ESTIMATING THE DEGREE OF BUYERS' MARKET POWER: EVIDENCE FROM THE UKRAINIAN MEAT PROCESSING INDUSTRY

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ABSTRACT

This study develops a structural market model for the econometric analysis of buyers' market power in the Ukrainian meat processing industry, because there is some evidence that suggests that meat processors may excise market power in the agricultural market of slaughtered livestock. The estimation results did not produce any evidence suggesting the existence of buyers' market power. Contrary to many other NEIO-studies, we extended the market structure market model by the three subsequent models. Using endogenously determined values for market power parameter, we found that meat processors concerning the buyers' market for slaughtered livestock behave consistently with Cournot conjectures.

Keywords: Cournot competition, market power, meat processing industry, new empirical industrial organisation (NEIO), Ukraine.

1. INTRODUCTION

Since the 1980s, numerous studies on New Empirical Industrial Organization (NEIO) concerning the oligopoly and/or oligopsony market power have been done in Western Europe and North America. Bresnahan (1989: 1051), Carlton and Perloff (2000: 263), Sheldon and Sperling (2003), Kaiser and Suzuki (2006: 3-61), Perloff, Karp and Golan (2007: 46), Sexton et al. (2007), Perekhozhuk (2007: 94) provide a summary review of empirical studies on market power. Comparatively many empirical studies have been devoted to the analysis of market power in the U.S. meat industry (Schroeter 1988, Azzam and Pagoulatos 1990, Schroeter and Azzam 1990, Muth and Wohlgenant 1999, Morrison Paul 2001). Some studies, such as those of Schroeter (1988), Azzam and Pagoulatos (1990), Schroeter and Azzam (1990), Anders (2008), Bakucs et al. (2010), provided evidence for the presence of oligopsony and/or oligopoly market power in the agricultural market of livestock, and in the industrial market of meat and meat products. However, some studies, like that of Hyde and Perloff (1998), Muth and Wohlgenant (1999) and Morrison Paul (2001), which measured the degree of oligopoly and/or oligopsony power in the meat sectors, did not find the presence of market power.

The studies of NEIO are of interest for several reasons. Firstly, they have contributed to our understanding of the relationship between market structure and pricing in agricultural and food sectors. Secondly, they are based on a structural model of the market and provide results for the estimation of consumer demand and/or farm-supply functions and processor technology. Thirdly, they have estimated the parameter of oligopoly and/or oligopsony market power by standard econometric methods, even when no cost or profit data were available. Finally, the studies of NEIO can be used to assess the impact of market structure and are a useful tool for analyzing the supply and/or demand price elasticities, economies of scale, factor productivity, efficiency, trade liberalization and some other economic aspects of agricultural and food markets.

Studies of NEIO are typically done for industries in developed market economies and have largely been focused on the U.S. and European agricultural and food sectors. However, the agricultural and food sectors in transition countries, which are potentially different from the ones in developed economies, have been largely ignored by research

so far. To understand the concerns about the market structure and pricing in transition countries, the issue of imperfect competition seems to be especially relevant to the Ukrainian meat sector as there is some evidence to suggest that the Ukrainian meat processing industry may exercise buyers' market power. During the investigation period in the Ukraine, as in other transition economies, there have been many economic reform and changes. Here, we distinguish only two main aspects of economic reforms, which had a huge influence on the development of competition in the agricultural and food markets. First of all, market liberalization, i. e. especially trade liberalization, that is taking place in the consumer markets for meat and products as well as in the agricultural markets for livestock products must be named here. At the same time there have been and still are various cases of government interventions by various government authorities in the agricultural market that directly affect the pricing and contribute to the existence of imperfect competition in that market.

Secondly, the former state and collective enterprises of the meat sector as well as other sectors of the agri-industrial complex, including the agricultural sector, have been privatized. This has contributed to the development of competitive relations in the agricultural and food markets. However, it should be noted that in the process of privatization, on one hand, small, private farms and agricultural enterprises on the basis of large-scale agricultural enterprise have been created, which have no opportunity to influence the purchasing price. On the other hand, there have been processes of concentration in the processing industry. In addition, according to the Antimonopoly Committee of Ukraine, meat processors in the processing industry sustain collusive agreements about the division of agricultural markets (quota cartel) and the fixation of low procurement prices for livestock products (price cartel).

The objective of this study is to provide an analysis of buyers' market power in the Ukrainian meat processing industry. The next section encompasses the liberalization and privatization processes as well as market developments in the Ukrainian meat sector. The third section outlines a structural model examining the market situation in the Ukrainian meat sector. In section four, the empirical specification designed to test buyers' market power is presented. The fifth section contains a brief description of data sources and variables used in the econometric analysis. Section six covers the estimation results and specification testing. The final section comprises the results, followed by concluding remarks.

