Testing for oligopsony power in the Kazakh grain processing industry: A Hall approach

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The present study uses Hall's approach to test for market power in the Kazakh grain processing industry using regional level panel data covered over the period 2000-2011. This study also tests and compares the degree of competition in three sub-periods, 2000-2004, 2004-2007 and 2008-2011. The results suggest that there is no evidence for the existence of oligopsony power in the time period from 2000 to 2011. However, the statistically significant parameters indicating market power was found for the period 2008-2011, which can be explained as a consequence of the government intervention on grain market.

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JEL Codes: Q13, D43

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Keywords: Grain processing industry, Kazakhstan, market power, oligopsony power, panel data.

JEL classifications: L13, Q13, D43

1 Introduction

Kazakhstan has become one of the top grain and grain flour products exporters in the world within the last decade. According to FAO statistics, Kazakhstan was on the top of the flour exporter countries list, with exports of 1.5 million tons in 2006/2007 and 1.7 million tons in 2007/2008. Nevertheless transition period from planned to market economy in 90's Kazakh grain processing industry[1], along with grain production sector has passed through severe crisis before it started to recover after 2000. After sharp fall in 1991-1995 average annual flour production has been increased from 1.57 ml. tons for the period 1995-2001 to 2.97 ml. tons in 2002-2011 (CSMNERK[2] (b)). Nonetheless, in line with expanding flour production the number of enterprises in grain processing industry has been diminishing especially after 2005.

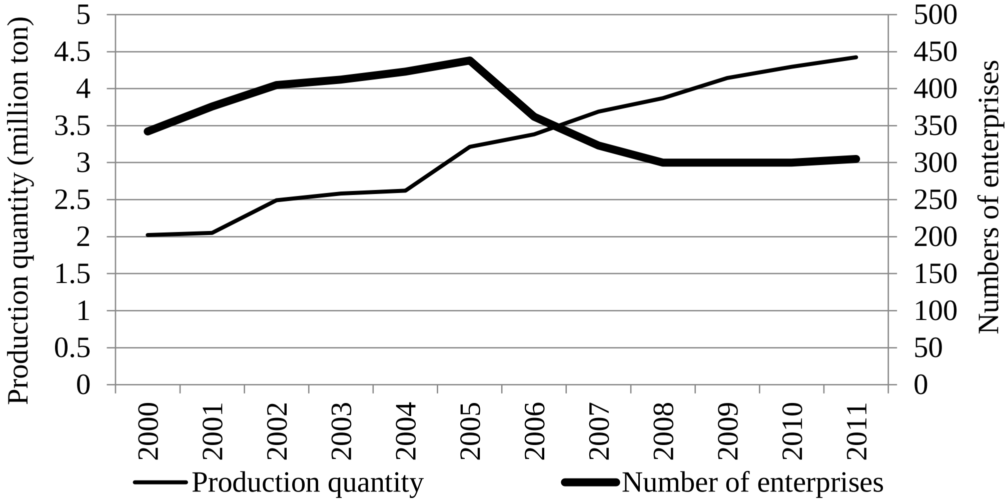
This process can be observed from Figure 1 depicting the development of the grain processing industry (including "Manufacture of grain mill products, starches and starch products" (NACE 10.6) and "Manufacture of prepared animal feeds (NACE 10.9). The graph combines the data regarding the number of the active enterprises operating in the Kazakh grain processing industry (secondary axis) and the total production quantity of processed products (that is: "Cereal and vegetable flour mix of fine grindings", "Groats, wholemeal flour and pellets and other cereal products",

[1] The grain industry includes two branches of economic activity classified by NACE "10.6 - Manufacture of grain mill products, starches and starch products" and "10.9 - Manufacture of prepared animal feeds". NACE is an acronym derived from "Nomenclature statistique des activités économiques dans la Communauté européenne" (in English "The Statistical classification of economic activities in the European Community").

[2] CSMNERK is an acronym for The Committee on Statistics of Ministry of National Economy of the Republic of Kazakhstan which was named the Agency of the Republic of Kazakhstan on Statistics before 2014.

“Ready feed for farm animals, except flour and lucerne pellets”, “Rice-peeled” and “Rice-semi or fully milled”) on national level.

Figure 1. Grain processing industry development



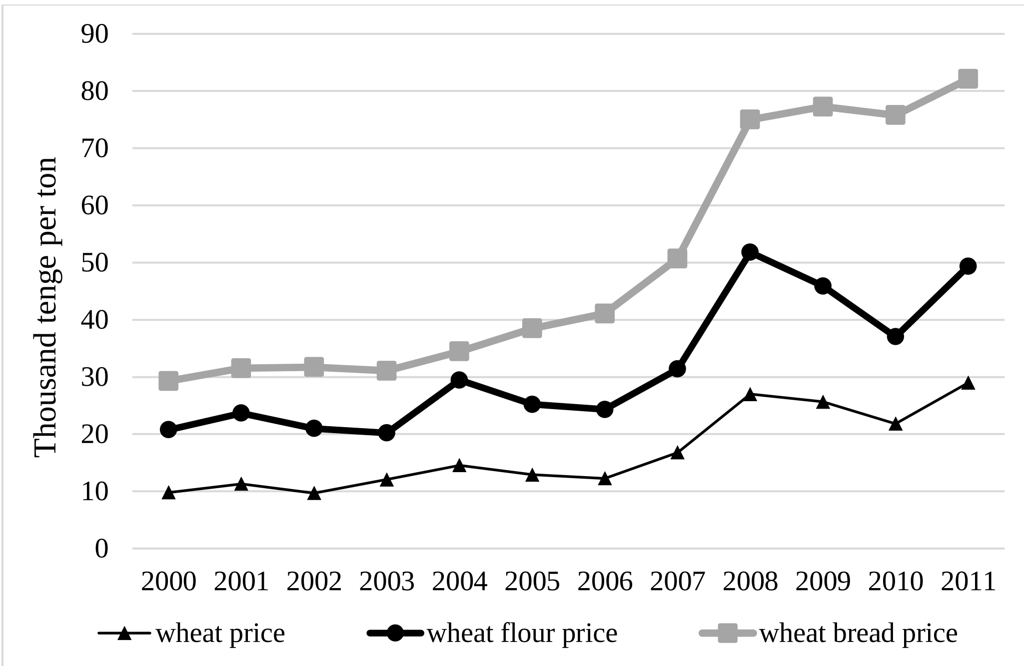
Source: Own illustration based on data received from ICCCSMNERK and annual data published by CSMNERK (b).

