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Abstract

Most of the studies based on the New Empirical Industrial Organization (NEIO) approach use industry data to estimate the degree of market power at the national level. Yet, only a few empirical studies presented results that measure the degree of market power at the regional level. Some of these studies found evidence for the existence of market power in regional markets. Although there is extensive evidence suggesting the existence of oligopsony market power in the Ukrainian milk processing industry (price cartels and geographic market sharing among milk processing enterprises, interference of the state authorities, relatively high concentration on regional markets), estimation results of a market structure model at the national level does not produce any evidence suggesting the exercise of oligopsony power on the Ukrainian market for raw milk (the estimated parameter of oligopsony power is close to zero and statistically insignificant). On the other hand, estimation of the market structure model at the regional level suggests the existence of oligopsony power in four out of twenty two regions of Ukraine with a potential deviation of procurement prices for raw milk from the value marginal product of raw milk in the range from 3.6 to 46.7 %.

Keywords: New Empirical Industrial Organization (NEIO), Oligopsony Power, Ukraine.

1 Introduction

March 2, 2002, when legislation on the "Protection of Economic Competition" was passed, can be considered as the commencement of legal functionality of the Antimonopoly Committee of Ukraine. Previously, the Antimonopoly Committee did not quite have an opportunity to protect economic competition between enterprises (cf. Seredyuk, 2003).

Particular attention is paid by the Antimonopoly Committee of Ukraine to the market of raw milk. For the period of 2000 through 2006 there were many antitrust law violations discovered in 18 out of the 25 oblasts of Ukraine by territorial offices of the Antimonopoly Committee (cf. Annual reports of Antimonopoly Committee of Ukraine). Only in 2002, there were six antitrust law violations stopped on the regional market of raw milk, involving individual milk factories in Zhytomyr oblast (province) that were setting low procurement prices for raw milk (cf. Seredyuk, 2003). Formerly, in a planned economy, procurement of raw milk was more or less limited to the boundaries of the administrative district, where the milk processing plant was located. Today, under the conditions of a developing market economy, these regions became "borderless", i.e., procurement of raw milk is conducted even outside of the district of milk plant's home location. It would seem that this situation is ideal for the development of competition between dairy enterprises on the raw milk market. Nevertheless, according to research results and the information obtained from representatives of the dairy enterprises by the territorial offices of the Antimonopoly Committee of Ukraine in Vinnytsia oblast, it was found that the heads of the dairy enterprises periodically meet, conduct gatherings during which they discuss the issues of raw milk procurement, corroborate the procurement prices for raw milk and also converse regarding the questions of geographical market sharing between the dairy enterprises in the region (cf. Dovgalyuk and Konovalyuk, 2003).

Furthermore, the Antimonopoly Committee of Ukraine has stopped a violation of antitrust laws in the form of a ban and restrictions on inter-regional trade in the raw milk market ordered by the Oblast State Administration in the oblasts of Cherkasy, Chernihiv, Ivano-Frankivsk and Khmelnytskyi (cf. Annual reports of Antimonopoly Committee of Ukraine, 2000).

Before the liberalization of prices in 1992, milk processing in Ukraine was concentrated in regionally almost equally distributed large state milk processing factories. 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 the ownership and incentive structures involved. 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 region of Ukraine.

In Ukraine, in comparison with other countries, such as Germany, there is a large number of dairy plants. In 2003, in Germany there were about 261 dairy plants, while in Ukraine there were two and a half times as much, amounting to 649 dairy plants. Measuring by value of shipments, Perekhozhuk (2007: 72) has calculated the concentration rate for the Ukrainian milk processing industry at the national level. In the period from 2001 to 2004, the revenue share of the six largest milk processing plants (CR_6) increased from 12 % to 15 %. While the 100 largest milk processing plants (CR_{100}) control about 70 % of sales of milk and milk products, the other 30 % are counted among more than 500 small milk processing plants. Still, the Herfindahl-Hirschman index is on average 7.9, which is relatively small when compared with other countries. For example, in 2002 the Herfindahl-Hirschman index for the German milk processing industry was 28.7. The U.S. dairy industry was even more concentrated with an index of 147.0 in 1997 (cf. US Census Bureau, 2001).

It should be noted that while calculating the concentration measures, there emerge specific methodological problems related to the identification of geographical and commodity boundaries of the market. Typically, the concentration is calculated based on the total revenue from a specific kind of merchandise or merchandise group in a domestic market.

However, processing enterprises may not only serve the domestic (national) market, but also foreign markets. About 50 % of the Ukrainian milk and dairy products go to the world market, albeit, first and foremost, it exports to the Russian Federation. In this case, we can get a significantly inflated measure of concentration of milk processing industry in Ukraine. On the other hand, when analyzing the market of raw milk, it is inappropriate to use the same milk processing industry concentration measure. Considering the commodity characteristics of raw milk and that the milk processing enterprises in Ukraine conduct a procurement of milk usually within a radius of no more than 150 km, the market of raw milk is, above all, a regional market. Therefore, while analyzing the structure of the raw milk market, it seems reasonable to use the share of a milk processing enterprise on the raw milk market in the geographical boundaries of an oblast or a region. Perekhozhuk (2007: 73-77) shows that the concentration of the Ukrainian milk processing industry at the regional level is vastly different. In 2 out of the 25 regions, the largest milk processing plants held shares of 77 % and 83 % in the regional market, respectively. Under such conditions milk processing enterprises were able to gain a regional monopsony or oligopsony position on the raw milk market. Although one might assume that the low operating rate (which was as low as 10 % at the end of the 1990s) triggered sharp competition between the milk processing plants for raw milk, the concentration of the milk processing enterprises in some regions suggests, on the other hand, a strong market position for the milk processors with the exertion of market power vis-à-vis the raw milk producers. Therefore, initially, it is not clear what competitive situation the country's dairies found themselves in, vis-à-vis the raw milk suppliers – i.e. the agricultural enterprises and small family farms in 1990s, which still may exist today. Moreover, given that the concentration of the Ukrainian milk processing industry differs radically at the regional level, we expect that the estimated degree of oligopsony power in some regions is significantly larger than in others.

Consequently, the objective of this study is to determine the degree of oligopsony power in the regional market for raw milk using a market structure model, which was estimated by a nonlinear estimation method. The model is based on the New Empirical Industrial Organization (NEIO) approach. Most of the empirical studies based upon this approach aim at estimating the degree of market power within the national boundaries of the market using industry level data[1]. As far as we know, only Wann and Sexton (1992), Weliwita and Azzam (1996), as well as Koontz and Garcia (1997), have estimated the degree of market power on a regional market level and found evidence of market power in the pear and meat packing industries, respectively. Thus, using regional data for the Ukrainian milk processing industry, it may be more probable to find oligopsony power of milk processing enterprises in the regional market for the raw milk than at the national level.

Our paper is organized as follows: The next section presents the theoretical model of oligopsony power followed by its econometric specification in Section 3. Section 4 describes the sources of the statistical data. The estimation results and specification tests are discussed in Section 5. The final section consists of the results and conclusions.

2 Structural model of oligopsony market power

The Ukrainian agricultural milk farms, as well as the households in agricultural areas, produce raw milk (*M*) and deliver it generally to the local milk processing plants. We assume that the supply of raw milk delivered to the milk processing plants can be represented by the following inverse supply function

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[1] For an overview of structural model estimates for the agricultural and food markets based on the New Empirical Industrial Organization (NEIO) approach, see Bresnahan (1989), Azzam (1998), Sexton and Lavoie (2001), Wohlgenant (2001) and Perekhozhuk (2007: 92-95).

$$W_M = g(M, \mathbf{S}), \tag{1}$$

where W_M is the price of raw milk and $\mathbf{S}$ is a vector of the supply shifters.

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

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

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

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

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

We assume that the milk processing plants maximize their profit and set the price for the raw milk. The first-order condition for profit maximization that allows for imperfect competition (oligopsony power) in the raw milk market is:

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

where Θ is the parameter indexing the degree of oligopsony 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 the supply of the raw milk. If $\Theta = 0$, then the market for raw milk is perfectly competitive and the aggregate value marginal product of the raw milk equals the market price of the raw milk. If $\Theta = 1$, then the market for the raw milk is monopsonistic or the dairies 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 aggregate value marginal product of raw milk.

3 Econometric specification of the market structure model

With regard to the empirical application of the market structure model, we assume that the raw milk supply function (1) can be written as a truncated second-order approximation to a general transcendental logarithmic function[2]:

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

where W_i $(i = M, D, B, F)$ is, respectively, the price at which the milk is supplied to the dairies (W_M), the direct marketing price for milk[3] 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 an autonomous change (technical change and other unaccounted for factors affecting short-run supply response over time; $T = 1,..., 96$).

Solving equation (5) for W_M and differentiating with respect to M, we obtain the following expression for the marginal effect of the input level on raw milk prices:

$$\frac{\partial g(\bullet)}{\partial M} = \frac{W_M}{(\beta_M + \delta_{MT} T)\, M}, \tag{6}$$

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[2] Bresnahan (1982) and Lau (1982) give proof of the conditions and properties of the functional forms for identification of market power. According to the authors, this function, in the context of this paper, must have the following specific properties: it (a) must be at least of a second degree in M, (b) must be non-separable in M and (c) must have no constant elasticity with respect to M. The truncated transcendental logarithmic function (5) fits all the properties at the same time.

[3] During the transition period in Ukraine the market share of milk sold directly to consumers rapidly increased from 0.1 % in 1990 to 21.2 % in 2000. This had a significant impact on the supply of raw milk delivered to the milk processing industry (cf. Perekhozhuk, 2007: 33-36).

where $\beta_M + \delta_{MT}T = \varepsilon_{WM}$ is the own price elasticity of raw milk supply.

