers and processors of meat supply chain, obviously, hoped for positive developments in the sector: an increase in the production of meat and meat products, salary and improved working conditions. However, from 1990 to 2007, first and foremost, there has been a sharp decline in livestock and poultry. The number of cattle (including cows) decreased from 24.6 to 5.5 million, accounting for only 22.3% of 1990 levels. The total number of pigs has dropped from 19.4 to 7.0 million heads, sheep and goats from 8.4 to 1.7 million heads, poultry from 246.1 to 169.2 million. Consequently there was a reduction in meat production of cattle and poultry. Hence, during this period, the meat production of livestock and poultry dropped from 4.4 to 1.9 million tons, including beef and veal from 2.0

to 0.5 million tons, pork from 1.6 to 0.6 million tonnes, mutton and goat from 45.8 to 15.3 thousand tons and rabbit, from30.2 to 12.4 thousand tons. Despite the fact that poultry production has dramatically decreased during 1990s and comprised only 193.2 thousand tons a year in 2000, in 2007, it increased to 689.4 tons, and nearly reached the level of 1990.

In response to a sharp decline in production there was a decline in sales of livestock and poultry for industrial processing. Hereby, since 1990 until 2007 the sales of livestock and poultry (in live weight) decreased from 4.4 to 1.3 million tons accounting for only 29.7 % of 1990 levels. It should be noted that the sales structure has undergone dramatic changes. Thus in 1990, the agricultural enterprises sold 94.8 % of the meat of cattle and poultry to the meat processing enterprises, 1.8 % to the market, 3.3 % to the population (including salary) and 0.1 % to other sales channels. While in 2007, there was only 34.6 % of cattle and poultry meat sold to the agricultural enterprises, 7.8 % to the market, 2.2 % to the population and 55.4 % by other sales channels.

As a result of a decrease in sales of livestock and poultry for the industrial processing, the utilization of production capacity of the meat processing industry has declined. While in 1990 the meat processing industry used 86.7% of its production capacity, in 1997 it composed only 21.7%. As a result, the production of meat and meat products were reduced as well. From 1990 to 2007 the production of beef and veal decreased from 1494.0 to 199.9 thousand tons and comprised only 13.4% of 1990 levels. During the same period, the pork production has decreased from 724.0 to 155.4 thousand tons, or up to 21.5% compared with 1990. The production of sausage products has decreased from 900.0 to 330.0 thousand tons. In 1990, meat processing enterprises produced 355.0 thousand tons of poultry meat. Since the 1990s, the production of poultry meat has begun to fall sharply and in made up only 22.8 thousand tons in 1997, which is less than 6.4% from 1990 levels. However, since 2001, the production of poultry meat started to gradually increase and in 2007it has already comprised 416.5 thousand tons which is 17.3 % more than in 1990.

While the supply of livestock and poultry for the industrial processing and production of meat and meat products has dropped sharply, the number of meat processing enterprises in Ukraine has increased. According to the State Statistics Committee of Ukraine there was an increase in the number of processors in meat and milk industry, from 648 to 916 enterprises during 1993-2000[1]. According to the State Statistics Committee of Ukraine (2008) there were 1178 enterprises that produce meat and meat products already registered in 2007, of which only 789 enterprises were active and offered its services. Out of 1178 enterprises, there were 14 large-scale enterprise (1.2 % of total number), 335 medium-sized enterprise (28.4 %) and 829 small-scale enterprise (70.4 %), respectively.

In spite of the fact that currently the number of enterprises in the meat processing industry of Ukraine is almost double the milk processing industry's (there are 396 active enterprises in 2007), the concentration level of the meat processing industry is much higher. Considering total sales revenue of the meat processing industry in 2007 the concentration ration of 14 large-scale enterprises is 34.5 % (cf. State Statistics Committee of Ukraine, 2008). The concentration ration of the 30 largest enterprises of the meat processing industry is 46.1 %. The rest of market share is shared by more as 700 enterprises.