2. DEVELOPMENTS IN THE UKRAINIAN MEAT SECTOR

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

The meat producers hoped for positive developments in the meat sector: an increase in the production of meat and meat products, better salaries and improved working conditions. However, from 1990 to 2007, there was 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 dropped from 19.4 to 7.0 million head; sheep and goats from 8.4 to 1.7 million head; poultry from 246.1 to 169.2 million head. Consequently, it came to a reduction in the production of both cattle and poultry.

During the period 1990-2007, the meat production of livestock and poultry dropped from 4.4 to 1.9 million tons, including beef (from 2.0 to 0.5 million tons), pork (from 1.6 to 0.6 million tons), mutton and goat (from 45.8 to 15.3 thousand tons), and rabbit (from 30.2 to 12.4 thousand tons). Despite the fact that poultry production dramatically decreased during the 1990s, and only comprised 193.2 thousand tons in 2000, this figure increased to 689.4 tons in 2007, and thus nearly reached the level of 1990 (cf. Figure 1).

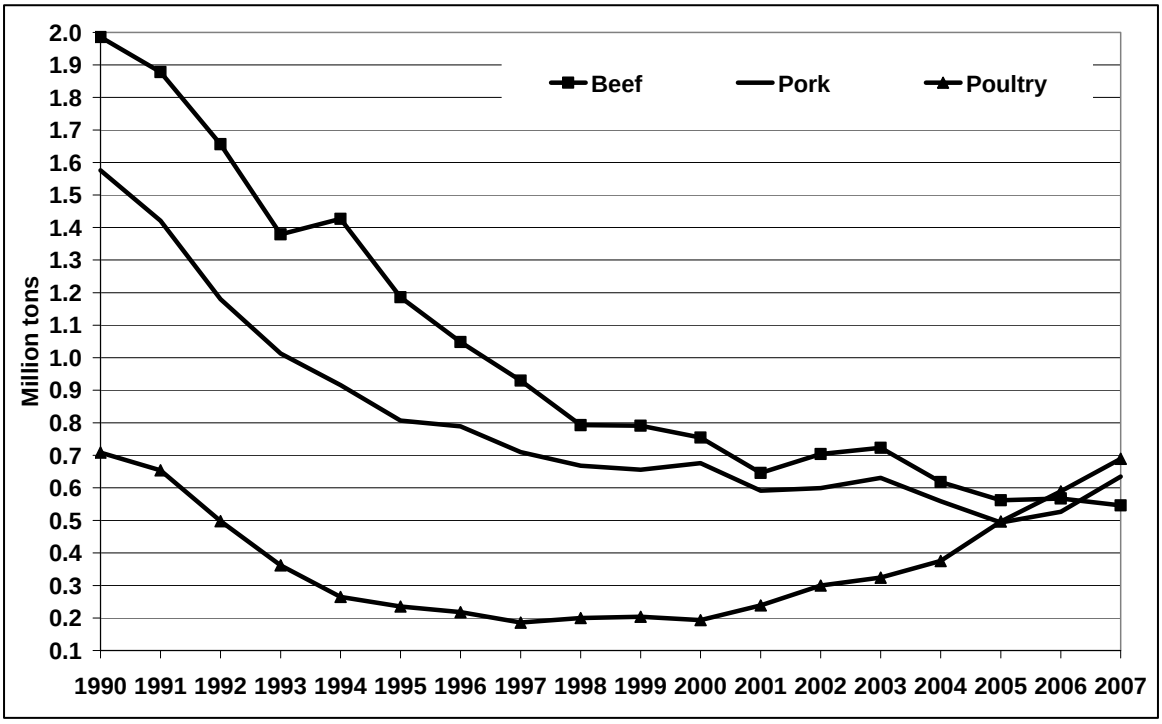

Figure 1. Production of livestock products in Ukraine, 1990-2007
Source: Own presentation based on statistical data of the State Statistics Committee of Ukraine: Statistical Yearbook of Ukraine.

In response to the sharp decline of production, sales of livestock and poultry for industrial processing decreased. Thus, from 1990 to 2007 the sales of livestock and poultry (in live weight)[1] fell from 4.4 to 1.3 million tons, accounting for only 29.7 % of 1990 levels. It should be noted that the sales structure underwent dramatic changes. In 1990, agricultural enterprises thus sold 94.8 % of the total of cattle and poultry meat to the meat processing

[1] The weight of an farm animal before it has been slaughtered and prepared as a carcass.

enterprises, 1.8 % to the town market, 3.3 % to private customers and 0.1 % to other sales channels. In 2007, only 34.6 % of cattle and poultry meat was sold to the meat processors, 7.8 % to the town market, 2.2 % to private customers and 55.4 % to other sales channels (including own consumptions).