Analyzing the graph it can be concluded that some players leave the industry or merge and the remaining actors increase their share on the market. Indeed, according to the Business Media Group report consolidation process has been observed in the grain processing market in recent years; companies merge and small players leave the market (Business Media Group, 2011: 11).

Outstanding aspect is price development within grain supply chain as well particularly after government interventions in 2008 grain export ban was introduced.

Figure 2 describes average price markups between wheat, wheat flour and wheat bread for the time period 2000-2011. As it can be detected, the prices follow the parallel pattern, however the spikes can be observed in 2008. In 2008 the government export ban on wheat lasted 5 months and accordingly influenced the whole supply chain. The prices have been risen on wheat, wheat flour and wheat bread. Consequently after lifting the ban, hence opening the export markets, the prices have been declined only on wheat and wheat flour. However, strikingly the bread prices have been maintained, considering that ultimately the goal of government was to the food price security.

Figure 2. Average price development in grain supply chain



Source: Own illustration based on annual data published by CSMNERK (d, e).

Overall the analysis show that within Kazakh grain market the prices differ according to the regions and several factors impact the price formation, including world grain prices, undeveloped infrastructure and thus high transaction costs, weather conditions and the level of grain production development, government regulations. The wheat supply chain analysis and the local and the world market price comparison indicate that government intervention in 2008 had counter effect on the Kazakh wheat market. Predominantly, the prices have been increased for the restriction time period and declined after cancelation on wheat and wheat flour products. Nevertheless the bakery industry managed to maintain the increased markup in the following years as well.

As it can be observed the wheat (agricultural sector) and the wheat flour producer prices (grain processor sector) and wheat bread (consumer sector) prices follow parallel pattern till 2008, demonstrating constant markups along the grain chain. Nevertheless the pattern has been significantly distorted in 2008, after government intervention on the grain market. Price dynamics suggest that some of the actors have benefited from mark ups. In fact Oskenbayev and Turabayev (2014) concluded asymmetric development of prices along the Kazakh grain supply chain, while Pomfret (2007: 18) report about price gap variation and distortion on Kazakh grain market.

On the other hand grain sector is characterized with market imperfections and high inefficiency caused by high transaction costs and undeveloped infrastructure. According to OECD (2013: 21) report infrastructural inefficiencies result in increased transactional costs for grain producers. Swinnen (2009: 728) reports about local authorities that still intervene in agricultural commodity markets in many ways.

Therefore questions arise whether Kazakh grain processing industry is competitive or not and if they are able to influence and define the grain purchase price. Above mentioned evidences suggest that processors might be exerting market power while purchasing grain. Hence, study investigates oligopsony power in Kazakh grain processing industry.

Our study is organized as follows. The next section provides an overview of related empirical studies examining market power using Hall's nonstructural approach. Section 3 presents the theoretical background of Hall's model adapted for estimating monopsony market power. The used data set is presented in Section 4.

The empirical results and discussion are presented in Section 5. In the final section, we summarize the results and provide some conclusions.

2 Review of related empirical studies

Hall, as one of the most famous authors of reduced-form model, has developed two similar but slightly different methods for testing competitiveness of a market (Hyde and Perloff, 1995). Both of the approaches are based on so called Solow residual θ which is an index of Hicks-neutral technical progress, which means that technical progress is not neither labor nor capital saving. In instrumental variable approach Hall argues that assuming constant returns to scale on the market, market power can be tested using instrumental variables according to whether it is correlated with Solow residual or not. If correlation is close to zero then null hypotheses can't be rejected, meaning that the market can be characterized as competitive otherwise in case of positive correlation null hypotheses is rejected and the alternative one of market power existence is accepted.

Nevertheless, the weakness of the approach is it does not provide properties for estimation the degree of the market power; accordingly Hall developed the other estimation approach which covers the estimation part as well. In this case the price and marginal cost ratio is estimated, consequently defining the degree of market power. However, in order to get nonbiased outcomes, additional information such as demand elasticity is necessary. Holding standard nonparametric approach assumptions in both methods, Hall has shown that by introducing instrumental variable in estimation and testing the correlation with Solow residual it can be examined whether the market is competitive or not.

Hall's methods give possibility to be applied on both input and output markets. Accordingly in case of testing input market for oligopsony power, a ratio of marginal product of a factor to marginal factor cost can be used as a good indicator of exercising market power (Perloff, 2007: 59). Of course the assumptions related to the Hall's approach have to hold as well. Hall (1986) undertook market structure analysis of various U.S. industries. Main focus was on identifying differences between price and marginal cost. According to his findings most of the industries analyzed were noncompetitive; however no results have been provided regarding the degree of the market power. Shapiro (1987) enhanced Hall's (1986) study and estimated the degree of market power in the same industries as well. He did so by incorporating demand elasticities in the analysis. He argued that the ratio of elasticity of demand and markup can be used for measuring market power. He suggested that the ratio should range between zero and one indicating competition and monopoly respectively.