According to the U.S. Census Bureau (2001), the concentration ratio in manufacturing for 1997 of 4 largest companies, was 35.0 % for the animal slaughtering and processing. The 8 largest companies in animal slaughtering and processing industry controlled 50 % of the market. Most of the mainstream research conducted in the United States meat sector

[1] As far as the authors know, the data concerning the number of enterprises is published in a general aggregate form of meat and milk industry by the State Statistics Committee of Ukraine for 1993–2000.

demonstrates a precipitous growth of concentration and consolidation of meat processing industries (Morrison, 2001). Since 1980s, there have been numerous studies done in Western Europe and North America concerning the market power exertion in the meat processing (packing) industries. Some studies, suchlike of Azzam and Schroeter (1990), measuring market power in multi-product oligopolies of the U.S. meat industry and Morrison (2001), conducting a plant-level analysis for the U.S. beef packing industry market and cost structure found the presence of market power, however, some studies, like of Muth and Wohlgenant (1999), measuring the degree of oligopsony power in beef packing industry, did not.

The objective of this study is to provide an analysis of potential market power in the Ukrainian meat supply chain. The next section encompasses a structural model examining the market situation in the meat sector of Ukraine. The third part shows the econometric specification of the market structure model. Part four reveals the estimation results and specification testing. The final section is comprised of the results followed by concluding remarks.

2.Modelling meat supply chain

Besides beef and dairy cattle, the animal farms, as well as, the households in agricultural areas, pigs, sheep, poultry and other livestock are raised for meat and supplied to slaughtering and meat processing plants. The market supply of slaughtered animals (A) can be represented by the following inverse function:

$$W_A = g(A, \mathbf{S}), \tag{1}$$

where W_A is the average price for slaughtered animals that the farms and households delivered to the slaughtering and meat processing industry and $\mathbf{S}$ is a vector of the supply shifters.

The slaughtering and meat processing plants procure cattle, pigs, sheep and other livestock in order to slaughter and process them for different kinds of meat and meat products. With respect to the input and output of the meat packing industry, the production function can be written in general form of:

$$Y = f(A, \mathbf{N}) \tag{2}$$

where Y is an aggregate industrial output of meat packing industry including beef, pork, poultry and sausage goods. $\mathbf{N}$ is a vector of non-agricultural inputs, such as labor, capital and energy that are utilized and have a large share in the cost structure of the meat packing industry.

Given this representation of the inverse supply function (1) and the production function (2), the profit equation for the meat packing industry can be written as:

$$\pi = P \cdot f(A, \mathbf{N}) - W_A \cdot A - \mathbf{W_N} \cdot \mathbf{N}, \tag{3}$$

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

We assume that the slaughtering and meat packing plants maximize their profit and set the price for slaughtered animals. The first-order condition for profit maximization that allows for imperfect competition (oligopsony power) in the market for slaughtered animals is:

$$W_A\left(1+\frac{\Theta}{\varepsilon}\right)=P\cdot f_A, \tag{4}$$

where Θ is the parameter indexing the degree of oligopsony power, f_A is the marginal product of slaughtered animals and $\varepsilon=(\partial A/\partial W_A)(W_A/A)$ is the market price elasticity of supply for slaughtered animals. If $\Theta=0$, then the market for slaughtered animals is perfectly competitive and the value of the marginal product of slaughtered animals equals the market price of the slaughtered animals. If $\Theta=1$, then the market for the slaughtered animals is monopsonistic or the slaughtering and meat packing plants act like a monopsony (cartel) and the marginal factor cost is equated to the value of the marginal product for profit maximization. Intermediate values of Θ imply the presence of an oligopsonistic market structure, where the interpretation of the first-order condition is that the "perceived" marginal factor cost equals the value of the marginal product of slaughtered animals.

3.Econometric specification of the market structure model

Concerning the econometric model building, we assume that the agricultural supply of slaughtered animals (1) can be written as a truncated second-order approximation to a general transcendental logarithmic function[2]:

$$\ln A=\beta_0+\sum_i\beta_i\ln W_i+\phi_C\ln C+\delta_T T+\sum_{iT}\delta_{iT}\ln W_i T+\varphi_{CT}\ln C\,T, \tag{5}$$

where W_i $(i=A,D,M,F)$ is, respectively, the average price of slaughtered animals which is supplied to the slaughtering and meat packing industry (W_A), the direct marketing price for slaughtered animals[3] sold on urban markets directly to consumers (W_D), the average price of raw milk which is delivered to milk processing industry (W_B) and the price of mixed feeds (W_F). C is the livestock as quasi-fixed factor and T is a linear time trend to account for an autonomous change (technical change and other unaccounted for factors affecting short-run supply for slaughtered animals response over time; $T=1,...,96$).