Considering the cost structure of the Ukrainian milk processing industry we focused on the most important factors of production in terms of cost components and assumed that the milk processing industry uses only four factors, namely, raw milk (M), labor (L), capital (K) and energy (E). The marginal product of raw milk M is defined as the partial derivative of the translog production function[4] and is given by:

$$\frac{\partial Y}{\partial M} = \frac{Y}{M}\left(\alpha_M + \sum_{j=1}^{4}\alpha_{Mj}\ln X_j + \gamma_{MT}T\right), \tag{7}$$

where $X_j = M, L, K, E$. T is a linear time trend to account for the technical change in the milk processing industry over time $(T = 1,..., 96)$. Using equations (6) and (7), equation (4) can now be re-written as:

$$W_X = P\frac{Y}{M}\left(\alpha_M + \sum_{j=1}^{4}\alpha_{Mj}\ln X_j + \gamma_{MT}T\right)\Bigg/\left(1 + \frac{\Theta}{\beta_M + \delta_{MT}T}\right). \tag{8}$$

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 A1) were added to equations (5) and (8), respectively.

4 Description of statistical data source

In order to test for the existence of oligopsony power on the regional markets for raw milk we use regional data sets that include 96 monthly observations from January, 1996, to December, 2003. The choice of the sample period was influenced by data availability. All

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

the statistical data were collected from the following statistical bulletins and periodicals of the State Committee of Statistics of Ukraine: “The sale of milk and dairy products to procurement organizations of the milk processing industry by all types of agricultural farms”, “The sale of agricultural products to procurement organizations by agricultural enterprises”, “The statistical summary data about state stock-breeding by all types of agricultural farms”, “Industrial products of Ukraine”, “Producer price indices”, the reports of the Division of Labor Statistics, the Statistical Yearbooks “Labor of Ukraine” and various issues of the Statistical Yearbook of Ukraine. For a more detailed definition of model variables and description of the sources of the statistical data, see Perekhozhuk (2007: 105-122).

5 Estimation results and specification testing

In the market structure model consisting of equations (5) and (8), the price of raw milk (W_M) and the quantity of raw milk (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).

We estimated 26 market structure models, one of them at the national level and 25 at the regional level. For a general comparison of the statistical properties of the estimated models, Table 1 lists the R-squares, Durbin-Watson statistics and objective values of models estimated at the national level for Ukraine, along with the models for Autonomous Republic of Crimea and twenty one administrative oblasts (regions). The results for three regions were not presented because estimation of parameters of these models did not converge. In addition, we give the minimal, maximal and the mean values of the R-squares, the Durbin-Watson coefficient and the objective value of the model[5].

Table 1 Basic coefficients of statistical inference of NL3SLS estimation of market structure models

Sample unit (region)	R^2		$\overline{R^2}$		DW		*Obj. Value*
	$\ln M$	W_M	$\ln M$	W_M	$\ln M$	W_M	
Ukraine	0.9788	0.9232	0.9728	0.9052	1.3279	2.0849	0.6299
01 Crimea	0.8497	0.6699	0.8093	0.5934	1.4938	1.6357	0.6274
02 Vinnytsia	0.9588	0.8561	0.9471	0.8225	1.2231	1.7632	0.3848
03 Volyn	0.9215	0.6011	0.9017	0.5087	1.2065	2.0767	0.5509
04 Dnipropetrovsk	0.8811	0.8056	0.8514	0.7602	1.3608	2.0574	0.3365
05 Donetsk	0.9186	0.7384	0.8980	0.6778	1.3886	1.8674	0.4010
06 Zhytomyr	0.9349	0.8853	0.9174	0.8588	1.6259	2.0669	0.6380
07 Zakarpattia	0.9000	0.2572	0.8716	0.0836	1.6559	2.0752	0.2725
08 Zaporizhia	0.8444	0.6744	0.8025	0.5990	1.0871	2.0863	0.3490
09 Ivano-Frankivsk	0.9406	0.9402	0.9237	0.9262	1.7656	1.4330	0.5460
10 Kiev	0.9348	0.9481	0.9163	0.9360	1.7930	1.6770	0.5295
11 Kirovohrad	0.9370	0.6085	0.9212	0.5170	1.0785	1.1030	0.5149
12 Luhansk	0.9054	0.7986	0.8817	0.7515	0.7537	1.8424	0.5125
13 Lviv	0.9227	0.8929	0.9019	0.8681	0.9177	1.4900	0.7242
14 Mykolaiv	0.9624	0.9212	0.9518	0.9028	1.2803	1.6106	0.6455
16 Poltava	0.9410	0.9276	0.9243	0.9107	1.7915	1.8725	0.5649
18 Sumy	0.9414	0.9158	0.9267	0.8962	1.5809	1.2823	0.5189
19 Ternopil	0.8830	0.8936	0.8535	0.8690	1.1492	1.7794	0.4573
21 Kherson	0.9074	0.6263	0.8843	0.5389	1.1489	1.7586	0.4301
22 Khmelnytskyi	0.9197	0.8980	0.9007	0.8744	0.9778	1.2228	0.6807
23 Cherkasy	0.8490	0.7935	0.8133	0.7457	0.8490	2.1681	0.5460
24 Chernivtsi	0.9257	0.7886	0.9057	0.7397	1.2958	1.4429	0.2751
25 Chernihiv	0.9619	0.3181	0.9510	0.1586	1.6246	1.9944	0.3692
Minimum	0.8444	0.2572	0.8025	0.0836	0.7537	1.1030	0.2725
Maximum	0.9788	0.9481	0.9728	0.9360	1.7930	2.1681	0.7242
Mean	0.9183	0.7688	0.8969	0.7150	1.3207	1.7561	0.5002

Note: Numbering of the regions correspond to the official numbers of administrative regions, applied by the State statistics committee of Ukraine.

The fit of the estimated market structure models for each region in Ukraine is quite good. The R-squares, as well as the adjusted R-squares $\left(\overline{R^2}\right)$, between observed and predicted values obtained for the equations of the raw milk supply function in each sample unit are very similar, with an arithmetic mean of about 0.90. For the equation of the first-order condition the variation of R-squares is larger than for the supply equation. For the

[5] The estimated parameters and the coefficients for statistical inference of the market structure models are reported in Table A 1 for Ukraine at the national level, for Autonomous Republic of Crimea and the 21 administrative oblasts (regions).

Zakarpattia and the Chernihiv regions the R-squares are particularly low. Otherwise, the R-squares range from 0.60 (0.50) to 0.95 (0.94).

The Durbin-Watson coefficient, obtained for each region, lies 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. With the exception of four regions (Luhansk, Lviv, Khmelnytskyi and Cherkasy), the Durbin-Watson coefficient is greater than 1.07 and 1.10 for the first and second equations of the market structure model. The mean of the obtained value of the Durbin-Watson statistic is 1.32 for the supply function and 1.75 for the equation of 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 NL3SLS estimation as an additional criterion for a comparison of the estimated models. The comparisons of the results of NL3SLS estimation reveal a good performance of the market structure model. The difference between the calculated minimal and maximal values of the objective function is a negligible margin and lies between 0.27 (Zakarpattia oblast) and 0.72 (Lviv oblast), respectively.

Table 2 shows the parameters of the market structure models as estimated by NL3SLS, which can easily be interpreted because all variables were measured as deviations from their geometric mean. Therefore, the parameters $\beta_j \left(j = M, D, B, F \right)$ of the estimated supply function represent the price elasticities of the raw milk supply, ϕ_C is the supply elasticity of quasi-fixed inputs represented by the number of milking cows, the parameter δ_T is the rate of an autonomous change in the farm milk supply and the parameter α_M is the production elasticity of raw milk, which appears in the first-order condition for profit maximization. The results of the model estimation indicate that the estimated own price elasticity of the raw milk supply $\left(\beta_M\right)$ is more elastic at the national level, compared with the own price elasticity for each region separately.

Table 2 Selected parameters of N3SLS estimation of the market structure models

Sample unit (region)	β_M	β_D	β_B	β_F	ϕ_C	δ_T	α_M	Θ
Ukraine	0.90	-0.39	0.43	-0.65	-2.84	-0.0164	1.44	0.0018
01 Crimea	0.01	-0.22	0.97	-0.76	-3.38	-0.0181	1.36	0.0046
02 Vinnytsia	0.07	0.20	0.71	-0.73	-3.01	-0.0097	1.71	-0.0009
03 Volyn	0.16	-	0.39	-0.55	-8.43	-0.0284	1.36	0.0060
04 Dnipropetrovsk	0.78	-	0.54	-0.74	-1.45	-0.0252	1.27	0.0293
05 Donetsk	0.44	-	0.36	-0.80	1.16	0.0051	1.17	0.0227
06 Zhytomyr	0.41	-0.06	0.40	-0.75	-3.21	-0.0107	1.28	0.0013
07 Zakarpattia	0.09	-0.05	0.77	-0.34	-5.24	-0.0136	1.23	-0.0001
08 Zaporizhia	0.05	-0.11	0.95	-0.90	0.75	0.0112	1.40	0.0097
09 Ivano-Frankivsk	0.18	0.07	1.07	-0.24	-4.31	-0.0273	0.94	0.0005
10 Kiev	0.62	-0.04	0.24	-0.90	0.19	0.0028	1.24	-0.0063
11 Kirovohrad	0.18	-	0.53	-1.00	-4.11	-0.0311	1.32	0.0242
12 Luhansk	0.03	-	0.97	-1.82	-5.45	-0.0166	1.29	0.0090
13 Lviv	0.01	-0.24	0.52	-0.29	2.06	0.0030	1.02	-0.0003
14 Mykolaiv	0.08	-0.52	0.69	-0.61	-2.65	0.0007	1.23	0.0000
16 Poltava	0.19	-0.23	0.87	-0.66	-4.07	-0.0208	1.22	-0.0007
18 Sumy	0.50	-	0.47	-0.48	-3.21	-0.0228	1.29	-0.0043
19 Ternopil	0.03	-	0.35	-0.37	-6.56	-0.0327	1.39	0.0050
21 Kherson	0.43	-	0.94	-0.45	1.20	-0.0027	1.41	-0.0071
22 Khmelnytskyi	0.07	-	0.81	-0.88	-5.13	-0.0207	1.36	0.0007
23 Cherkasy	0.44	-	0.55	-0.99	1.70	0.0111	1.24	0.0033
24 Chernivtsi	0.01	-0.15	0.77	-0.63	-2.13	-0.0146	1.46	0.0078
25 Chernihiv	0.04	-0.19	0.92	-1.33	-7.36	-0.0352	1.58	0.0102
Minimum	0.01	-0.52	0.24	-1.82	-8.43	-0.0352	0.94	-0.0071
Maximum	0.90	0.20	1.07	-0.24	2.06	0.0112	1.71	0.0293
Mean	0.25	-0.15	0.66	-0.73	-2.85	-0.0136	1.31	0.0051

In many regions, such as the Crimea, Lviv and Chernivtsi, the raw milk supply is inelastic and is not larger than 0.01. The own price elasticity of the raw milk supply in Dnipropetrovsk, Kiev and Sumy is larger than 0.50. There is a large difference between the minimum and maximum values for the price elasticity of the raw milk supply among the regions. On average, it is 0.25. In 15 out of the 23 estimated models, the own price elasticity is statistically significant at the 5 % level.