In the early nineties of the last century, during the transition from planned to market economy many workers and employees who lost their jobs and did not have any income were forced to engage in agricultural production, including farming of cattle, pigs and poultry. One part of the livestock products (beef, pork, poultry, milk), they consume themselves. The other part of livestock products they sell to processing enterprises or to local markets. Thus, in Ukraine, in contrast to developed countries, there are two forms of agricultural farms: 1) agricultural enterprises that have usually 10 or more heads of cattle or pigs, or more than 100 heads of poultry and 2) so-called personal subsidiary plots (private family plots or private subsidiary plots), which as a rule, have 1-3 heads of cattle or pigs or other livestock, or up to 30 head of poultry. In consideration of property qualification the term “personal property” is not to be confused with “private property” as “personal property” may serve for personal consumption only (cf. Wädekin, 1973, p. 6). In the literature of transition economies these two forms of agricultural production are also called the dual structure of agricultural production that is inherent in the Central and Eastern European Countries (CEEC), New Independent States (NIS), China and India. (cf. OECD, 1999, p. 68-69). According to Perekhozhuk (2007, p. 41-42), there were 58575 agricultural farms and about 4.7 million private subsidiary plots, which keep cattle, pigs and other livestock in the Ukraine in 2004.

As a result of the decrease in sales of livestock and poultry to industrial processing, the meat processing industry’s production capacity declined. While in 1990 the meat processing industry used 86.7 % of its production capacity, in 1997, this figure was only 21.7 %. Thus, the production of meat and meat products declined as well. From 1990 to 2007, the production of beef decreased from 1,494.0 to 199.9 thousand tons and comprised only 13.4 % of 1990 levels. During the same period, pork production decreased from 724.0 to 155.4 thousand tons, i. e. just 21.5 % of its 1990 level. The production of sausage products decreased from 900.0 to 330.0 thousand tons. In 1990, meat processing enterprises produced 355.0 thousand tons of poultry. In the 1990s, the production of poultry began to fall sharply, and amounted to only 22.8 thousand tons in 1997, which is less than 6.4 % of 1990 levels. However, in 2001, the production of poultry started to gradually increase, and in 2007 it already comprised 416.5 thousand tons, which was 17.3 % more than in 1990.

On account of the State Statistics Committee of Ukraine, in the period of 1993-2000, there was an increase in the number of processors from 648 to 916 in the meat and milk processing industries (cf. Perekhozhuk, 2007, p. 50). Following a report of the State Statistics Committee of Ukraine (2008), 1,178 enterprises that produced meat and meat products were already registered in 2007, thereof only 789 enterprises were active and offered their services. Out of 1,178 enterprises, there were 14 large-scale enterprises (1.2 % of total number), 335 medium-sized enterprises (28.4 %) and 829 small-scale enterprises (70.4 %), respectively.

In spite of the fact that the current number of enterprises in the Ukrainian meat

processing industry is almost double that of the milk processing industry's, (there were 396 active enterprises in 2007), the concentration of the meat processing industry is much higher. Considering total sales revenue of the meat processing industry in 2007, the concentration ratio (*CR*) of 14 large-scale enterprises amounted to 34.5 % (cf. State Statistics Committee of Ukraine, 2008); the concentration ratio of the 30 largest enterprises of the meat processing industry came to 46.1 %; the rest of market was shared by more than 700 enterprises.

3. THEORETICAL MODEL OF BUYERS' MARKET POWER

We assume that the meat processing industry produces a homogeneous product Y using both specialized agricultural input A (over which price the meat processing plant has the buyer market power) and non-specialized inputs $\mathbf{N}$ (that are assumed to be sold in perfectly competitive markets). The production function of the meat processing industry can be generally written as:

$$Y = f(A, \mathbf{N}) \tag{1}$$

where Y is the aggregate industrial output of the meat processing industry, including beef, pork, poultry and sausage goods, A is specialized agricultural input which the meat processing industry buys and slaughters cattle, pigs, poultry, sheep and other livestock in order to finally process them into various sorts of meat and meat products, and $\mathbf{N}$ is a vector of non-specialized inputs like labour, capital and energy.

The agricultural sector produces pigs, sheep, poultry and other livestock for meat production and supplies them to the meat processing industry. The market supply of slaughtered livestock (A) can be described through the following inverse function:

$$W_A = g(A, \mathbf{S}) \tag{2}$$

where W_A represents the average price for slaughtered livestock that the farms and personal subsidiary plots deliver to the meat processing industry, and $\mathbf{S}$ is a vector of the supply shifters.