Solving equation (5) for W_A and differentiating with respect to A, we obtain the following expression for the marginal effect of the input level on prices for slaughtered animals:

$$\frac{\partial g(\bullet)}{\partial A}=\frac{W_A}{(\beta_A+\delta_{AT}T)\;A}, \tag{6}$$

where $\beta_A+\delta_{AT}T=\varepsilon_{WA}$ is the own price elasticity of animal products supply.

in terms of the cost structure of the meat packing industry we focused on the most important factors of production and assumed that it uses only four factors, namely, animal products (A), labor (L), capital (K) and energy (E). The marginal product of slaughtered animals (A) is defined as the partial derivative of the translog production function[4] and is given by:

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[2] Perekhozhuk (2007) used a similar function form to model the agricultural supply for raw milk.

[3] The market share of animal products for meat sold directly to consumers is relatively large; it averages 30 percent during the period from 1997 to 2002. This had a considerable influence on the supply of animal products for meat delivered to the slaughtering and meat packing industry.

[4] Cf. Christensen, Jorgenson and Lau (1973).

$$\frac{\partial Y}{\partial A} = \frac{Y}{A}\left(\alpha_A + \sum_{j=1}^{4}\alpha_{Aj}\ln A_j + \gamma_{AT}T\right), \tag{7}$$

where $X_j = A, L, K, E$. T is a linear time trend to account for the technical change in the meat packing industry for the time period of 90 months $(T = 1,..., 90)$. Using equations (6) and (7), equation (4) can now be re-written as:

$$W_A = P\frac{Y}{A}\left(\alpha_A + \sum_{j=1}^{4}\alpha_{Aj}\ln X_j + \gamma_{AT}T\right)\Bigg/\left(1 + \frac{\Theta}{\beta_A + \delta_{AT}T}\right). \tag{8}$$

The econometric model consists of equations (5) and (8), where, to allow for the existence of random shocks, an additive disturbance term is added, which is assumed to have a zero mean, constant variance, and be independently and normally distributed. In addition, to account for the seasonality in our monthly time series data, eleven monthly dummy variables (cf. β_i and α_i, $i = 2,..., 12$, in Table 2) were added to equations (5) and (8), respectively.

The time series data used to test for the existence of oligopsony power in the meat supply chain was obtained from the State Committee of Statistics of Ukraine. The data set includes 90 monthly time-series from January 1996 to June 2003. The choice of the sample period was dictated by data availability. A detailed description of the data sources is available from the authors upon request.

4.Estimation results and specification testing

In the market structure model consisting of equations (5) and (8), the price of animal products (W_M) and the quantity of animal products (M) are endogenous. Since equation (8) is intrinsically nonlinear in its parameters, the market structure model represents a nonlinear simultaneous equation system. Therefore, the model was estimated using nonlinear three-stage least squares (cf. Amemiya, 1977). All the exogenous variables in the system were used as instruments. Estimation was carried out using the statistical software SAS (SAS, 2008: 925-1239).

Table 1 lists the Rsquares, Durbin-Watson statistics and objective values of market structure model estimated at the national level for Ukraine.

Table 1 Statistical inference of NL3SLS estimation of market structure model

Equation	*DF*	*ADJ*	*SSE*	*MSE*	R^2	$\overline{R^2}$	*DW*	*Objective value*
$\ln M$	22	1.4252	0.0210	0.1448	0.8346	0.7835	1.3697	0.501
W_M	18	7.6640	0.1079	0.3285	0.7707	0.7126	1.4256	

The fit of the estimated market structure model is quite good. While the values of the Rsquare and the adjusted Rsquare $\left(\overline{R^2}\right)$ obtained for the equations of the animal products supply function are 0.83 and 0.78, the equations of the first-order condition are a little less in value and amounted to 0.77 and 0.71, respectively.