Only for four out of the twenty two regions, the parameter of the variable for the price of milk sold directly to consumers has the expected sign and is statistically significant at the 10 % level. The originally estimated raw milk supply function for ten out of twenty two regions unexpectedly showed a positive sign for this variable. Therefore, the variable for the price of the consumer milk was omitted from the supply function for these regions and the corresponding market structure models have been reestimated. The Wald test of the hypothesis that the own and cross-price elasticities of raw milk supply evaluated at the sample mean add up to zero, in about half of the sample units, is not rejected. In ten out of the twenty two regions, homogeneity of degree zero of the supply function in prices originally was rejected at the 5 % significance level or less. In order to guarantee the important theoretical property of homogeneity of raw milk supply, these sample units were reestimated with the restriction for zero degree homogeneity in prices. The own-price and cross-price elasticities of raw milk supply were evaluated at the sample mean. The price elasticities are less than one, have the expected signs and are compatible with economic theory. The raw milk delivered to the milk processing industry is a substitute for the milk that was sold directly to consumers, while there is a complementarity relationship with beef cattle. The cross-price elasticity for the beef cattle for all sample units is highly statistically significant at least at the 5 % level of significance or less. The price elasticity of mixed feeds (β_F) is negative and statistically significant in eighteen out of the twenty three sample units at least at the 5 % level.

From a theoretical point of view, the supply elasticity of quasi-fixed inputs (ϕ_C) does not in general conform with expectations, because it is positive only in five out of the twenty three sample units. This result may in part be attributed to the fact that the share of raw milk delivered to dairies in total production of raw milk is rather small for milk producing households (about 30 %) and that even for agricultural firms it is not larger than 60 %. Therefore, this variable does not seem to have a considerable impact on the raw milk supply delivered to the milk processing industry.

The estimation results for the rate of autonomous change in the raw milk supply (δ_T) are remarkable in that in most sample units we find a negative rate of autonomous change. Only in five out of the twenty three samples, the rate of the autonomous change was positive, yet statistically insignificant. This outcome may be attributed to the turmoil of the transition process in the 1990s. In accordance with Bresnahan (1982), the linear time trend variable T that we applied, enters interactively with the supply-side exogenous variables, so that the supply curve rotates every successive time period. The parameter β_M and δ_{MT} are highly significant at any reasonable level of significance in all the samples and are shared by two of the simultaneous equations (supply function and FOC) to be estimated.

The estimation results of the models show that the estimated production elasticity of raw milk (α_M) is highly statistically significant but, at first sight, unexpectedly large in all the sample units. This result may be due, in part, to the fact that only some of the parameters of the complete translog production function have been estimated. This suggests that in this particular case, the translog production function (2) should be added as an additional equation to the market structure model. On the other hand, in another study (Perekhozhuk et al., 2008) we estimated the production function at the national level and found some evidence, first, for increasing returns to scale and, second, for a negative production elasticity of labour input. These findings can be attributed to the low level of capacity utilisation in the 1990s in the milk processing industry of Ukraine and to state regulation preventing reduction of labour input to an extent, which was considered necessary from an economic point of view. In view of these findings the large production elasticities of raw milk input may be considered less surprising even at the regional level.

The estimation of the degree of oligopsony power in the regional markets for raw milk is the main issue of this study. The parameter of oligopsony power at the national level Θ is close to zero and statistically insignificant. However, the estimates of the parameter Θ indicate oligopsony power in four out of the twenty three regions. In two regions, Chernivtsi (24) and Chernihiv (25), the estimates of the parameter Θ are statistically significant at the $10\,\%$ level. If one is prepared to accept levels of significance for parameter Θ of up to 15 %, the regions of Dnipropetrovsk (11.2 %) and Kirovohrad

(13.6 %) can be added to the list of regions where oligopsony market power may have been exerted. This conforms with the statements of the Antimonopoly Committee of Ukraine in its annual reports about investigated cases of violations of the antitrust laws in, among others, the regions of Chernivtsi, Chernihiv and Kirovohrad. Moreover, the regional concentration of the milk processing industry as measured by the Herfindahl-Hirschman index is particularly high in two of these regions.. The index amounts to 104.7 in Dnipropetrovsk and to 626.9 in Kirovohrad (cf. Perekhozhuk, 2007: 74).

On the basis of equation (8) and the estimation results for parameters Θ and β_M , for these four regions the potential percentage deviation of procurement prices from value marginal products of raw milk can be calculated. It amounts to –3.6 % for the region of Dnipropetrovsk, -11.7 % for Kirovohrad, -46.7 % for Chernivtsi, and –22.5 % for Chernihiv.

6 Summary and conclusions

The objective of this study was to estimate the degree of oligopsony power in the Ukrainian milk processing industry. In spite of the fact that there is an extensive evidence for the existence of a potential oligopsony market power in the Ukrainian milk processing industry (price cartels and geographic market sharing among milk processing enterprises, interference of the state authorities, high concentration on regional markets), the estimation results of the market structure model at the national level did not produce any evidence suggesting the exercise of oligopsony power. The estimated parameter indicating oligopsony power is close to zero and statistically insignificant. However, the estimation results at the regional level indicate the existence of oligopsony power in at least two and possibly in up to four out of the twenty three regions of Ukraine, for which market structure models have been estimated. The hypothesis of perfect competition can be rejected, in two cases with a 10 % and in another two cases with a level of statistical significance of less than 15 %. For these regions the results suggest that procurement prices for raw milk potentially may be 3.6 to 46.7 % lower than the value marginal product of raw milk. Moreover, the econometric analysis of the structural model and the measurement of oligopsony power at the regional level confirm the results of the investigations conducted by the Antimonopoly Committee of Ukraine for the regions of Kirovohrad (11), Chernivtsi (24) and Chernihiv (25). In addition, the results of this study suggest the existence of oligopsony power also in the region of Dnipropetrovsk (4). As far as the authors are aware, the Antimonopoly Committee of Ukraine has not investigated violations of antitrust law by the milk processing enterprises in this region.

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Table A 1. Estimated parameters and statistical inference of N3SLS estimation of market structure models