Given this representation of the production function (1) and the inverse supply function (2) the profit equation for the meat processing 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 processing industry and $\mathbf{W_N}$ is a vector of prices of non-agricultural inputs.

We assume that the meat processing industry maximises its profit and sets the price for slaughtered livestock. The first-order condition for profit maximisation that allows for imperfect competition (buyers' market power) in the market for slaughtered livestock is:

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

where Θ is a parameter indexing the degree of buyers' market power in the meat

processing industry, f_A is the marginal product of slaughtered livestock and $\varepsilon = (\partial A/\partial W_A)(W_A/A)$ is the market price elasticity of supply of slaughtered livestock.

The equations (2) and (4) can be used to distinguish between the following three models of market structure. The first model relates to a competitive market structure in which the market price of the slaughtered livestock equals the value of the marginal product of slaughtered livestock, implying $\Theta = 0$. The second model refers to a monopsonistic market structure. If $\Theta = 1$, then the market for the slaughtered livestock is monopsonistic or the meat packing plants act like a monopsony (cartel). Thus, the marginal factor cost may be set equal to the value of the marginal product for profit maximization. The third model implies the presence of an oligopsonistic market structure where the parameter indexing the degree of buyers' market power in the meat processing industry Θ has an intermediate value between 0 and 1.

4. ECONOMETRIC SPECIFICATION OF EMPIRICAL MODEL

In order to measure the degree of buyers' market power in the meat processing industry, we need to select a functional form for the production function (1). The transcendental logarithmic (translog) production function[2] imposes much less a priori restrictions on the production technology than neoclassical variants. The variable proportion technology in the meat processing industry is assumed. Using a simplified notation (X) for all factor quantities, the translog production function can be written as:

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

where $\alpha_{jl} = \alpha_{lj} \; (j \neq l)$ and $X_j, X_l = A, L, K, E$. The time trend variable T is a proxy for technical change in the meat processing industry.

The marginal product of slaughtered livestock (A) is defined as the partial derivative of the translog production function (5) and is given by:

$$\frac{\partial Y}{\partial A} = \frac{Y}{A} \left(\alpha_A + \sum_{j=1}^{4} \alpha_{Aj} \ln X_j + \gamma_{AT} T \right) \tag{6}$$

where $X_j = A, L, K, E$.

In order to estimate market structure model developed in the previous section (equations 2 and 4), to test the hypothesis of price-taking behaviour in the meat processing industry

[2] Cf. Christensen *et al.* (1973).

we need to select a functional form[3] for supply function of slaughtered livestock (2). We assume that the supply function (2) can be written as a truncated second-order approximation of a general transcendental logarithmic function

$$\begin{aligned}\ln A = \beta_0 + \beta_A \ln W_A + \sum_i \beta_i \ln W_i + \phi_C \ln C + \delta_T T \\ + \delta_{AT} \ln W_A T + \sum_{iT} \delta_{iT} \ln W_i T + \varphi_{CT} \ln C\, T,\end{aligned} \tag{7}$$

where W_i $(i = D, M, F)$ represents the average price of slaughtered livestock supplied to the meat processing industry (W_A), the direct marketing price of slaughtered livestock[4] sold on urban markets directly to consumers (W_D), the average farm price of raw milk (W_M) and the farm input price of mixed feeds (W_F), respectively[5]. The variable C contains the aggregate number of livestock as a quasi-fixed factor, and T is a linear time trend accounting for an autonomous change (technical change and other factors affecting the short-run supply of slaughtered livestock response over time unaccounted for, implying $T = 1,..., 90$).

Solving the agricultural supply of slaughtered livestock (5) for W_A and differentiating with respect to the quantity of slaughtered livestock supplied to the meat processing industry (A), we obtain the following expression for the marginal effect of the input level on prices for slaughtered livestock:

$$\frac{\partial g(A, \mathbf{S})}{\partial A} = \frac{W_A}{(\beta_A + \delta_{AT} T)\, A} \tag{8}$$

where $\beta_A + \delta_{AT} T = \varepsilon_{WA}$ gives the price elasticity of supply of slaughtered livestock.

Using equations (6) and (8), the equation (4) can now be rewritten as:

$$W_A = P \frac{Y}{A} \left(\alpha_A + \sum_{j=1}^{4} \alpha_{Aj} \ln X_j + \gamma_{AT} T \right) \Bigg/ \left(1 + \frac{\Theta}{\beta_A + \delta_{AT} T} \right) \tag{9}$$

The econometric model consists of the equations (7) and (9), where, to allow for the existence of random shocks, an additive disturbance term was added, which is assumed to

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[3] 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 A, (b) must be non-separable and (c) has no constant elasticity with respect to A.