Crépon (2005) extended Hall's (1986) approach and applied factor productivity approach to estimate the degree of competition. For that he analyzed firm-level balanced panel data using 1026 French manufacturing industries. The focus of the study was bargaining power between employers and its workers. By estimating parameter θ in the model, he assessed the degree of imperfect competition on the market. He concluded that firms' true markup was undervalued in consequence of not taking into account labor market imperfections.

Martins (1996) estimated mark-up ratios in 36 manufacturing industries of 14 OECD countries. As a methodology combination of Hall and Roeger approaches have been applied. According to the finding mark-ups vary depending on industries and countries. Departures from perfect competition have been identified in manufacturing industries. Similar studies were conducted by Boulhol (2008) covering 13 OECD countries analyzing two digit industries for the time period 1970-2000.

In his later paper Hall (1988) analyzed seven industry groups and 26 industries in the US. These findings correspond to the results of the studies summarized in Table 1.

Table 1. Overview of selected results from empirical studies using Hall's method

Author(s) (year)	Country	DA[a]	DF[b]	TP[c]	Industry/Market	Method[d]	Estimated Parameter β	Conducted Parameter, θ
Hall (1988)	USA	N	A	1953-84	7 one-digit and 26 two-digit industry groups:	2SLS		
					Food products		0.189	5.291
					Tobacco manufactures		0.362	2.766
					Textile mill products		0.388	2.578
					Lumber and wood products		0.555	1.801
					Petroleum and coal products		-0.007	-139.478
					Leather and leather products		0.476	2.100
					Whole trade		-0.271	-3.688
					Retail trade		0.425	2.355
Boyle (2004)	Ireland	N	A	1991-1999	Food	OLS	0.60	-
					Textiles		1.00	-
					Wearing Apparel		1.50	-
					Wood & Wood Prods.		0.20	-
					Pulp & Paper		0.50	-
					Printing & Rec. Media		-0.10	-
					Chemicals		1.60	-
					Rubber & Plastic		0.15	-
					Other Non-Metallic		0.60	-
					Fabricated Metals		0.10	-
					Machinery & Equipment		0.30	-
					Electrical Machinery		0.30	-
					Radio, TV & Comm. Equip.		0.60	-
					Med., Prec. & Opt. Instrum.		-0.30	-
					Motor Vehicles		-0.04	-
					Other Trans. Equip.		-1.20	-
					Furniture		1.50	-

(Continued)

Author(s) (year)	Country	DA[a]	DF[b]	TP[c]	Industry/Market	Method[d]	Estimated Parameter β	Conducted Parameter, θ
Levinsohn (1993)	Turkey	P	A	1983-1986	Manufacture of paper and paper products	OLS	2.17	-
					Manufacture of industrial chemicals		1.05	-
					Manufacture of other chemical products		1.25	-
					Manufacture of pottery, china, earthenware		1.06	-
					Non-ferrous metal basic industries		0.455	-
					Manufacture of metal products except		1.27	-
					Manufacture of machinery except el.		0.427	-
					Manufacture of electrical machinery		1.14	-
					Manufacture of transport equipment		1.35	-
					Manufacture of scientific equipment, etc.		1.15	-
Crespi *et al*. (2005)	USA	N	A	1978/79-2000/01	Rice milling	2SLS	1.893	0.27
Crépon (2005)	France	F	A	1986-92	1026 manufacturing firms	GMM	1.5	0.6

Notes: [a] DA = level of Data Aggregation: F = Firm, N = National, P = Plant, R = Regional, W = World; [b] DF = Data Frequency: A = Annual, Q = Quarterly, M = Monthly and D = Daily; [c] TP = Time Period;
[d] Method: BE = Bayesian Estimation, FGNLS = Feasible Generalized Nonlinear Least-Squares, FIML = Full Information Maximum Likelihood, GMM = Generalized Method of Moments, I3SLS = Iterative Three-Stage Least Squares, ILS = Iterative Least Squares, 2SLS = Two-Stage Least Squares, N2SLS = Nonlinear Two-Stage Least Squares, N3SLS = Nonlinear Three-Stage Least Squares, SUR = Seemingly Unrelated Regression, NISUR = Nonlinear Iterative Seemingly Unrelated Regression, NIV = Nonlinear Instrumental Variables, TEM = Taylor Expansion Method;
n.a.= not available.
Sources: Articles cited.

In the study he introduced methodology with the assumption of constant returns to scale. The tested hypothesis combined both competition and constant returns to scale, by restricting covariance between Solow residual and instrumental variable to zero. According to findings monopsonistic behavior has been found in the labor market and noncompetitive structure in the product market.

Levinsohn (1993) analyzed Turkey's trade liberalization policy affects. In order to identify the consequences he examined the degree of competition using market structure analysis. Like Hall (1988), he employed one equation model to estimate price-marginal cost ratios in different industries. Balanced firm-level panel data (unlike Hall (1988) who used industry aggregated data) covered greater Istanbul area for the period 1983-1986. According to the study, prior to liberalization firms in two industries were able to set price above marginal cost, hence having noncompetitive behavior.

Norrbin (1993) re-estimated Hall findings using the same data, but with some extension. He incorporated intermediate inputs in the original model. According to his findings markups by Hall were overestimated. Accordingly small markups are insignificant and therefore the results are strongly deviating depending on the estimating technique applied.