Parameter	Ukraine				Region 01 Crimea				Region 02 Vinnytsia				Region 03 Volyn				Region 04 Dnipropetrovsk				Region 05 Donetsk			
	Estimate	St. Error	*t*-Ratio	Pr >|*t*|	Estimate	St. Error	*t*-Ratio	Pr >|*t*|	Estimate	St. Error	*t*-Ratio	Pr >|*t*|	Estimate	St. Error	*t*-Ratio	Pr >|*t*|	Estimate	St. Error	*t*-Ratio	Pr >|*t*|	Estimate	St. Error	*t*-Ratio	Pr >|*t*|
β_0	-0.9797	0.0502	-19.50	<.0001	-0.8706	0.1264	-6.89	<.0001	-0.7008	0.0708	-9.90	<.0001	-1.2020	0.1059	-11.35	<.0001	-1.1347	0.1069	-10.61	<.0001	-0.7323	0.0831	-8.81	<.0001
β_M	0.8984	0.1647	5.45	<.0001	0.0143	0.0091	1.58	0.1194	0.0727	0.0374	1.94	0.0559	0.1569	0.0655	2.40	0.0191	0.7800	0.1194	6.53	<.0001	0.4444	0.0968	4.59	<.0001
β_D	-0.3904	0.1722	-2.27	0.0264	-0.2196	0.1513	-1.45	0.1508	0.1967	0.1081	1.82	0.0730	-	-	-	-	-	-	-	-	-	-	-	-
β_B	0.4314	0.0543	7.94	<.0001	0.9654	0.1990	4.85	<.0001	0.7110	0.0680	10.46	<.0001	0.3940	0.1365	2.89	0.0051	0.5370	0.1234	4.35	<.0001	0.3586	0.1149	3.12	0.0025
β_F	-0.6498	0.1724	-3.77	0.0003	-0.7600	0.2234	-3.40	0.0011	-0.7302	0.2304	-3.17	0.0022	-0.5509	0.1431	-3.85	0.0002	-0.7375	0.3973	-1.86	0.0673	-0.8030	0.1702	-4.72	<.0001
ϕ_C	-2.8360	1.2123	-2.34	0.0220	-3.3840	1.7256	-1.96	0.0536	-3.0058	1.5195	-1.98	0.0516	-8.4325	1.5980	-5.28	<.0001	-1.4501	0.9036	-1.6	0.1127	1.1595	0.4187	2.77	0.0071
δ_T	-0.0164	0.0043	-3.79	0.0003	-0.0181	0.0094	-1.92	0.0593	-0.0097	0.0033	-2.96	0.0041	-0.0284	0.0069	-4.15	<.0001	-0.0252	0.0062	-4.06	0.0001	0.0051	0.0035	1.48	0.1421
δ_{MT}	0.0193	0.0035	5.45	<.0001	0.0181	0.0063	2.86	0.0054	0.0058	0.0030	1.94	0.0558	0.0111	0.0046	2.40	0.0186	0.0309	0.0047	6.6	<.0001	0.0258	0.0054	4.74	<.0001
δ_{DT}	0.0093	0.0038	2.47	0.0159	0.0084	0.0060	1.40	0.1662	-0.0054	0.0035	-1.55	0.1264	0.0052	0.0052	1.01	0.3157	-	-	-	-	0.0112	0.0048	2.35	0.0211
δ_{BT}	0.0122	0.0024	5.12	<.0001	-0.0115	0.0073	-1.57	0.1201	0.0037	0.0050	0.74	0.4626	0.0243	0.0047	5.20	<.0001	0.0083	0.0052	1.62	0.1103	0.0155	0.0075	2.08	0.0409
δ_{FT}	0.0026	0.0056	0.46	0.6433	0.0258	0.0122	2.11	0.0379	-0.0121	0.0057	-2.14	0.0359	0.0052	0.0108	0.48	0.6331	-0.0030	0.0127	-0.23	0.8156	0.0267	0.0077	3.45	0.0009
φ_{CT}	0.0481	0.0188	2.56	0.0125	0.0176	0.0329	0.54	0.5939	-0.1297	0.0316	-4.10	0.0001	0.0426	0.0536	0.79	0.4295	0.0192	0.0228	0.84	0.4013	0.0877	0.0261	3.37	0.0012
β_2	-0.0656	0.0538	-1.22	0.2269	-0.2247	0.1240	-1.81	0.0739	-0.1281	0.0634	-2.02	0.0470	-0.3023	0.1169	-2.59	0.0116	-0.0358	0.1055	-0.34	0.7354	-0.2676	0.0989	-2.71	0.0084
β_3	-0.0478	0.0509	-0.94	0.3511	0.0644	0.1236	0.52	0.6036	-0.1591	0.0634	-2.51	0.0143	-0.1576	0.1170	-1.35	0.1818	-0.0294	0.1053	-0.28	0.7811	-0.2425	0.0995	-2.44	0.0172
β_4	0.3495	0.0493	7.09	<.0001	0.2856	0.1389	2.06	0.0432	0.0977	0.0637	1.53	0.1294	0.4142	0.1186	3.49	0.0008	0.5658	0.1109	5.1	<.0001	0.0490	0.0981	0.50	0.6191
β_5	0.5813	0.0500	11.64	<.0001	0.5819	0.1431	4.07	0.0001	0.1849	0.0643	2.88	0.0053	0.7110	0.1210	5.88	<.0001	0.7320	0.1183	6.19	<.0001	0.1908	0.0983	1.94	0.0559
β_6	1.1944	0.0544	21.96	<.0001	1.0339	0.1577	6.56	<.0001	0.7224	0.0661	10.93	<.0001	1.5025	0.1257	11.95	<.0001	1.3602	0.1372	9.91	<.0001	0.7272	0.1002	7.26	<.0001
β_7	1.4399	0.0571	25.22	<.0001	1.2340	0.1699	7.26	<.0001	0.9402	0.0703	13.36	<.0001	1.7799	0.1262	14.10	<.0001	1.6436	0.1476	11.13	<.0001	1.0726	0.1027	10.45	<.0001
β_8	1.3484	0.0581	23.19	<.0001	1.1699	0.1613	7.25	<.0001	0.9808	0.0718	13.65	<.0001	1.6159	0.1266	12.76	<.0001	1.5940	0.1523	10.47	<.0001	0.9721	0.1044	9.31	<.0001
β_9	1.2194	0.0562	21.69	<.0001	1.0674	0.1545	6.91	<.0001	0.8642	0.0703	12.30	<.0001	1.5009	0.1238	12.12	<.0001	1.3585	0.1399	9.71	<.0001	0.7972	0.1012	7.87	<.0001
β_{10}	0.9682	0.0518	18.68	<.0001	0.8198	0.1448	5.66	<.0001	0.6927	0.0662	10.46	<.0001	1.3421	0.1217	11.03	<.0001	1.0933	0.1230	8.89	<.0001	0.6475	0.1021	6.34	<.0001
β_{11}	0.7093	0.0484	14.66	<.0001	0.6266	0.1405	4.46	<.0001	0.4328	0.0624	6.93	<.0001	0.8712	0.1233	7.07	<.0001	0.7384	0.1140	6.48	<.0001	0.4516	0.1011	4.47	<.0001
β_{12}	0.2368	0.0449	5.27	<.0001	0.3497	0.1228	2.85	0.0057	0.1086	0.0575	1.89	0.0629	0.0956	0.1170	0.82	0.4165	0.2750	0.1069	2.57	0.0120	-0.0709	0.0987	-0.72	0.4744
α_M	1.4362	0.0850	16.89	<.0001	1.3563	0.1809	7.50	<.0001	1.7057	0.1426	11.96	<.0001	1.3560	0.1724	7.86	<.0001	1.2685	0.1445	8.78	<.0001	1.1705	0.1295	9.04	<.0001
α_{MM}	0.8657	0.1586	5.46	<.0001	1.5794	0.3179	4.97	<.0001	1.0013	0.1617	6.19	<.0001	0.8190	0.2649	3.09	0.0028	1.0603	0.3494	3.03	0.0033	0.8796	0.3029	2.90	0.0048
α_{ML}	-1.4274	0.6066	-2.35	0.0212	-0.1163	0.6797	-0.17	0.8646	0.8778	0.4781	1.84	0.0702	-0.6720	0.6501	-1.03	0.3046	-1.0334	0.8487	-1.22	0.2271	1.4452	0.7334	1.97	0.0524
α_{MK}	0.3321	0.2680	1.24	0.2189	-0.0332	0.3070	-0.11	0.9142	-0.2699	0.4186	-0.64	0.5210	-0.1000	0.4570	-0.22	0.8274	0.0504	0.4055	0.12	0.9014	-0.6447	0.7008	-0.92	0.3604
α_{ME}	-0.4673	0.1501	-3.11	0.0026	-1.8124	0.3335	-5.43	<.0001	-1.0317	0.0905	-11.39	<.0001	-1.0262	0.2507	-4.09	0.0001	-1.4519	0.5432	-2.67	0.0092	-0.7665	0.2541	-3.02	0.0035
γ_{MT}	-0.0022	0.0021	-1.07	0.2879	-0.0012	0.0048	-0.24	0.8101	-0.0038	0.0043	-0.89	0.3753	-0.0003	0.0049	-0.06	0.9499	0.0054	0.0044	1.24	0.2183	0.0029	0.0090	0.32	0.7464
α_2	-0.3119	0.0903	-3.46	0.0009	-0.4136	0.1711	-2.42	0.0180	-0.6658	0.1741	-3.82	0.0003	-0.6444	0.2805	-2.30	0.0243	-0.2430	0.1692	-1.44	0.1550	0.0787	0.1784	0.44	0.6605
α_3	-0.0579	0.1286	-0.45	0.6537	-0.4215	0.1921	-2.19	0.0312	-0.5875	0.1677	-3.50	0.0008	-0.5555	0.2580	-2.15	0.0344	-0.2561	0.1735	-1.48	0.1440	0.1271	0.1662	0.76	0.4467
α_4	-0.3058	0.0866	-3.53	0.0007	-0.3069	0.1809	-1.70	0.0940	-0.6809	0.1623	-4.20	<.0001	-0.4083	0.2290	-1.78	0.0785	-0.1783	0.1766	-1.01	0.3158	0.0116	0.1558	0.07	0.9410
α_5	-0.2887	0.0880	-3.28	0.0016	-0.2251	0.1984	-1.13	0.2600	-0.6657	0.1548	-4.30	<.0001	-0.3489	0.2253	-1.55	0.1255	-0.2353	0.1713	-1.37	0.1736	-0.1023	0.1521	-0.67	0.5035
α_6	-0.5526	0.1278	-4.32	<.0001	-0.2145	0.2013	-1.07	0.2900	-0.6612	0.1726	-3.83	0.0003	-0.2852	0.2553	-1.12	0.2674	-0.2346	0.1863	-1.26	0.2117	-0.2218	0.1730	-1.28	0.2035
α_7	-0.5606	0.1373	-4.08	0.0001	-0.2972	0.2082	-1.43	0.1575	-0.6405	0.1786	-3.59	0.0006	-0.2005	0.2561	-0.78	0.4360	-0.2236	0.1938	-1.15	0.2522	-0.4356	0.2064	-2.11	0.0381
α_8	-0.5125	0.1282	-4.00	0.0001	-0.2548	0.2034	-1.25	0.2142	-0.6137	0.1690	-3.63	0.0005	-0.1951	0.2541	-0.77	0.4449	-0.2397	0.1882	-1.27	0.2066	-0.1162	0.2804	-0.41	0.6798
α_9	-0.5175	0.1234	-4.19	<.0001	-0.3488	0.2054	-1.70	0.0936	-0.6687	0.1669	-4.01	0.0001	-0.2055	0.2541	-0.81	0.4213	-0.2440	0.1851	-1.32	0.1913	-0.2070	0.2065	-1.00	0.3192
α_{10}	-0.4842	0.1140	-4.25	<.0001	-0.2389	0.2062	-1.16	0.2503	-0.6355	0.1579	-4.02	0.0001	-0.2491	0.2627	-0.95	0.3459	-0.2443	0.1801	-1.36	0.1790	-0.1461	0.1894	-0.77	0.4427
α_{11}	-0.3758	0.0969	-3.88	0.0002	-0.2886	0.2135	-1.35	0.1805	-0.6224	0.1472	-4.23	<.0001	0.0263	0.3045	0.09	0.9315	-0.3515	0.2610	-1.35	0.1820	-0.1696	0.1694	-1.00	0.3199
α_{12}	-0.2179	0.0765	-2.85	0.0056	-0.3773	0.3125	-1.21	0.2311	-0.4427	0.1359	-3.26	0.0017	0.1343	0.2371	0.57	0.5727	0.0060	0.1715	0.03	0.9724	0.1296	0.1502	0.86	0.3912
Θ	0.0018	0.0029	0.62	0.5391	0.0046	0.0054	0.86	0.3927	-0.0009	0.0011	-0.83	0.4119	0.0060	0.0048	1.24	0.2192	0.0293	0.0183	1.61	0.1121	0.0227	0.0233	0.97	0.3337
Equation	R^2	$\overline{R^2}$	*DW*	*Obj. Value*	R^2	$\overline{R^2}$	*DW*	*Obj. Value*	R^2	$\overline{R^2}$	*DW*	*Obj. Value*	R^2	$\overline{R^2}$	*DW*	*Obj. Value*	R^2	$\overline{R^2}$	*DW*	*Obj. Value*	R^2	$\overline{R^2}$	*DW*	*Obj. Value*
$\ln M$	0.9788	0.9728	1.3279	0.6299	0.8497	0.8093	1.4938	0.6274	0.9588	0.9471	1.2231	0.3848	0.9215	0.9017	1.2065	0.5509	0.8811	0.8514	1.3608	0.3365	0.9186	0.8980	1.3886	0.4010
W_M	0.9232	0.9052	2.0849		0.6699	0.5934	1.6357		0.8561	0.8225	1.7632		0.6011	0.5087	2.0767		0.8056	0.7602	2.0574		0.7384	0.6778	1.8674	