The Durbin-Watson coefficient lies, for both equations, in the inconclusive range. In spite of a relatively large number of time-series observations, the range between the lower and upper critical values is rather large. The Durbin-Watson coefficient is greater than 1.34 and 1.43 for the equation of supply function and the equation for the first order condition.

It is a common practice to use the minimized values of the objective function (residual sum of squares of the model, which is to be minimized) in the nonlinear three-stage least squares estimation (NL3SLS) as an additional criterion for a comparison of the estimated models. The NL3SLS estimation reveals a good performance of the market structure model. The estimation results of market structure model show that the objective value verges towards zero.

Table 2 shows the parameters of the market structure models as estimated by N3SLS, which can easily be interpreted because all variables were measured as deviations from their geometric mean.

Table 1 Parameters of N3SLS estimation of the market structure model

Supply of animal products					First-order condition				
Parameter	Estimate	St. Error	*t*-Ratio	Pr >|*t*|	Parameter	Estimate	St. Error	*t*-Ratio	Pr >|*t*|
β_A	0.3400	0.3700	0.92	0.3614	α_A	0.7838	0.1578	4.97	<.0001
β_D	-0.7936	0.4062	-1.95	0.0549	α_{AA}	0.7930	0.2728	2.91	0.0049
β_M	0.7733	0.2257	3.43	0.0010	α_{AL}	-0.6131	1.9814	-0.31	0.7579
β_F	-0.0283	0.3291	-0.09	0.9317	α_{AK}	0.6019	0.3365	1.79	0.0779
ϕ_C	2.5844	1.9463	1.33	0.1887	α_{AE}	-2.3599	0.5563	-4.24	<.0001
δ_T	0.0033	0.0109	0.30	0.7623	γ_{AT}	0.0270	0.0050	5.37	<.0001
δ_{AT}	-0.0102	0.0111	-0.92	0.3614	-	-	-	-	-
δ_{DT}	0.0264	0.0169	1.56	0.1229	-	-	-	-	-
δ_{MT}	-0.0148	0.0060	-2.46	0.0163	-	-	-	-	-
δ_{FT}	-0.0406	0.0139	-2.93	0.0046	-	-	-	-	-
φ_{CT}	-0.1155	0.0342	-3.38	0.0012	-	-	-	-	-
β_2	-0.3270	0.0809	-4.04	0.0001	α_2	0.5388	0.1956	2.76	0.0074
β_3	-0.4161	0.0776	-5.36	<.0001	α_3	0.3958	0.2030	1.95	0.0552
β_4	-0.4707	0.0774	-6.08	<.0001	α_4	0.3034	0.2364	1.28	0.2037
β_5	-0.4384	0.0824	-5.32	<.0001	α_5	0.2473	0.2472	1.00	0.3205
β_6	-0.3031	0.0998	-3.04	0.0034	α_6	0.2794	0.2431	1.15	0.2542
β_7	-0.1598	0.1151	-1.39	0.1695	α_7	0.0871	0.3059	0.28	0.7765
β_8	-0.0467	0.1211	-0.39	0.7012	α_8	0.4680	0.2230	2.10	0.0394
β_9	-0.0975	0.1094	-0.89	0.3759	α_9	0.4242	0.2194	1.93	0.0572
β_{10}	-0.0133	0.1057	-0.13	0.9001	α_{10}	0.3582	0.1915	1.87	0.0655
β_{11}	-0.0370	0.0917	-0.40	0.6880	α_{11}	0.3188	0.1741	1.83	0.0712
β_{12}	-0.1007	0.0812	-1.24	0.2189	α_{12}	0.3616	0.1632	2.22	0.0300
β_0	0.0973	0.1257	0.77	0.4417	Θ	-0.0051	0.0060	-0.84	0.4062