Love and Shumway (1994) have developed nonparametric approach testing for monopsonistic market power. The model incorporated the Hicks-neutral technical change and allowed testing the ability of processors to exert the market power over agricultural producers. It assumes the possibility that processors are the price takers on nonagricultural inputs market but not on agricultural ones. Estimating index of monopsony market power allowed defining residual input supply curve that processors face and accordingly conclude whether the market power is exercised or not. Using simulated firm level data the authors have proved the robustness of the model.

Hyde and Perloff (1995) compared three different structural, Hall and Panzar-Rosse approaches with simulation method. Results suggested that Hall method has an advantage that it requires less data and does not require examining functional forms for supply and demand. However it is not stable in respect to assumptions and responsive to deviations from constant returns to scale. Furthermore Hall method does not provide estimates to describe degree of market power without additional information.

Eden (1993) introduced spot market analysis where he challenged Hall's (1988) marginal productivity assumption and argued that capacity, rather than output utilization, should be included in the analysis. He also questioned assumption regarding constant returns to scale and concluded that Hall's analysis is not robust.

Roeger (1995) derived alternative approach based on Hall (1988) method. The methodology proposed had an advantage that it does not require instrumental variable. He applied the model for the same dataset use by Hall (1988) in analysis and in line with his findings he also detected imperfect competition in US manufacturing industries. However estimated markups from his study were much lower compare to ones from Hall, which he suggests happened because of poor instrumental variable choice.

Boyle (2004) applied Hall-Roeger methodology to analyze Irish Manufacturing Industries. According to the author the main motivation of employing this particular approach was that it requires less data compared to other approaches and does not demand specifying functional forms. The panel data with 872 observations for the time period 1991-1999 have been used for analysis. The findings prove the existence of the market power in certain industries in production input pricing.

Hall's approach was used by Crespi et al. (2005) in testing US rice milling industry for oligopsony behavior. Assuming Hick's neutral technological change the model was derived to estimate market power in input purchasing without specifying functional forms of input supply equations. The analyses covered the period of crop years 1978/79-2000/01. The data used were: (1) National output quantities and prices aggregated and averaged respectively from state-level data. (2) Quantities and price of the rough rice paid to farmers – cost which account 85% of total input costs. (3) Labor, capital and energy expenditures as non-specialized input costs. The estimations were conducted using OLS and 2SLS. Hausman tests examined the consistency of the estimated coefficients. Estimated parameter, comprising conjectural and input supply elasticities, allowed concluding if processors exert market power while purchasing rice.

Halls approach was introduced to measure price-marginal cost ratio in US industries. The main advantage of methodology is that it needs less data and does not require to define functional forms. Nevertheless, the model is based on constant returns to scale and perfect competition assumption for which it has been heavily criticized. However, as it is summarized on Table , various scholars have successfully applied model for analysis and estimated market power in different industries across many countries.

3 Theoretical and empirical model specification

For measuring of oligopsony power Hall’s approach has been applied to test for market competitiveness for processors on input level. Hall’s approach gives possibility to undertake market power analysis with relatively few data based on the assumption of constant returns to scale (Hall, 1988).

Production function of the i-th grain processor using J inputs can be defined in the following way:

$$q_{it} = \phi_{it} f_{it}(x_{i1t}, \dots, x_{iJt}), \tag{1}$$

where q_{it} is the quantity produced by processor i using x quantity of J inputs at time period t, ϕ_{it} which captures Hick's neutral technical progress factor of i processor at time t and based on Hall (1988) approach it follows random walk:

$$\phi_{it} = \phi_{it-1} + \varepsilon_{it};\ \varepsilon_{it} \sim N(0, \sigma_i^2\ ), \tag{2}$$

ε_{it} representing productivity shock.

Using Taylor expansion (1) Crespi et al. (2005) rearranges the equation (1) in the following way:

$$\Delta q_{it} = \phi_{it}\left[\sum_{j=1}^{\mathrm{J}} \frac{\Delta f_{it}}{\Delta x_{\mathrm{ijt}}} \Delta x_{\mathrm{ijt}}\right] + f_{it}\Delta\phi_{it} \tag{3}$$

where the error terms, capturing the productivity shocks, have been integrated within the difference equation.

Using the production function (1), the firm's profit maximization problem facing grain processor can be expressed as follows:

$$\max_{x_{i1t},\dots,x_{iJt}} \pi_{it} = p_t q_{it} - \sum_{j=1}^{J} w_{ijt}\left(X_{jt}\left(x_{jt}\right)\right) x_{ijt} \tag{4}$$

where X_{jt} represents aggregated market supply of J input and deriving the first-order conditions will lead to:

$$p_t\phi_{it}\frac{\Delta f_{it}}{\Delta x_{ijt}} = w_{ijt} + \frac{\Delta w_{ijt}}{\Delta \mathrm{X}_{jt}} \cdot \frac{\Delta X_{jt}}{\Delta x_{ijt}} x_{ijt}, j = 1, \dots, J \tag{5}$$

In order to introduce conjectural elasticity as a measure of market power Crespi et al. (2005) rearranges equation (5) in the following way:

$$p_t\phi_{it}\frac{\Delta f_{it}}{\Delta x_{ijt}} = w_{ijt}\left[1 + \frac{\theta_{ijt}}{v_{ij}}\right], \tag{6}$$

where θ_{ijt} denotes the conjectural elasticity of processor i and $v_{ijt} = \frac{\Delta \mathrm{x}_{jt}}{\Delta \mathrm{w}_{ijt}} \cdot \frac{\mathrm{x}_{jt}}{\mathrm{w}_{ijt}}$ is the market input-supply price elasticity of processor i while buying j input at time period t. If θ_{ijt} equals to 0 it means that marginal product of the factor equals to marginal costs thus conditions for perfect competition hold, otherwise if θ_{ijt} equals to 1 the market is monopsonistic (Love, 1994).