Table A 1. Estimated parameters and statistical inference of N3SLS estimation of market structure models (continued)

Parameter	Region 06 Zhytomyr				Region 07 Zakarpattia				Region 08 Zaporizhia				Region 09 Ivano-Frankivsk				Region 10 Kiev				Region 11 Kirovohrad			
	Estimate	St. Error	*t*-Ratio	Pr > $\lvert t\rvert$	Estimate	St. Error	*t*-Ratio	Pr > $\lvert t\rvert$	Estimate	St. Error	*t*-Ratio	Pr > $\lvert t\rvert$	Estimate	St. Error	*t*-Ratio	Pr > $\lvert t\rvert$	Estimate	St. Error	*t*-Ratio	Pr > $\lvert t\rvert$	Estimate	St. Error	*t*-Ratio	Pr > $\lvert t\rvert$
β_0	-0.7261	0.0706	-10.28	<.0001	-0.8435	0.1314	-6.42	<.0001	-0.8311	0.1508	-5.51	<.0001	-0.8308	0.0745	-11.15	<.0001	-0.6088	0.0529	-11.51	<.0001	-0.8309	0.0847	-9.81	<.0001
β_M	0.4054	0.1086	3.73	0.0004	0.0916	0.1283	0.71	0.4776	0.0550	0.0334	1.65	0.1036	0.1774	0.0539	3.29	0.0015	0.6150	0.0833	7.38	<.0001	0.1824	0.0365	4.99	<.0001
β_D	-0.0569	0.1189	-0.48	0.6336	-0.0547	0.2338	-0.23	0.8156	-0.1065	0.2428	-0.44	0.6621	0.0671	0.0861	0.78	0.4380	-0.0425	0.0618	-0.69	0.494	-	-	-	-
β_B	0.3967	0.1336	2.97	0.0040	0.7750	0.1970	3.93	0.0002	0.9526	0.2738	3.48	0.0008	1.0748	0.0873	12.32	<.0001	0.2421	0.0800	3.02	0.003	0.5296	0.1032	5.13	<.0001
β_F	-0.7452	0.1907	-3.91	0.0002	-0.3409	0.3387	-1.01	0.3175	-0.9010	0.4165	-2.16	0.0337	-0.2395	0.3359	-0.71	0.4780	-0.8997	0.1476	-6.09	<.0001	-0.9989	0.2181	-4.58	<.0001
ϕ_C	-3.2135	1.1527	-2.79	0.0067	-5.2356	4.5419	-1.15	0.2527	0.7510	1.3582	0.55	0.5819	-4.3078	2.7227	-1.58	0.1179	0.1876	0.5885	0.32	0.751	-4.1132	0.8574	-4.80	<.0001
δ_T	-0.0107	0.0065	-1.66	0.1020	-0.0136	0.0064	-2.11	0.0386	0.0112	0.0146	0.77	0.4459	-0.0273	0.0025	-10.76	<.0001	0.0028	0.0038	0.75	0.458	-0.0311	0.0044	-7.04	<.0001
δ_{MT}	0.0111	0.0030	3.73	0.0004	0.0059	0.0083	0.71	0.4775	0.0164	0.0098	1.67	0.0986	0.0183	0.0047	3.89	0.0002	0.0190	0.0026	7.38	<.0001	0.0203	0.0037	5.44	<.0001
δ_{DT}	0.0013	0.0040	0.34	0.7338	0.0161	0.0093	1.74	0.0852	0.0034	0.0068	0.50	0.6211	0.0043	0.0029	1.47	0.1449	0.0034	0.0018	1.87	0.065	-	-	-	-
δ_{BT}	0.0090	0.0035	2.58	0.0118	0.0215	0.0057	3.80	0.0003	0.0214	0.0123	1.74	0.0868	-0.0016	0.0032	-0.49	0.6265	0.0033	0.0025	1.32	0.192	-0.0136	0.0042	-3.29	0.0015
δ_{FT}	0.0046	0.0080	0.57	0.5691	-0.0135	0.0074	-1.82	0.0729	-0.0177	0.0209	-0.85	0.4007	0.0140	0.0058	2.41	0.0183	-0.0011	0.0054	-0.21	0.832	-0.0049	0.0071	-0.70	0.4887
φ_{CT}	0.0260	0.0273	0.95	0.3449	-0.0927	0.1285	-0.72	0.4730	-0.0250	0.0505	-0.49	0.6222	0.1386	0.0619	2.24	0.0282	0.0321	0.0105	3.06	0.003	-0.0603	0.0157	-3.83	0.0003
β_2	-0.5078	0.0903	-5.63	<.0001	-0.7728	0.1725	-4.48	<.0001	-0.5703	0.1814	-3.14	0.0024	-0.1061	0.0785	-1.35	0.1808	0.0551	0.0485	1.14	0.259	-0.3618	0.0719	-5.04	<.0001
β_3	-0.2911	0.0888	-3.28	0.0016	-0.6309	0.1753	-3.60	0.0006	-0.5477	0.1788	-3.06	0.0030	-0.0922	0.0751	-1.23	0.2238	0.0262	0.0487	0.54	0.592	-0.2952	0.0716	-4.13	<.0001
β_4	0.0419	0.0876	0.48	0.6340	-0.2140	0.1700	-1.26	0.2121	0.0752	0.1771	0.42	0.6723	0.2027	0.0739	2.74	0.0076	0.2553	0.0507	5.03	<.0001	-0.0207	0.0719	-0.29	0.7743
β_5	0.3143	0.0873	3.60	0.0006	0.1958	0.1611	1.21	0.2282	0.3772	0.1759	2.14	0.0352	0.5525	0.0803	6.88	<.0001	0.3692	0.0527	7.00	<.0001	0.1978	0.0731	2.71	0.0084
β_6	1.0629	0.0963	11.03	<.0001	1.1435	0.1633	7.00	<.0001	0.8875	0.1812	4.90	<.0001	1.1931	0.1002	11.91	<.0001	0.7409	0.0579	12.79	<.0001	0.8227	0.0788	10.44	<.0001
β_7	1.3042	0.0989	13.18	<.0001	1.3728	0.1658	8.28	<.0001	1.0444	0.2012	5.19	<.0001	1.4136	0.1041	13.58	<.0001	0.9444	0.0638	14.80	<.0001	1.0576	0.0821	12.88	<.0001
β_8	1.2495	0.0997	12.53	<.0001	1.3206	0.1777	7.43	<.0001	0.7147	0.1896	3.77	0.0003	1.2805	0.1091	11.73	<.0001	0.9074	0.0631	14.37	<.0001	1.0512	0.0806	13.04	<.0001
β_9	1.1274	0.0976	11.55	<.0001	1.2865	0.1671	7.70	<.0001	0.6344	0.1935	3.28	0.0016	1.1645	0.1004	11.60	<.0001	0.7624	0.0626	12.18	<.0001	0.9069	0.0796	11.39	<.0001
β_{10}	0.9376	0.0965	9.71	<.0001	1.0457	0.1641	6.37	<.0001	0.3973	0.1888	2.10	0.0387	0.8579	0.0867	9.90	<.0001	0.6129	0.0597	10.26	<.0001	0.7003	0.0767	9.13	<.0001