[4] The market share of livestock products directly sold to consumers is relatively large; it averages 30% from 1997 to 2002. This had a considerable influence on the supply of slaughtered livestock delivered to the meat packing industry.

[5] In Ukraine, historically, there is little distinction between beef cattle and dairy cattle, with the same stock often being used for both meat and milk production.

have a zero mean, constant variance, and to be independently and normally distributed. In addition, in order to account for seasonality in our monthly time series data, eleven monthly dummy variables (cf. β_i and α_i, $i = 2,..., 12$, in Table 3) were added to equations (7) and (9), respectively.

5. DATA DESCRIPTION

The monthly time series data used to test for the existence of buyers' market power in the Ukrainian meat processing industry was obtained from monthly statistical reports and statistical bulletins of the State Committee of Statistics of Ukraine. All of these statistical reports have been provided by the five Divisions of the State Committee of Statistics of Ukraine: 1) Division of Agriculture and Environment Statistics, 2) Division of Price Statistics, 3) Division of Manufacturing Statistics, 4) Division of Household Surveys, and 5) Division of Labour Statistics. 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. Table 1 provides a description of model variables applied, and summarizes statistical descriptions of the monthly time series data used in the econometric analysis.

Data on quantities of slaughtered livestock delivered to the meat processing industry, farm prices for slaughtered livestock, direct selling prices of slaughtered livestock directly sold to consumers and farm prices of raw milk were collected from two Statistical Bulletins: 'The sale of livestock products to procurement organizations of the meat processing industry by all types of agricultural farms' and 'The sale of agricultural products to procurement organizations by agricultural enterprises'.

To obtain an aggregate number of livestock, the numbers of beef cattle, milk cows, pigs, sheep and poultry were converted into livestock units (LSU). The livestock units were calculated by multiplying the number of animals with the following values: 0.70 for beef cattle, 1.20 for milk cows, 0.13 for pigs, 0.10 for sheep and goats and 0.0015 for poultry (KTBL, 2005). The numbers of beef cattle, milk cows, pigs, sheep and poultry were obtained from the Statistical Bulletin 'The statistical summary data about state stock-breeding by all types of agricultural farms'.

Data on monthly price indices (output price index of the meat processing industry and mixed feed price index) were collected from the periodical 'Industrial producer price indices'.

Data on aggregate output of the meat processing industry were calculated using the data on quantity of the meat and meat products and the following specific weights (also known as the unit weight): 1.6 for sausage goods, 1.1 for boiled sausage goods for children, 1 for half-finished meat and 0.85 for canned meat. These specific weights stem from the Division of Household Surveys. The data on production quantity of the meat and meat products are regularly published in the statistical issues of 'Industrial products'.

The monthly average numbers of workers in the meat processing industry were taken from the Division of Labour Statistics. The annual and some monthly data can be found in 'Labour of Ukraine'.

Table 1. Model variables and some descriptive statistics

Description of variables	Symbol	Mean	St. Dev.	Minimum	Maximum
Quantity of slaughtered livestock, tons	A	43622.5	14486.0	20979.4	87034.0
Farm price of slaughtered livestock, UAH per ton	W_A	2428.0	1282.7	912.4	4810.3
Direct selling price of slaughtered livestock, UAH per ton	W_D	2134.9	1077.7	902.9	4420.4
Farm price of raw milk, UAH/ton	W_M	431.5	202.5	166.9	826.7
Mixed feed price index	W_F	252.9	88.0	100.0	395.3
Aggregate number of livestock, thousand	C	11879.2	1984.8	8767.3	16633.0
Aggregate output of the meat processing industry, tons	Y	1489.8	800.5	512.7	3160.0
Number of workers in the meat processing industry	L	50037.0	4821.3	43591.0	61539.1
Capital in the meat processing industry, thousand UAH	K	778.0	334.8	491.0	2228.7
Energy consumption in the meat processing industry, thousand kWh	E	51.7	4.3	42.4	56.6
Output price index of the meat processing industry	P	199.5	77.0	100.0	321.5
Time trend	T	45.5	26.1	1.0	90.0

Note: Contracted notations UAH denote the Ukrainian Hryvnia, the official currency of Ukraine.
Source: Own calculation based on the monthly time series data provided by the State Statistics Committee of Ukraine.

The capital variable was constructed based on monthly and annual data on amortization of capital (of fixed assets) in the meat processing industry provided by the Division of Manufacturing Statistics and the annual price indices for capital goods obtained from the Statistical Yearbook of Ukraine. The construction of this variable unfolds in two steps. First, the annual price indices for capital goods were used to deflate the annual data for amortization of capital. In a second step, the deflated annual data were interpolated into monthly data using the spline method and applying the expanding procedure utilizing the statistical software SAS (SAS, 2008: 701-753).