Dividing both sides of equation (6) by p_t, multiplying by Δx_{ijt} and respectively summing up, the profit maximization problem can be expressed as follows:

$$\phi_{it}\left[\sum_{j=1}^{J}\frac{\Delta f_{it}}{\Delta x_{ijt}} \cdot \Delta x_{ijt}\right] = \sum_{j=1}^{J}\frac{w_{ijt}}{p_t}\left[1+\frac{\theta_{ijt}}{v_{ij}}\right] \cdot \Delta x_{ijt} \qquad (7)$$

Crespi et al. (2005) pointed out the processor and period-specific technological shocks (ϕ_{it}) affect the relationship described in equation (7). Using Monto Carlo simulations Examining Hall's method in estimating market power based on Monto Carlo simulations Hyde and Perloff (1994, 1995) drew two conclusions from their findings that are very important for market power analysis, especially in countries with transition economies. First, the market power estimates are underestimated with increasing return to scale. Second, by decreasing returns to scale the market power estimates are overestimated.

Estimation model is based on equation developed by Crespi et al. (2005) after integrating equations (2) and (7) in (3) using production function for estimations:

$$\Delta q_{it} = \sum_{j=1}^{J} \beta_{ij} \frac{w_{ijt}}{p_{it}} \Delta x_{ijt} + f_{it}\,\varepsilon_{it}, i = 1, \dots, I, \qquad (8)$$

where q_{it} is the output quantity produced by grain processors i, p_{it}output price of grain processors i, w_{ijt} price paid by grain processors i to purchase J agricultural inputs, x_{ijt} quantity of J agricultural inputs purchased by processors i, ε_t unexpected productivity shocks; β_{ij} is the estimation parameter defined as:

$$\beta_{ij} = 1 + \frac{\theta_{ijt}}{v_{ij}}, \tag{9}$$

where θ_{ijt} is conjectural elasticity of grain processor i and v_{ij} is the market input-supply elasticity facing firm i with respect to input j at time t. The hypothesis $\mathrm{H}_0: \widehat{\beta_{ij}} = 1$ assumes competitive purchase of the grain processors, while rejection indicates noncompetitive behavior.

Three main variables of Labor, Capital and grain inputs have been incorporated in the model. Accordingly following parameters have been estimated: parameter for Labor reported as "β^L" is defined as $(pLr/pQr) * dL$ where pLr is deflated real price index of the labor, pQr real price of aggregated output and dL change in labor. In the similar way the capital parameter "β^C" is estimated as $(pCr/pQr) * dCr$, where pCr is the real price index of capital and dCr change in capital. As for β^M parameter, $\beta^M = (pMr/pQr) * dM$, where pMr is the real price and dM change in the agricultural inputs accordingly. Parameter β^M is an indicator of the market power and is more than 1 in case if it holds. Estimations for every sample have been conducted and reported with and without constant.

4 Description of model data

The data used for analysis have been obtained from the website of Statistical Agency of Kazakhstan. Dataset combines data provided in statistical yearbooks, such as "Industry of Kazakhstan and its regions", "Agriculture, forestry and fishery in the Republic of Kazakhstan", "Prices in agriculture, forestry and fishery in the Republic of Kazakhstan", "Regions of Kazakhstan". Nevertheless, since the compilations do not provide the full set of data necessary for analysis particularly on regional level, the missing data have been supplemented by other sources such as Information and Computing Center of the Agency of the Republic of Kazakhstan on Statistics.

Regional level data have been chosen for the analysis. The data contains observations from 14 regions: Akmola, North Kazakhstan, Atyrau, Aktobe, East Kazakhstan, Karaganda, Mangystau, South Kazakhstan, Kostanay, Almaty region, Pavlodar, West Kazakhstan, Jambyl, Kyzylorda and two cities Almaty and Astana. Since grain production and processing industries are not significantly represented in these cities the observations have been integrated them in Almaty and Akmola regions respectively.

Our empirical analysis is based on a balanced regional panel data set of output and input variable of processors for the time period from 2000 to 2011. In the dataset the observations have been combined from grain processors for fodder and flour production ("Manufacture of grain mill products, starches and starch products" NACE 10.6 and "Manufacture of prepared animal feeds" NACE 10.9), since in many case grain processors produce both of the products. Therefore the quantities and prices for input/outputs are given in aggregated form for both of the sectors. In details for grain processors output quantities (Q) used in analysis combine following products: 1. Flour products – "Cereal and vegetable flour, mix of fine grindings"; 2. Groats – "Groats, wholemeal flour and pellets and other cereal products; 3. Fodder – "Ready feed for farm animals, except flour and lucerne pellets"; 4. Rice-peeled; 5. Rice-semi or fully milled.

The aggregated output values (OV) of all products produced by grain processors have been provided by the Committee on Statistics of Ministry of National Economy of the Republic of Kazakhstan (CSMNERK (j)). Even though variable is not included in the model for analysis it was used to estimate average aggregate grain prices. Accordingly average price for aggregated grain processor outputs (pQ) have been estimated based on simple division of aggregated output value over output quantity (Q). Table 2 show the descriptive statistics for the model variables of the panel datasets covered the time period 2000-2011.