β_{11}	0.6121	0.0919	6.66	<.0001	0.7372	0.1577	4.67	<.0001	0.0585	0.1733	0.34	0.7365	0.5919	0.0830	7.13	<.0001	0.4240	0.0546	7.77	<.0001	0.4289	0.0726	5.90	<.0001
β_{12}	0.0969	0.0884	1.10	0.2769	0.2631	0.1607	1.64	0.1059	-0.0961	0.1734	-0.55	0.5812	0.1608	0.0737	2.18	0.0322	0.1338	0.0512	2.61	0.011	0.0781	0.0719	1.09	0.2811
α_M	1.2837	0.0838	15.32	<.0001	1.2303	0.1754	7.02	<.0001	1.3979	0.1646	8.49	<.0001	0.9357	0.0524	17.85	<.0001	1.2365	0.0560	22.06	<.0001	1.3217	0.1574	8.40	<.0001
α_{MM}	0.6480	0.1002	6.47	<.0001	0.7530	0.1227	6.14	<.0001	1.0046	0.1590	6.32	<.0001	0.7372	0.0978	7.54	<.0001	0.8896	0.2106	4.22	<.0001	0.8203	0.1657	4.95	<.0001
α_{ML}	-0.3046	0.4219	-0.72	0.4725	0.0412	0.1438	0.29	0.7753	-0.2772	0.5256	-0.53	0.5994	-0.4635	0.1557	-2.98	0.0039	0.2755	0.4382	0.63	0.531	2.5483	1.2936	1.97	0.0524
α_{MK}	-0.2966	0.2642	-1.12	0.2651	-0.6080	0.2587	-2.35	0.0213	0.1684	0.5667	0.30	0.7671	-0.0733	0.1513	-0.48	0.6296	-0.4767	0.2014	-2.37	0.020	-1.0787	0.4783	-2.26	0.0270
α_{ME}	-0.6518	0.0811	-8.04	<.0001	-0.7420	0.1405	-5.28	<.0001	-1.1867	0.1913	-6.20	<.0001	-0.7584	0.1062	-7.14	<.0001	-0.9226	0.1218	-7.58	<.0001	-1.0732	0.2045	-5.25	<.0001
γ_{MT}	-0.0060	0.0028	-2.10	0.0390	-0.0087	0.0040	-2.17	0.0330	0.0063	0.0059	1.06	0.2923	0.0049	0.0016	3.00	0.0036	-0.0014	0.0019	-0.72	0.474	0.0063	0.0085	0.74	0.4632
α_2	-0.2920	0.1233	-2.37	0.0204	0.1143	0.3044	0.38	0.7083	-0.4024	0.2101	-1.92	0.0591	0.0839	0.0692	1.21	0.2289	-0.2525	0.0769	-3.28	0.002	0.0148	0.2300	0.06	0.9488
α_3	-0.2825	0.1146	-2.47	0.0159	0.0168	0.2739	0.06	0.9514	-0.3499	0.2081	-1.68	0.0968	0.1541	0.0782	1.97	0.0524	-0.1813	0.0715	-2.53	0.013	0.0998	0.2682	0.37	0.7108
α_4	-0.2078	0.1027	-2.02	0.0465	0.0588	0.2601	0.23	0.8217	-0.2082	0.2089	-1.00	0.3220	0.1389	0.0866	1.60	0.1128	-0.1873	0.0702	-2.67	0.009	0.2763	0.2501	1.10	0.2727
α_5	-0.1049	0.0990	-1.06	0.2931	0.0219	0.2260	0.10	0.9229	-0.3388	0.1963	-1.73	0.0884	0.2658	0.0738	3.60	0.0006	-0.1132	0.0790	-1.43	0.156	0.1356	0.2274	0.60	0.5525
α_6	-0.2948	0.1089	-2.71	0.0084	-0.2826	0.2188	-1.29	0.2004	-0.3152	0.2169	-1.45	0.1503	0.0563	0.0747	0.75	0.4535	-0.3017	0.1148	-2.63	0.010	-0.0165	0.2234	-0.07	0.9414
α_7	-0.2889	0.1114	-2.59	0.0114	-0.2327	0.2162	-1.08	0.2850	-0.3812	0.2195	-1.74	0.0865	0.0322	0.0763	0.42	0.6738	-0.2838	0.1060	-2.68	0.009	-0.0391	0.2358	-0.17	0.8687
α_8	-0.2138	0.1078	-1.98	0.0508	-0.1576	0.2144	-0.73	0.4646	-0.4115	0.2285	-1.80	0.0756	0.0341	0.0735	0.46	0.6442	-0.2348	0.1004	-2.34	0.022	-0.0802	0.2226	-0.36	0.7197
α_9	-0.2217	0.1071	-2.07	0.0418	-0.1808	0.2371	-0.76	0.4482	-0.5721	0.2841	-2.01	0.0475	0.0528	0.0727	0.73	0.4698	-0.2801	0.0868	-3.23	0.002	-0.0895	0.2155	-0.42	0.6790
α_{10}	-0.3158	0.1076	-2.94	0.0044	0.0454	0.2630	0.17	0.8633	-0.1232	0.2544	-0.48	0.6296	0.0242	0.0708	0.34	0.7329	-0.2461	0.0800	-3.08	0.003	-0.0983	0.2123	-0.46	0.6445
α_{11}	-0.1764	0.1036	-1.70	0.0927	-0.0875	0.1989	-0.44	0.6614	-0.0956	0.1939	-0.49	0.6235	0.0213	0.0663	0.32	0.7487	-0.2014	0.0705	-2.86	0.006	0.0439	0.1985	0.22	0.8258
α_{12}	-0.1724	0.1101	-1.57	0.1214	0.0271	0.1927	0.14	0.8887	-0.2274	0.1859	-1.22	0.2251	0.0630	0.0647	0.97	0.3331	-0.1786	0.0661	-2.70	0.008	0.1611	0.1861	0.87	0.3894
Θ	0.0013	0.0023	0.60	0.5530	-0.0001	0.0045	-0.03	0.9765	0.0097	0.0085	1.14	0.2579	0.0005	0.0045	0.11	0.9118	-0.0063	0.0037	-1.69	0.096	0.0242	0.0160	1.51	0.1361
Equation	R^2	$\overline{R}^2$	*DW*	*Obj. Value*	R^2	$\overline{R}^2$	*DW*	*Obj. Value*	R^2	$\overline{R}^2$	*DW*	*Obj. Value*	R^2	$\overline{R}^2$	*DW*	*Obj. Value*	R^2	$\overline{R}^2$	*DW*	*Obj. Value*	R^2	$\overline{R}^2$	*DW*	*Obj. Value*
$\ln M$	0.9349	0.9174	1.6259	0.6380	0.9000	0.8716	1.6559	0.2725	0.8444	0.8025	1.0871	0.3490	0.9406	0.9237	1.7656	0.5460	0.9348	0.9163	1.7930	0.5295	0.9370	0.9212	1.0785	0.5149
W_M	0.8853	0.8588	2.0669		0.2572	0.0836	2.0752		0.6744	0.5990	2.0863		0.9402	0.9262	1.4330		0.9481	0.9360	1.6770		0.6085	0.5170	1.1030	