For calculating the energy variable, the annual data on electric power consumption relating to the production of canned meat were used, because no other data on energy consumption in the meat processing were available. These data were collected from the Statistical Yearbook of Ukraine for 2003 (p. 103), for 2001 (p. 111), for 2000 (p. 96) and for 1998 (p. 104). In order to obtain the variable on a monthly basis it has been assumed that electric power consumption has developed proportionally to canned meat output in the meat processing industry throughout the year.

6. ESTIMATION RESULTS

In the market structure model consisting of equations (7) and (9), the price of slaughtered livestock (W_A) and the quantity of slaughtered livestock (A) are endogenous. Since equation (9) is intrinsically nonlinear in its parameters, the market structure model is represented by a nonlinear simultaneous equation system. Therefore, the model was estimated using nonlinear three-stage least squares (cf. Amemiya, 1977). All of the exogenous variables in the system were used as instruments. Estimation was carried out

using the nonlinear three-stage least squares estimation (NL3SLS) provided by the statistical software SAS (SAS, 2008: 925-1239).

Table 2 lists the statistical inference of estimation of the market structure model estimated for the Ukrainian meat processing industry.

Table 2. Statistical inference of estimation of the market structure model

Equation	*DF*	R^2	$\overline{R^2}$	*DW*	*Objective value*
(7)	22	0.8346	0.7835	1.3697	0.5010
(9)	18	0.7707	0.7126	1.4256	

The fit of the estimated market structure model is quite good. While the values of the R-square and the adjusted R-square obtained for the equations of the slaughtered livestock supply function reached 0.83 and 0.78, the equations of the first-order condition came out to be a little lower and amounted to 0.77 and 0.71, respectively.

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

It is common practice to use the minimized values of the objective function (residual sum of squares of the model, which is to be minimized) as an additional criterion for comparing the estimated models in the NL3SLS estimation. The NL3SLS estimation reveals a good performance of the market structure model, because the objective value tends towards zero.

Table 3 shows the parameters of the market structure models as estimated by N3SLS, which can easily be interpreted as all variables have been measured as deviations from their geometric mean. Thus, the parameters $\beta_j \ (j = A, D, M, F)$ of the estimated supply function represent the own price and cross price supply elasticities. The estimated results indicate that the estimated own price elasticity of supply of slaughtered livestock (β_A) is 0.34 and reveals that the change in quantity is smaller than the change in price. However, the estimated own price elasticity of slaughtered animal is still bigger compared to those values estimated in other empirical studies. Muth and Wohlgenant (1999) estimated an own price elasticity for cattle supply in the United State ranging from 0.017 to 0.042, depending on the model specification, while Ospina and Shumway (1979) obtained 0.14 for the supply of slaughtered beef. Azzam and Pagoulatos (1990) used the values 0.49 for demand and 0.16 for supply elasticities as exogenous point for the estimation of oligopsony and oligopoly market power. Bakucs et al. (2010) obtained the values 0.08 for supply elasticities for hogs in Hungary.

The estimated parameters β_D (cross price elasticity for meat directly sold to consumers) and β_M (cross price elasticity for raw milk) are relatively high and statistically significant, at least at the 5 % level of significance. Moreover, the slaughtered livestock, delivered to the slaughtering and meat processing industry, are a complement for raw milk and a substitute for meat directly sold to consumers.

Table 3. NL3SLS parameter estimates of the market structure model

Supply function		First-order condition	
Parameter	Estimate	Parameter	Estimate
β_A	0.3400	α_A	0.7838***
	(0.3700)		(0.1578
β_D	-0.7936*	α_{AA}	0.7930***
	(0.4062)		(0.2728
β_M	0.7733***	α_{AL}	-0.6131
	(0.2257)		(1.9814
β_F	-0.0283	α_{AK}	0.6019*
	(0.3291)		(0.3365
ϕ_C	2.5844	α_{AE}	-2.3599***
	(1.9463)		(0.5563
δ_T	0.0033	γ_{AT}	0.0270***
	(0.0109)		(0.0050
δ_{AT}	-0.0102	α_2	0.5388***
	(0.0111)		(0.1956)
δ_{DT}	0.0264	α_3	0.3958**
	(0.0169)		(0.2030)
δ_{MT}	-0.0148**	α_4	0.3034
	(0.0060)		(0.2364)
δ_{FT}	-0.0406***	α_5	0.2473
	(0.0139)		(0.2472)
φ_{CT}	-0.1155***	α_6	0.2794
	(0.0342)		(0.2431)
β_2	-0.3270***	α_7	0.0871
	(0.0809)		(0.3059)
β_3	-0.4161***	α_8	0.4680**
	(0.0776)		(0.2230)
β_4	-0.4707***	α_9	0.4242*
	(0.0774)		(0.2194)
β_5	-0.4384***	α_{10}	0.3582*
	(0.0824)		(0.1915)
β_6	-0.3031***	α_{11}	0.3188*
	(0.0998)		(0.1741)
β_7	-0.1598	α_{12}	0.3616**
	(0.1151)		(0.1632)
β_8	-0.0467	Θ	-0.0051
	(0.1211)		(0.0060)
β_9	-0.0975		
	(0.1094)		
β_{10}	-0.0133	Wald statistics for test of:	χ^2 statistic
	(0.1057)		
β_{11}	-0.0370	$H_0 : \beta_A + \beta_D + \beta_M + \beta_F = 0$	1.53
	(0.0917)		
β_{12}	-0.1007	$H_0 : \Theta = 0$	0.70
	(0.0812)		
β_0	0.0973	$H_0 : \Theta = 1$	27697***
	(0.1257)		