Table 2. Variables used in the model

Variable	Definition	Unit	Min	Max	Mean	Source
Q	Aggregated output quantities of grain	Ton	493	1025995	230910.5	CSMNERK (b, 2012: 82-86; 2008: 95-96; 2006: 99; 2002: 76)
pQ	Price of output	Tenge/kg	3.7	81.3	22.5	Constructed based on OV and Q data
M	Grain input quantities	Ton	701.0	1202969	301280.1	Constructed based on CSMNERK (j)
pM	Wheat producer price	Tenge/Ton	4053.7	35955	15678.7	CSMNERK (d, 2012: 130; 2011: 84; 2006: 108)
L	Labor employed	Thousand employees	16.2	2299	831.3	ICCCSMNERK
pL	Labor wage	Tenge	2758.6	57347.7	15462.2	ICCCSMNERK
C	Capital depreciation	Thousand Tenge	1781.0	1495909	218409.4	ICCCSMNERK
pC	Capital price index	%	100.0	205.1	134.2	CSMNERK (i, 2013: 214)
CPI	Consumer price index	%	100.0	264.9	157.1	CSMNERK (g, 2013: 203)
NuE	Number of enterprises		1	98	25.6	ICCCSMNERK

Source: Own illustration based on the panel data from the CSMNERK and the ICCCSMNERK, respectively

As to the grain input quantities for processors (M), the data have been estimated in the following way: as a first step the ratio of "Grain processing products" and "Grain used for processing purposes" balanced data have been calculated on national level provided by the Agency of Kazakhstan of Statistics. Afterwards, the aggregated grain input quantities for processors on the regional level has been estimated by multiplying the output quantity data by the ratio (since the output quantity data is available on regional level). As for the price of grain inputs (pM)

wheat prices have been taken since the wheat is the most produced and processed grain in Kazakhstan[3]. The input data contains observations of eight different types of grains produced in Kazakhstan: wheat, rye, maize, oat, barley, buckwheat, rice and millet.

Regarding nonagricultural inputs three main elements have been used for analysis Electricity, Capital and Labor. It should be admitted that it was possible to acquire only part of the electricity variable data necessary for analysis. The other part of the data was either incomplete or not reliable. Therefore since electricity costs represent only 3% in the total cost structure[4] it was excluded from analysis to avoid bias in estimations. As for Capital variable (pC) "Price index in construction" have been used - all elements of the technological structure" from annual yearbooks "Regions of Kazakhstan" as price index data of capital for processors. Depreciation data have been employed for capital quantity variable (C). The data for labor covers the number of employees (L) and average monthly salary of employees (pL) in grain processing industry. Variable for number of enterprises (NuE) combines records of registered active enterprises in flour and fodder production sectors. The capital quantity and labor, as well as number of enterprises data have been obtained from the Information and Computing Center of the Agency of the Republic of Kazakhstan on Statistics.

Consumer Price Index (CPI) data have been obtained from Statistical Agency of Kazakhstan and used for deflation of all price observations provided in dataset. Data from 2000 have been taken as the base year and deflated all the price data

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[3] Wheat price are given as "at the end of the year", since it was the only available data in statistical journals on regional level.

[4] Empirical findings based on correspondence with Kazakh grain experts

from consequent period to the base year to exclude inflation factor in price development.

It should be admitted that the data obtained from abovementioned sources were incomplete and missing values have been observed for certain regions, namely Atyrau and Mangystau. Therefore econometrical tools have been used for filling missing values. Particularly, linearly interpolate and extrapolate technics have been employed in Stata to solve the problem.

Since the wheat export ban has occurred in 2008 it was credible to analyze that time period separately in order to capture the ban effects on the grain market structure. Therefore, the periodical samples have been introduced. The total dataset has been disintegrated into three period subsamples and ultimately four different samples have been employed for analyses: (1) Sample "I" – time period 2000-2011, (2) Sample "I.A" – time period 2000-2003, (3) Sample "I.B" – time period 2004-2007, (4) Sample "I.C" – time period 2008-2011.

The total dataset sample "I" covered the time period 2000-2011 and comprehended 168 observations. Accordingly each of the subsamples comprised 42 observations and have been analyzed separately. Samples "I.A" and "I.B" accounts to the time period 2000-2003 and 2004-2007 respectively, when the grain sector started to recover and was growing annually. Consequently, sample "I.C" covers the time period 2008-2011, when the government restrictions has been introduced.

In a similar manner the total dataset has been analyzed according to the geographical areas, since the regions are characterized by heterogeneity in the grain sector development. Due to four different geographical areas, four different sub-samples has been defined: (1) Sub-sample "North", (2) Sub-sample "East", Sub-sample "South", and (4) Sub-sample "West". Each of the geographical samples aggregated the data from certain regions. Sample "North" comprised Akmola, Kostanay, North Kazakhstan and Pavlodar regions. Sample "East" covered Almaty, East Kazakhstan, and Karaganda regions. Sample "South" aggregated the data from Jambyl, Kyzylorda and South Kazakhstan and sample "West" Aktobe, Atyrau, West Kazakhstan and Mangystau regions. Since "North" and "West" geographical areas incorporated 4 regions each and aggregated 48 observation each. Accordingly "South" and "East" covered 3 regions each and combines 36 observations each.

5 Estimation results

In this subchapter the estimation results obtained from tests using Hall's approach are discussed. The analyses are undertaken using Stata 14.1 program and estimations presented according to the samples discussed in the data section. The main focus is on β and conducted θ parameters indicating the existence and the degree of the market power accordingly.

To estimate the degree of the market power the grain supply elasticity was needed and accordingly wheat supply elasticity parameter for processors has been applied since wheat and wheat flour products comprise the biggest share in grain processing industry. Wheat own price elasticity estimate of 0.2395 has been estimated after analyzing supply function of grain processors. Therefore detecting the degree of market power was possible using conducted parameter θ = 0.2395*(β^{M}-1).