Table A 1. Estimated parameters and statistical inference of N3SLS estimation of market structure models (continued)

Parameter	Region 12 Luhansk				Region 13 Lviv				Region 14 Mykolaiv				Region 16 Poltava				Region 18 Sumy				Region 19 Ternopil			
	Estimate	St. Error	t-Ratio	Pr >|t|	Estimate	St. Error	t-Ratio	Pr >|t|	Estimate	St. Error	t-Ratio	Pr >|t|	Estimate	St. Error	t-Ratio	Pr >|t|	Estimate	St. Error	t-Ratio	Pr >|t|	Estimate	St. Error	t-Ratio	Pr >|t|
β_0	-1.5078	0.1613	-9.35	<.0001	-0.9848	0.1093	-9.01	<.0001	-0.6151	0.0778	-7.90	<.0001	-1.0698	0.1263	-8.47	<.0001	-0.9870	0.0869	-11.36	<.0001	-1.1665	0.1066	-10.94	<.0001
β_M	0.0298	0.0141	2.11	0.0386	0.0080	0.0113	0.71	0.4813	0.0836	0.0581	1.44	0.1543	0.1867	0.0596	3.13	0.0025	0.4980	0.1082	4.60	<.0001	0.0255	0.0123	2.08	0.0409
β_D	-	-	-	-	-0.2390	0.0977	-2.45	0.0167	-0.5189	0.1191	-4.36	<.0001	-0.2273	0.1285	-1.77	0.0811	-	-	-	-	-	-	-	-
β_B	0.9685	0.1777	5.45	<.0001	0.5199	0.1138	4.57	<.0001	0.6935	0.1039	6.68	<.0001	0.8714	0.1150	7.58	<.0001	0.4701	0.1531	3.07	0.0030	0.3465	0.1091	3.18	0.0022
β_F	-1.8200	0.4616	-3.94	0.0002	-0.2888	0.1523	-1.90	0.0617	-0.6133	0.2952	-2.08	0.0412	-0.6624	0.2572	-2.58	0.0120	-0.4806	0.1925	-2.50	0.0147	-0.3720	0.1095	-3.40	0.0011
ϕ_C	-5.4456	2.0134	-2.70	0.0084	2.0611	1.8104	1.14	0.2586	-2.6455	1.0541	-2.51	0.0143	-4.0728	1.5543	-2.62	0.0107	-3.2093	1.1014	-2.91	0.0047	-6.5628	1.0201	-6.43	<.0001
δ_T	-0.0166	0.0092	-1.81	0.0745	0.0030	0.0028	1.06	0.2912	0.0007	0.0031	0.22	0.8237	-0.0208	0.0068	-3.06	0.0031	-0.0228	0.0057	-4.03	0.0001	-0.0327	0.0050	-6.57	<.0001
δ_{MT}	0.0185	0.0068	2.71	0.0084	0.0055	0.0077	0.72	0.4733	-0.0080	0.0055	-1.44	0.1535	0.0150	0.0048	3.14	0.0024	0.0130	0.0028	4.60	<.0001	0.0167	0.0076	2.21	0.0303
δ_{DT}	-	-	-	-	0.0060	0.0032	1.90	0.0616	0.0105	0.0042	2.53	0.0137	0.0088	0.0048	1.82	0.0725	-	-	-	-	0.0014	0.0055	0.26	0.7989
δ_{BT}	0.0219	0.0084	2.61	0.0110	0.0003	0.0057	0.05	0.9620	-0.0057	0.0042	-1.36	0.1775	0.0039	0.0080	0.49	0.6274	0.0040	0.0078	0.51	0.6085	0.0159	0.0041	3.90	0.0002
δ_{FT}	-0.0194	0.0155	-1.25	0.2159	0.0000	0.0069	0.00	0.9989	-0.0135	0.0088	-1.53	0.1313	-0.0065	0.0089	-0.73	0.4662	0.0045	0.0069	0.66	0.5113	0.0161	0.0078	2.06	0.0429
φ_{CT}	-0.0676	0.0438	-1.54	0.1270	-0.0276	0.0538	-0.51	0.6095	-0.0901	0.0332	-2.72	0.0082	-0.0270	0.0275	-0.98	0.3304	-0.0001	0.0222	0.00	0.9982	0.0461	0.0368	1.25	0.2150
β_2	-0.2504	0.1454	-1.72	0.0891	-0.0612	0.1227	-0.50	0.6196	-0.3746	0.0784	-4.78	<.0001	0.0173	0.0825	0.21	0.8347	0.0209	0.0797	0.26	0.7942	-0.3170	0.1128	-2.81	0.0063
β_3	-0.1248	0.1450	-0.86	0.3920	-0.0941	0.1227	-0.77	0.4454	-0.2304	0.0778	-2.96	0.0041	0.0227	0.0828	0.27	0.7850	-0.0107	0.0785	-0.14	0.8920	-0.2227	0.1125	-1.98	0.0513
β_4	0.3979	0.1474	2.70	0.0086	0.4099	0.1226	3.34	0.0013	0.1527	0.0780	1.96	0.0542	0.5077	0.0864	5.87	<.0001	0.3293	0.0809	4.07	0.0001	0.2881	0.1158	2.49	0.0151
β_5	0.7918	0.1523	5.20	<.0001	0.8129	0.1229	6.61	<.0001	0.5764	0.0781	7.38	<.0001	0.5970	0.0867	6.88	<.0001	0.5476	0.0877	6.24	<.0001	0.6536	0.1201	5.44	<.0001
β_6	1.5255	0.1576	9.68	<.0001	1.5391	0.1290	11.93	<.0001	0.9083	0.0884	10.28	<.0001	1.0969	0.0987	11.12	<.0001	1.1739	0.0945	12.42	<.0001	1.1880	0.1207	9.84	<.0001
β_7	1.6917	0.1625	10.41	<.0001	1.7456	0.1383	12.62	<.0001	1.0317	0.0941	10.96	<.0001	1.3005	0.1049	12.39	<.0001	1.5306	0.1059	14.46	<.0001	1.5041	0.1240	12.13	<.0001
β_8	1.6737	0.1694	9.88	<.0001	1.5265	0.1405	10.87	<.0001	1.0178	0.0993	10.25	<.0001	1.2163	0.1000	12.16	<.0001	1.4421	0.1052	13.71	<.0001	1.4434	0.1284	11.24	<.0001
β_9	1.4810	0.1638	9.04	<.0001	1.4467	0.1360	10.64	<.0001	0.8778	0.0961	9.14	<.0001	1.1584	0.1000	11.58	<.0001	1.3241	0.1005	13.18	<.0001	1.3099	0.1262	10.38	<.0001
β_{10}	1.2598	0.1509	8.35	<.0001	1.2709	0.1276	9.96	<.0001	0.6894	0.0931	7.41	<.0001	0.9665	0.0939	10.30	<.0001	1.0765	0.0939	11.47	<.0001	1.1158	0.1221	9.14	<.0001
β_{11}	0.8641	0.1469	5.88	<.0001	1.0106	0.1210	8.35	<.0001	0.5521	0.0824	6.70	<.0001	0.7385	0.0841	8.78	<.0001	0.8804	0.0908	9.69	<.0001	0.7471	0.1221	6.12	<.0001
β_{12}	0.1139	0.1441	0.79	0.4317	0.3446	0.1219	2.83	0.0060	0.1935	0.0802	2.41	0.0182	0.3235	0.0784	4.13	<.0001	0.3476	0.0784	4.44	<.0001	0.2780	0.1147	2.42	0.0177
α_M	1.2944	0.1270	10.19	<.0001	1.0248	0.1198	8.56	<.0001	1.2330	0.1005	12.26	<.0001	1.2232	0.0765	15.99	<.0001	1.2894	0.0814	15.83	<.0001	1.3869	0.1106	12.54	<.0001
α_{MM}	1.0929	0.1916	5.70	<.0001	0.7283	0.1844	3.95	0.0002	0.4168	0.1565	2.66	0.0094	0.6899	0.1296	5.32	<.0001	0.6336	0.1188	5.33	<.0001	1.3315	0.1510	8.82	<.0001
α_{ML}	-0.5289	0.4901	-1.08	0.2838	-0.1662	0.2991	-0.56	0.5801	-0.4526	0.7046	-0.64	0.5225	-1.6603	0.5202	-3.19	0.0020	-3.4234	1.0105	-3.39	0.0011	-0.2012	0.8859	-0.23	0.8210
α_{MK}	-0.4903	0.3537	-1.39	0.1697	-0.2560	0.1825	-1.40	0.1648	0.0446	0.2698	0.17	0.8690	0.0015	0.1990	0.01	0.9941	0.4961	0.3649	1.36	0.1779	-0.3959	0.2917	-1.36	0.1786
α_{ME}	-1.0275	0.1493	-6.88	<.0001	-0.9531	0.1637	-5.82	<.0001	-0.4820	0.1332	-3.62	0.0005	-0.6628	0.1304	-5.08	<.0001	-0.5096	0.1558	-3.27	0.0016	-1.4011	0.1647	-8.51	<.0001
γ_{MT}	-0.0020	0.0050	-0.39	0.6949	0.0026	0.0024	1.06	0.2946	0.0057	0.0033	1.75	0.0836	-0.0013	0.0028	-0.48	0.6360	-0.0037	0.0026	-1.44	0.1528	0.0008	0.0028	0.27	0.7845
α_2	-0.0113	0.1485	-0.08	0.9398	-0.1688	0.1114	-1.52	0.1338	-0.4961	0.1349	-3.68	0.0004	-0.3793	0.0964	-3.94	0.0002	-0.2674	0.0908	-2.94	0.0043	-0.2551	0.1225	-2.08	0.0406
α_3	0.0761	0.1383	0.55	0.5839	-0.1463	0.1168	-1.25	0.2140	-0.3668	0.1086	-3.38	0.0011	-0.2163	0.0943	-2.29	0.0245	-0.2141	0.0921	-2.32	0.0227	-0.1991	0.1223	-1.63	0.1075
α_4	-0.1223	0.1325	-0.92	0.3591	-0.0088	0.1225	-0.07	0.9428	-0.2033	0.1051	-1.93	0.0568	-0.1346	0.0907	-1.48	0.1421	-0.2834	0.0935	-3.03	0.0033	-0.1906	0.1281	-1.49	0.1406
α_5	-0.1474	0.1441	-1.02	0.3096	0.1372	0.1390	0.99	0.3269	-0.1105	0.1156	-0.96	0.3423	-0.1742	0.0916	-1.90	0.0610	-0.2467	0.0942	-2.62	0.0106	-0.2290	0.1232	-1.86	0.0668
α_6	-0.3532	0.1928	-1.83	0.0708	0.0281	0.1640	0.17	0.8645	-0.2245	0.1550	-1.45	0.1516	-0.1968	0.1048	-1.88	0.0642	-0.3907	0.1290	-3.03	0.0033	-0.2970	0.1546	-1.92	0.0585
α_7	-0.4005	0.2131	-1.88	0.0640	0.0551	0.1663	0.33	0.7411	-0.1576	0.1580	-1.00	0.3215	-0.2101	0.1153	-1.82	0.0724	-0.4045	0.1384	-2.92	0.0046	-0.3406	0.1542	-2.21	0.0301
α_8	-0.3715	0.2088	-1.78	0.0792	0.0310	0.1583	0.20	0.8454	-0.1238	0.1505	-0.82	0.4131	-0.2142	0.1129	-1.90	0.0615	-0.3240	0.1244	-2.60	0.0110	-0.3674	0.1509	-2.44	0.0172
α_9	-0.3670	0.2143	-1.71	0.0909	0.0332	0.1596	0.21	0.8360	-0.1700	0.1470	-1.16	0.2512	-0.2032	0.1093	-1.86	0.0668	-0.2573	0.1229	-2.09	0.0396	-0.4133	0.1503	-2.75	0.0074
α_{10}	-0.4207	0.2133	-1.97	0.0521	0.0916	0.1572	0.58	0.5617	-0.1747	0.1414	-1.24	0.2204	-0.2170	0.1043	-2.08	0.0408	-0.2702	0.1194	-2.26	0.0265	-0.3867	0.1507	-2.57	0.0122
α_{11}	-0.4070	0.2705	-1.50	0.1365	0.0254	0.1550	0.16	0.8701	-0.1727	0.1364	-1.27	0.2095	-0.1066	0.0956	-1.11	0.2686	-0.1674	0.1208	-1.39	0.1696	-0.4826	0.1649	-2.93	0.0045
α_{12}	0.2205	0.1413	1.56	0.1228	-0.0282	0.1726	-0.16	0.8704	-0.1979	0.1095	-1.81	0.0746	-0.1229	0.0877	-1.40	0.1652	-0.1899	0.1245	-1.52	0.1315	-0.1017	0.1587	-0.64	0.5236
Θ	0.0090	0.0070	1.28	0.2047	-0.0003	0.0015	-0.18	0.8571	0.0000	0.0015	0.00	0.9999	-0.0007	0.0019	-0.36	0.7206	-0.0043	0.0059	-0.74	0.4643	0.0050	0.0038	1.33	0.1864
Equation	R^2	$\overline{R^2}$	DW	*Obj. Value*	R^2	$\overline{R^2}$	DW	*Obj. Value*	R^2	$\overline{R^2}$	DW	*Obj. Value*	R^2	$\overline{R^2}$	DW	*Obj. Value*	R^2	$\overline{R^2}$	DW	*Obj. Value*	R^2	$\overline{R^2}$	DW	*Obj. Value*
$\ln M$	0.9054	0.8817	0.7537	0.5125	0.9227	0.9019	0.9177	0.7242	0.9624	0.9518	1.2803	0.6455	0.9410	0.9243	1.7915	0.5649	0.9414	0.9267	1.5809	0.5189	0.8830	0.8535	1.1492	0.4573
W_M	0.7986	0.7515	1.8424		0.8929	0.8681	1.4900		0.9212	0.9028	1.6106		0.9276	0.9107	1.8725		0.9158	0.8962	1.2823		0.8936	0.8690	1.7794	

Table A 1. Estimated parameters and statistical inference of N3SLS estimation of market structure models (continued)