Notes: The values in the parentheses are standard deviations. The superscript ***,** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

The estimated coefficient cross price elasticity of supply for mixed feeds (β_F) is negative but statistically insignificant[6]. This result may in part be attributed to the fact that the share of mixed feeds is rather small, in average about 12 %. Thus, it is evident that it is not only the mixed feeds but also green and coarse fodders that have a profound influence on the supply of slaughtered livestock.

A well-behaved supply function must be homogeneous of degree zero in prices. A Wald test of the hypothesis that the own and cross price elasticities of supply evaluated at the sample mean add up to zero is not rejected with a Wald χ^2 statistic of 1.53 even at the 20 percent level.

The estimated supply elasticity of quasi-fixed inputs (ϕ_C) represented by livestock as a quasi-fixed factor is very elastic and amounts to 2.5 at the sample mean. At first sight, this seems to be very large. However, considering the construction of an aggregate livestock variable, the supply of slaughtered livestock includes not only beef cattle, but also milk cows, pigs, sheep and poultry.

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

Concerning this research, the main issue was the estimation of a parameter that measures the degree of buyers' market power in the market for slaughtered livestock. The estimated parameter of buyers' market power Θ is -0.0051. The negative value of Θ is theoretically not possible, but it is close to zero and statistically insignificant. The estimated parameter Θ ranges from -0.0169 to 0.0068 in the 95 % confidence interval. With a Wald χ^2 statistic of 0.70, the hypothesis that the meat processing industry is a price-taker in the market of slaughtered livestock $(H_0 : \Theta = 0)$ is not rejected, even at the 40 % level of significance. The hypothesis that the industry reflects monopsonistic behavior $(H_0 : \Theta = 1)$ can be rejected at the 1 % level.

The estimation results of the market structure models did not produce any evidence suggesting the exercise of buyers' market power in the market for slaughtered livestock by the Ukrainian meat processing industry. The same results were obtained by Hyde and Perloff (1998) for oligopsony market power in the Australian retail meat sector, by Muth and Wohlgenant (1999) for oligopsony market power in the U.S. Beef Packing Industry, by Morrison Paul (2001) for market power in either the cattle input or beef output markets and by Quagrainie et. al. (2003) for processor power in the Canadian markets for cattle and hogs.

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

However, in contrast to this results many others empirical studies found the existence of market power in the meat sectors. Schroeter (1988) estimated the degree of oligopoly and oligopsony market power in the beef packing industry that ranges from 0.0141 to 0.0417. Schroeter and Azzam (1990) found that the value of oligopoly and oligopsony market power equal 0.0475 for beef and 0.0558 for pork markets, respectively. Anders (2008) analyzed the oligopsony and oligopoly market power in the Germany markets for beef and pork and estimated the values of market power that lie between 0.003 and 0.176. Bakucs et al. (2010) obtained relatively low value of oligopsony market power in the Hungarian market for slaughter hogs. Here it must be emphasized that all of these studies were based on aggregated industry data. Using industry level data, it is important to understand that there are alternative interpretations of the parameter used to estimate buyers' market power.

Muth and Wohlgenant (1999) have demonstrated two alternative interpretations of the market power parameter which depend on assumptions about the aggregate marginal product in equation (4). Firstly, if the aggregate marginal product is assumed to be the average of the marginal product of firms in the industry, then the parameter of buyers' market power can be interpreted as the average of the input conjectural elasticities. Secondly, if the aggregate marginal product is assumed to be the share-weighted marginal product of firms in the industry, then the parameter of buyers' market power takes on the interpretation of the input market, counterpart to the Herfindahl index. This interpretation is obtained by the essential assumption of the "Cournot conjecture" that each firm in the industry expects other firms in the industry to not react to changes in its input level. Corts (1999) discussed the interpretation of a parameter of market power that is explicitly derived from a conjectural variation model and draws the conclusion that the "conduct parameter method is useful as a means of testing hypotheses about well-specified behavioral extremes." Using endogenously determined values for the market power parameter (0 for perfect competition, 1 for perfect collusion, and $1/n$ for Cournot competition), the estimation of the market structure model can be extended by subsequent models. Applying the NL3SLS method, the estimation of the market structure models with the endogenously determined values for market power provides for a lower value of the objective function and, thus, gives a better approximation of the available data.