The estimations are based on equation (8). An ordinary least squares (OLS) method was used to test for a market power parameter. However, to eliminate endogeneity problem in the model 2SLS was introduced as well. As an instrumental variable "The number of active enterprises in milling sector" has been applied in 2SLS. The variable denotes the aggregated registers for the active enterprises in two NACE 10.6 and NACE 10.9 sectors. Estimations for heteroscedasticity and autocorrelation were tested based on White and Wooldridge tests respectively. Hausman test was employed to analyze the consistency of the estimated parameters.

Results are presented in three parameters for following inputs: β^M for grain, β^L for labor and β^C for capital factor variables. The model has been estimated with and without constant to exclude the constant factor in the model; it should be admitted that in most of the cases where the constant factor was significant, exclusion did not provide significantly different results. Results also combine estimations for conducted parameter θ which identifies the degree of market power.

Table depicts the estimates for the sample of total time period 2000-2011.

Table 3. Estimation results for the sample "I" – time period 2000-2011

Coefficient	OLS	2SLS	OLS	2SLS
β^M	0.400***	0.381***	0.425***	0.375***
	[6.31]	[9.27]	[6.40]	[9.02]
β^L	0.019	0.015	0.008	0.013
	[0.84]	[0.72]	[0.38]	[0.67]
β^C	0.006	0.006	0.006	0.005
	[1.06]	[1.52]	[1.07]	[1.50]
Constant	11158.298***	2493.444		
	[3.31]	[0.59]		
θ	-0.143	-0.148	-0.137	-0.149
	[-9.49]	[-15.08]	[-8.65]	[-15.06]
Observations	154	154	154	154
R-squared	0.40	0.45	0.41	
Adjusted R-squared	0.39	0.43	0.40	
Wooldridge test	0.83	0.83	0.83	0.83
	(0.38)	(0.38)	(0.38)	(0.38)
White test (Prob > chi2)	(31.89) 0.0002		(31.75) 0.0002	

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

Source: Own estimation based on the panel data from the CSMNERK and the ICCCSMNERK, respectively.

Sample comprised 154 observations. As it can be detected β parameter for agricultural inputs fluctuates around 0.400 with at 1% significant level, which mean that there is no evidence of noncompetitive behavior on the market. Taking into account formula (13) the estimation results of the conducted parameter θ are negative since β parameter is less than one. Similar problem have been detected in study of Hall (1988) and low parameter estimates have been interpreted as indicator of increased returns to scale. Hyde and Perloff (1995) also concluded that the results obtained by Hall's method are very sensitive to deviations from constant returns to scale. In the case of decreasing returns to scale test results reveals overestimates of the price markup, in the case of increasing returns to scale they obtained underestimates and works well by the industry with constant returns to scale. Consequently following Hyde and Perloff (1995) low estimates for the period samples till 2008 can be related to increased returns to scale, since Kazakh agriculture sector including milling sector went through wave of investments in grain processing sector after 2000. According to the UNECE (2014: 186) report growth of the mill plants capacity during the period 1998-2009 facilitated to increased flour production and raise in flour exports by 9 times. Therefore investing in new machinery and growth in flour production and export could result in increased return to scales in flour production sector.

Similar estimates have been received in case of other periodical samples. Just like in case of total sample the β^{M} estimates for 2000-2003 and 2004-2007 range between 0.335 and 0.382 (for detailed results see Tables A1 and Table A2 in the Appendix) and are statistically significant. From results analyzed for the period samples 2000-2003, 2004-2007 and 2000-2011 it can be concluded that there is no evidence that processors exert market power when purchasing grain. Furthermore conducted parameter is negative which theoretically means that input suppliers were getting higher price than it would hold in case of perfect competition. The results can be partly explained with the fact that after 90's crisis period for Kazakh grain sector government started to interfere on the market (Pomfret, 2007). Introducing heavy subsides government distorted the market in favor of grain producers. Grain producers expanded their production but they benefited from getting higher price in form of subsidies. Therefore market distortions can be reflected in parameters estimated for the time periods.

Similar results have been obtained from samples of geographical areas. None of the parameters indicate existence of market power. The parameters are either too low and/or statistically insignificant. The estimations of the geographical area samples area summarized in appendix Table A3-Table A6). Nevertheless, different scenario has been received for the periodical sample 2008-2011. In this sample the parameter β^M estimates range from 1.234 to 1.296 at 1% significance level. Consequently estimated conducted parameter varies between 0.06 and 0.07. Even though θ parameter is closer to 0 rather than to 1 still noncompetitive behavior by grain processors can be advocated.

Looking at the processes occurring at that time period, particularly export ban of grain in 2008, the results for time period 2008-2011 can be explained (see Table 3). After government intervention in 2008, most of the grain produced in the country could only be sold on the local market since export was not banned and traders would not be able to operate on foreign markets. On the other hand grain processors had opportunity to use the situation in their favor. It’s expected that increased grain supply on the Kazakh grain market would push the price down. But interestingly that was not the case and furthermore wheat price increase has been observed on the market (Oskenbayev 2014).

Along with grain prices wheat flour and bread product prices have been increasing for the same time period as well. As it can be seen from the price development graph on figure 2 price increase on flour and bread products was much higher than wheat price shift. Furthermore the bakery industry maintained increased prices in the following periods, despite the fact that flour and wheat prices decrease substantially during 2008-2011. Accordingly even estimated θ parameter is relatively small it can still concluded that grain processors exerted oligopsony market power while purchasing grain for the time period analyzed.