Parameter	Region 21 Kherson				Region 22 Khmelnytskyi				Region 23 Cherkasy				Region 24 Chernivtsi				Region 25 Chernihiv			
	Estimate	St. Error	*t*-Ratio	Pr >|*t*|	Estimate	St. Error	*t*-Ratio	Pr >|*t*|	Estimate	St. Error	*t*-Ratio	Pr >|*t*|	Estimate	St. Error	*t*-Ratio	Pr >|*t*|	Estimate	St. Error	*t*-Ratio	Pr >|*t*|
β_0	-0.6432	0.1000	-6.43	<.0001	-0.7602	0.0745	-10.20	<.0001	-0.4977	0.0907	-5.49	<.0001	-0.5138	0.0655	-7.84	<.0001	-1.0771	0.0880	-12.24	<.0001
β_M	0.4295	0.1932	2.22	0.0292	0.0732	0.0942	0.78	0.4394	0.4386	0.1259	3.48	0.0008	0.0089	0.0053	1.69	0.0954	0.0351	0.0105	3.33	0.0013
β_D	-	-	-	-	-	-	-	-	-	-	-	-	-0.1479	0.1016	-1.46	0.1495	-0.1947	0.0959	-2.03	0.0460
β_B	0.9397	0.2624	3.58	0.0006	0.8091	0.1576	5.13	<.0001	0.5534	0.1559	3.55	0.0007	0.7699	0.0811	9.50	<.0001	0.9160	0.1284	7.14	<.0001
β_F	-0.4481	0.3892	-1.15	0.2533	-0.8823	0.1249	-7.07	<.0001	-0.9920	0.1342	-7.39	<.0001	-0.6308	0.1162	-5.43	<.0001	-1.3281	0.3420	-3.88	0.0002
ϕ_C	1.2010	1.1405	1.05	0.2956	-5.1340	0.8329	-6.16	<.0001	1.7007	1.0366	1.64	0.1050	-2.1293	0.8653	-2.46	0.0162	-7.3553	1.8119	-4.06	0.0001
δ_T	-0.0027	0.0038	-0.72	0.4754	-0.0207	0.0040	-5.16	<.0001	0.0111	0.0066	1.68	0.0969	-0.0146	0.0020	-7.27	<.0001	-0.0352	0.0084	-4.21	<.0001
δ_{MT}	0.0106	0.0048	2.23	0.0290	0.0034	0.0044	0.78	0.4398	0.0161	0.0046	3.49	0.0008	0.0183	0.0046	3.95	0.0002	0.0162	0.0048	3.42	0.0010
δ_{DT}	-	-	-	-	-	-	-	-	-	-	-	-	-0.0056	0.0042	-1.34	0.1829	0.0147	0.0044	3.34	0.0013
δ_{BT}	-0.0009	0.0106	-0.08	0.9337	0.0122	0.0045	2.68	0.0089	-0.0014	0.0041	-0.34	0.7368	0.0073	0.0036	2.01	0.0478	0.0023	0.0065	0.36	0.7180
δ_{FT}	-0.0211	0.0111	-1.89	0.0620	-0.0057	0.0078	-0.72	0.4722	0.0075	0.0081	0.93	0.3527	-0.0203	0.0051	-3.99	0.0002	-0.0099	0.0086	-1.15	0.2539
φ_{CT}	-0.0959	0.0334	-2.87	0.0053	-0.0522	0.0412	-1.26	0.2097	0.0332	0.0275	1.21	0.2316	-0.0981	0.0320	-3.07	0.0030	-0.0052	0.0261	-0.20	0.8430
β_2	-0.7139	0.1107	-6.45	<.0001	-0.2816	0.0815	-3.45	0.0009	-0.0273	0.0895	-0.30	0.7615	-0.1903	0.0725	-2.62	0.0105	-0.1165	0.0791	-1.47	0.1448
β_3	-0.7241	0.1107	-6.54	<.0001	-0.3206	0.0814	-3.94	0.0002	-0.0977	0.0890	-1.10	0.2757	-0.2830	0.0727	-3.89	0.0002	-0.2082	0.0773	-2.69	0.0088
β_4	-0.3076	0.1142	-2.69	0.0087	0.1333	0.0818	1.63	0.1072	0.1350	0.0914	1.48	0.1437	-0.0055	0.0723	-0.08	0.9396	0.4461	0.0835	5.34	<.0001
β_5	-0.0170	0.1205	-0.14	0.8882	0.3654	0.0850	4.30	<.0001	0.1883	0.0966	1.95	0.0549	0.0687	0.0766	0.90	0.3723	0.7019	0.0917	7.65	<.0001
β_6	0.5706	0.1347	4.24	<.0001	0.9400	0.0925	10.17	<.0001	0.5951	0.1040	5.72	<.0001	0.5234	0.0752	6.96	<.0001	1.4397	0.1003	14.35	<.0001
β_7	0.7004	0.1375	5.09	<.0001	1.1022	0.0940	11.73	<.0001	0.8427	0.1113	7.57	<.0001	0.8507	0.0760	11.19	<.0001	1.6746	0.1052	15.92	<.0001
β_8	0.8488	0.1402	6.06	<.0001	1.0068	0.0940	10.71	<.0001	0.8499	0.1134	7.50	<.0001	0.7663	0.0827	9.27	<.0001	1.5941	0.1020	15.63	<.0001
β_9	0.6760	0.1309	5.16	<.0001	0.8733	0.0943	9.26	<.0001	0.7142	0.1100	6.49	<.0001	0.6630	0.0778	8.53	<.0001	1.4586	0.0961	15.18	<.0001
β_{10}	0.5196	0.1266	4.11	0.0001	0.6346	0.0885	7.17	<.0001	0.5012	0.0994	5.04	<.0001	0.4703	0.0758	6.20	<.0001	1.2537	0.0894	14.03	<.0001
β_{11}	0.3799	0.1250	3.04	0.0032	0.4757	0.0899	5.29	<.0001	0.4990	0.0987	5.06	<.0001	0.2447	0.0710	3.45	0.0009	0.7534	0.0789	9.55	<.0001
β_{12}	-0.0999	0.1126	-0.89	0.3777	0.0160	0.0811	0.20	0.8441	0.1969	0.0926	2.13	0.0367	-0.0550	0.0707	-0.78	0.4396	0.2997	0.0785	3.82	0.0003
α_M	1.4124	0.1534	9.21	<.0001	1.3646	0.0823	16.59	<.0001	1.2366	0.1081	11.44	<.0001	1.4597	0.1664	8.77	<.0001	1.5759	0.1869	8.43	<.0001
α_{MM}	1.0052	0.1303	7.71	<.0001	1.1560	0.1153	10.03	<.0001	0.8553	0.5779	1.48	0.1430	1.1887	0.1551	7.66	<.0001	0.8252	0.4081	2.02	0.0467
α_{ML}	0.5153	1.4870	0.35	0.7299	-0.1397	0.3794	-0.37	0.7137	-2.0190	1.5140	-1.33	0.1863	0.1361	0.6382	0.21	0.8317	-2.0409	0.9456	-2.16	0.0340
α_{MK}	0.0859	0.6037	0.14	0.8872	-0.7772	0.1889	-4.11	<.0001	0.2332	0.4592	0.51	0.6129	-0.3412	0.3204	-1.06	0.2903	-0.1976	0.4249	-0.47	0.6432
α_{ME}	-0.6679	0.3355	-1.99	0.0500	-0.9385	0.0949	-9.89	<.0001	-0.9296	0.5083	-1.83	0.0713	-1.3062	0.1648	-7.93	<.0001	-0.6010	0.3941	-1.53	0.1313
γ_{MT}	0.0104	0.0055	1.88	0.0633	-0.0044	0.0027	-1.62	0.1084	0.0029	0.0032	0.92	0.3594	0.0019	0.0045	0.41	0.6833	-0.0065	0.0054	-1.20	0.2349
α_2	0.1999	0.2236	0.89	0.3741	-0.1391	0.1082	-1.29	0.2024	-0.3028	0.1651	-1.83	0.0706	-0.2252	0.1806	-1.25	0.2160	-0.3993	0.2416	-1.65	0.1025
α_3	0.1587	0.2234	0.71	0.4796	-0.1551	0.1283	-1.21	0.2303	-0.2871	0.1508	-1.90	0.0606	-0.1710	0.1949	-0.88	0.3830	-0.4426	0.2829	-1.56	0.1219
α_4	-0.1336	0.1927	-0.69	0.4901	-0.1222	0.1254	-0.97	0.3332	-0.1612	0.1467	-1.10	0.2752	-0.2005	0.1905	-1.05	0.2958	-0.3123	0.2106	-1.48	0.1422
α_5	-0.2237	0.1922	-1.16	0.2482	-0.2251	0.1106	-2.04	0.0452	-0.2127	0.1415	-1.50	0.1368	-0.2199	0.1940	-1.13	0.2607	-0.3468	0.2095	-1.66	0.1019
α_6	-0.5232	0.2500	-2.09	0.0397	-0.4113	0.1269	-3.24	0.0018	-0.2211	0.1630	-1.36	0.1790	-0.3038	0.1924	-1.58	0.1185	-0.6532	0.2843	-2.30	0.0243
α_7	-0.4635	0.2409	-1.92	0.0581	-0.3991	0.1263	-3.16	0.0023	-0.2085	0.1863	-1.12	0.2666	-0.2853	0.1915	-1.49	0.1402	-0.7655	0.3251	-2.35	0.0211
α_8	-0.3492	0.2148	-1.63	0.1081	-0.3795	0.1208	-3.14	0.0024	-0.1610	0.1894	-0.85	0.3979	-0.3653	0.1889	-1.93	0.0567	-0.6937	0.3015	-2.30	0.0241
α_9	-0.3743	0.2302	-1.63	0.1080	-0.4451	0.1225	-3.63	0.0005	-0.2169	0.1674	-1.30	0.1989	-0.3706	0.1913	-1.94	0.0564	-0.7394	0.3128	-2.36	0.0206
α_{10}	-0.6879	0.3276	-2.10	0.0390	-0.4083	0.1231	-3.32	0.0014	-0.4738	0.4086	-1.16	0.2498	-0.4303	0.1978	-2.18	0.0327	-0.9298	0.3519	-2.64	0.0100
α_{11}	-0.4636	0.2251	-2.06	0.0428	-0.3045	0.1073	-2.84	0.0058	-0.1350	0.1771	-0.76	0.4482	-0.3129	0.1979	-1.58	0.1180	-0.1374	0.2659	-0.52	0.6067
α_{12}	-0.1857	0.1879	-0.99	0.3260	-0.0279	0.0987	-0.28	0.7779	-0.1326	0.1515	-0.87	0.3843	-0.2619	0.2151	-1.22	0.2272	-0.2699	0.2006	-1.35	0.1824
Θ	-0.0071	0.0088	-0.81	0.4214	0.0007	0.0013	0.51	0.6115	0.0033	0.0089	0.36	0.7162	0.0078	0.0045	1.75	0.0841	0.0102	0.0058	1.76	0.0822
Equation	R^2	$\overline{R^2}$	*DW*	*Obj. Value*	R^2	$\overline{R^2}$	*DW*	*Obj. Value*	R^2	$\overline{R^2}$	*DW*	*Obj. Value*	R^2	$\overline{R^2}$	*DW*	*Obj. Value*	R^2	$\overline{R^2}$	*DW*	*Obj. Value*
$\ln M$	0.9074	0.8843	1.1489	0.4301	0.9197	0.9007	0.9778	0.6807	0.8490	0.8133	0.8490	0.5460	0.9257	0.9057	1.2958	0.2751	0.9619	0.9510	1.6246	0.3692
W_M	0.6263	0.5389	1.7586		0.8980	0.8744	1.2228		0.7935	0.7457	2.1681		0.7886	0.7397	1.4429		0.3181	0.1586	1.9944	