Hereby, the parameters β_j ($j = A, D, M, F$) of the estimated supply function represent the own and cross price supply elasticities. The estimated results indicate that the estimated own price elasticity of supply for slaughtered animals (β_A) is relatively inelastic, so that the change in quantity is smaller than the change in price. The estimated parameters β_D (cross price elasticity for meat sold directly to consumers) and β_M (cross price elasticity for raw milk) is relatively high and statistically significant, at least, at the 5 percent level of significance. Moreover, the slaughtered animals, delivered to the slaughtering and meat packing industry, are a complement for raw milk and a substitute for the meat that was sold directly to consumers. Since the price of meat that is sold directly goes up 1 percent, the quantity of slaughtered animals supplied to the slaughtering and meat packing industry decreases to 0.79 percent. However, in response to an increase in the price of raw milk to 1 percent, the supply for slaughtered animals will rise to 0.77 percent. The estimated coefficient cross price elasticity of supply for mixed feeds (β_F) is negative, but statistically insignificant[5]. This result may in part be attributed to the fact that the share of mixed feeds is rather small and averages out at 12 percent (cf. Perekhozhuk, 2007: 29-32). Thus, it is evident

[5] Schroeter (1988) also obtained similar results concerning insignificance of price elasticity of supply for feeds in the United States.

that it is not only the mixed feeds but also the green and coarse fodder that have a profound influence on the supply of slaughtered animals.

The estimated supply elasticity of quasi-fixed inputs (ϕ_C) represented by livestock as quasi-fixed factor is very elastic and amounts to 2.5 at the sample mean. Initially, it seems to be very large. However, considering the construction of an aggregate livestock variable, the supply of slaughtered animals includes not only cattle but also pigs, sheep and poultry. The supply elasticity of slaughter cattle is the same in the United States (cf. Schroeter, 1988).

For the period from January 1996 to June 2003 the estimates of δ_T indicate a positive rate of autonomous change in the supply of slaughtered animals and amount to 0.33 percent per month or 4.03 percent per year. This result confirms the theory, yet it is statistically insignificant. The estimated production elasticity of animal products (α_A) is 0.78 and highly statistically significant at any reasonable level of significance.

The main issue of this research is the estimates of the parameter that measure the degree of oligopsony power in the markets for animal products. The estimated parameter of oligopsony power at the national level Θ is -0.0051. The negative value of Θ is not theoretically possible, but it close to zero and statistically insignificant. The estimated parameter Θ ranges from -0.0169 to 0.0068 in the 95 percent confidence interval. With a Wald $\chi^{٢}$ statistics of 0.70, the hypothesis that the slaughtering and meat packing industry is a price-taker in the market of animal product for meat $(H_{\cdot} : \Theta = ٠)$ is not rejected even at the 10 percent level of significance. The estimation results of the market structure models did not produce any evidence suggesting the exercise of oligopsony power in the market of animal product for meat by the slaughtering and meat packing industry.

5.Summary and conclusions

The objective of this study is to provide an analysis of potential market power in the Ukrainian meat supply chain. With reference to the contribution by NEIO studies we constructed a market structure model to measure the degree of oligopsony power, particularly, in the market of slaughtered animals. The empirical model of market structure consists of two equations, first, the agricultural supply of slaughtered animals and second, the demand relationships of the slaughtering and meat packing industry. Using the monthly time series data, the parameter of oligopsony power, supply and production elasticities were estimated simultaneously. The estimation results of supply function indicate that the own and cross price elasticities of animal products supply are less than one in absolute terms, they have the expected signs and are compatible with an economic theory. The estimation results show that the rate of autonomous change in the animal products supply is positive and amounts to 4.03 percent annually.

The estimation results of the market structure model give no evidence for the existence of oligopsony power at the national level in the investigation period from January 1996 to June 2003. The estimated parameter indicating oligopsony power is approaching zero and is statistically insignificant. The hypothesis of perfect competition is not rejected even at 10 percent level of statistical significance. This empirical result is consistent with the low operating rate and relatively small concentration ratio of the meat processing industry at the national level. However, there is evidence for higher concentration of the slaughtering and meat packing industry at the regional level. Hence, it may be desirable to conduct similar analyses on a regional level and to apply the structural econometric model also to regional data and to measure the oligopsony power on a regional market level.

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