Table 4 presents the estimation results of the market structure market models under three different assumptions.

Table 4. Estimation of the market models under different assumptions

Model	Model 1 Market power	Model 2 Perfect competition	Model 3 Cournot competition
Parameter restriction	Θ	$\Theta = 0$	$\Theta = 1/n$
Objective value	0.5010	0.8514	0.8479

The results for the model of perfect collusion $(\Theta = 1)$ could not be obtained as the parameter estimates of this model did not converge. The estimation result of the model of market power (Model 1) provides a better approximation to the available data. The objective value in the Model 1 is 0.5010, while in the Model 2 and Model 3 equals

0.8514 and 0.8479, respectively.

Assuming that the Cournot conjectures are present (Model 3), our results suggest that livestock and poultry farms as well as personal subsidiary plots, on average, may negotiate with 730 meat processors. Hence, the determined value for the conduct parameter under Cournot competition equals 0.0014. The estimated value of the parameter of buyers' market power is negligible smaller than the values that result from Cournot conjectures. This result reveals that, concerning the buyer's market for slaughtered livestock, meat processors behave consistently with Cournot conjectures. Taking into account the number of meat processors in the Ukrainian meat processing industry, the determined values for the market power parameter of the Cournot competition model (Model 3) are nearly equal to the values determined for the market power parameter of the perfect competition model (Model 2). This conclusion is also supported by the estimation results, because the obtained values of the objective function of these both models differ only slightly.

7. SUMMARY AND CONCLUSIONS

The objective of this study was to provide an analysis of buyers' market power in the Ukrainian meat processing industry. With reference to the contribution by NEIO studies, we have constructed a market structure model to measure the degree of buyers' market power, in particular in the market for slaughtered livestock. For the first time the market structure model was applied to the Ukrainian meat processing industry. The empirical model of market structure consists of two equations. Firstly, one for the agricultural supply of slaughtered livestock, and secondly, one for the demand of the slaughtering and meat processing industry. Using monthly time series data, the parameter of buyers' market power, supply and production elasticities were estimated simultaneously. The estimation results of the supply function indicate that the own price and cross price elasticities of supply of slaughtered livestock amount to less than one in absolute terms, have the expected signs and are compatible with economic theory.

The estimation results of the first-order condition for profit maximization provide no evidence for the existence of buyers' market power in the investigated period of January 1996 to June 2003. The same results were obtained in many other NEIO-studies for oligopsony and/or oligopsony market power in the Australian and Canadian meat sector as well as in the U.S. meat packing industry. The econometrical result obtained in this study is on one hand consistent with the low operating rate and relatively small concentration ratio of the Ukrainian meat processing industry. On the other hand, the estimated supply of slaughtered livestock is relatively inelastic. However, in contrast to many other empirical studies, we estimated that elasticity of supply of slaughtered livestock is bigger than the supply elasticity in other countries. The bigger supply elasticity in Ukraine reveals that the agricultural farms and personal subsidiary plots that produce livestock products were able to use alternative marketing channels to sell their livestock products.

The decrease of production concerning agricultural farms and personal subsidiary plots, and the sales of livestock and poultry for industrial processing cannot be associated with buyers' market power in the Ukrainian meat processing industry. The existence of price cartels and collusive agreements on quotas detected by the Antimonopoly Committee

of Ukraine could not be confirmed in this analysis. Our results indicate that the meat processing industry is competitive.

Contrary to many other NEIO-studies, we extended the market structure market model by three subsequent models. Using endogenously determined values as market power parameters, we found that, concerning the buyer's market for slaughtered livestock, meat processors behave consistently with Cournot conjectures. Considering the number of meat processors in the Ukrainian meat processing industry, the determined values for the market power parameter of the Cournot competition model nearly equal the values determined for the market power parameter of the perfect competition model.

Because of data availability we used the aggregated industry data. Hence, this empirical investigation could only detect average buyers' market power in the meat processing industry. Due to the market shares of meat processor firms, some processors might be able to exert significant market power. In order to analyze the firm-specific market power requires firm-level data. Unfortunately, those statistical data of individual meat processing firms is not available.

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