To sum up the results suggest that grain processors have no market power for overall analyzed period 2000-2011. The only significant parameters indicating market power was found for the period 2008-2011, which can be explained as a consequence of the government intervention on grain market. Export ban facilitated to higher increase in flour product prices compared to the local wheat prices. Therefore the processors have benefited from increased profit margin for the period (see Table 4).

Table 4. Estimation results for the sample "I.C" – time period 2008-2011

Coefficient	OLS	2SLS	OLS	2SLS
β^M	1.276*** [6.88]	1.234*** [11.89]	1.296*** [6.88]	1.241*** [12.03]
β^L	0.013 [0.49]	0.010 [0.34]	0.011 [0.45]	0.011 [0.39]
β^C	0.011 [1.03]	0.009 [1.49]	0.011 [1.03]	0.009 [1.55]
Constant	6848.553* [1.86]	-4547.414 [-0.88]		
θ	0.066 [1.49]	0.056 [2.26]	0.071 [1.57]	0.058 [2.34]
Observations	42	42	42	42
R-squared	0.83	0.85	0.82	
Adjusted R-squared	0.81	0.83	0.81	
Wooldridge test	4.36 (0.06)	4.36 (0.06)	4.36 (0.06)	4.36 (0.06)
White test (Prob > chi2)	(25.23) 0.0027		(25.64) 0.0023	

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

Source: Own estimation based on the panel data from the CSMNERK and the ICCCSMNERK, respectively.

The findings of these studies are similar to the results obtained by Hall (1988), Levinsohn (1993), Boyle (2004), Crespi *et al.* (2005), and Crépon (2005). The authors found that estimates of β for the models range from -1.2 to 2.17 and are statistically, significantly different from zero. These indicate that the prices paid for inputs by the processing industry were lower than what would be found under competitive conditions.

6 Conclusions

Hall's (1988) approach has been to test for market power Kazakh grain processing industry based on regional level panel data covered the time period from 2000 to 2011. The panel dataset have been applied for the analysis for total time period and thorough analysis three data subsamples covered time different time periods, 2000-2004, 2004-2007 and 2008-2011.

According to the estimation results from Hall's approach no oligopsony market power have been detected for the time period 2000-2011. The low estimate of the market power parameter indicates that the grain processors are not able to influence the price on the grain supply market, hence there is no oligopsony power. However, analyzing subsamples it has been concluded that during 2008-2011 time period the degree of market parameter has been increased. Thus, the parameter might be reflecting the ban effect in 2008, when the grain producers were allowed to sell grain only on the local market and principally to the processors, since the export of the wheat flour was still allowed.

The results suggest that grain processing sector is not characterized by noncompetitive behavior. In most of the cases analyzed no significant market power parameter was detected except for the time period 2008-2011. For the period analysis revealed statistically significant results for uncompetitive behavior. The findings can be explained by government intervention in 2008, which might have caused distortion on the grain market. Based on the observation of price development on wheat, wheat flour and bread, it can be concluded that the price change was the smallest for wheat compared to price change on flour and bread markets. It leads to conclusion that processors have used the opportunity and influenced price on input level. Hence, exerting oligopsonistic market power on grain suppliers' level.

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Appendix

Table A 1. Estimations for sample "I.A" – time period 2000-2003

Coefficient	OLS	2SLS	OLS	2SLS
β^M	0.362*** [4.34]	0.352*** [6.36]	0.382*** [4.58]	0.342*** [6.31]
β^L	-0.014 [-0.61]	-0.022 [-1.17]	-0.018 [-0.70]	-0.017 [-0.91]
β^C	0.005** [2.65]	-0.003 [-0.63]	0.006** [2.63]	-0.001 [-0.12]
Constant	5375.927 [1.17]	-9315.388 [-1.53]		
θ	-0.15 [-7.66]	-0.16 [-11.7]	-0.15 [-7.4]	-0.16 [-12.16]
Observations	42	42	42	42
R-squared	0.50	0.53	0.55	
Adjusted R-squared	0.46	0.48	0.51	
Wooldridge test	9.06 (0.01)	9.06 (0.01)	9.06 (0.01)	9.06 (0.01)
White test (Prob > chi2)	(7.9) 0.54		(8.4) 0.49	

Notes: The values in parentheses are asymptotic standard errors. The superscripts ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.
Source: Own estimation based on the panel data from the CSMNERK and the ICCCSMNERK, respectively.

Table A 2. Estimations for sample “I.B” – time period 2004-2007

Coefficient	OLS	2SLS	OLS	2SLS
β^M	0.335*** [3.60]	0.361*** [6.35]	0.338** [2.55]	0.366*** [6.55]
β^L	0.174** [2.21]	0.139*** [2.72]	0.097 [1.26]	0.127*** [2.66]
β^C	-0.006 [-0.59]	-0.006 [-0.89]	0.001 [0.09]	-0.005 [-0.83]
Constant	29235.758*** [3.49]	6381.444 [0.68]		
θ	-0.15 [-7.14]	-0.15 [-11.24]	-0.15 [-5.01]	-0.15 [-11.36]
Observations	42	42	42	42
R-squared	0.44	0.63	0.32	
Adjusted R-squared	0.39	0.58	0.26	
Wooldridge test	2.33 (0.15)	2.33 (0.15)	2.33 (0.15)	2.33 (0.15)
White test (Prob > chi2)	(23.4) 0.0054		(24) 0.0043	

Note: For notes and sources, see table A 1 in the Appendix.

Table A 3. Estimations for sub-sample "North"

Coefficient	OLS	2SLS	OLS	2SLS
β^M	0.345*** [3.67]	0.325 *** [4.11]	0.366*** [3.64]	0.321*** [4.05]
β^L	-0.001 [-0.02]	-0.003 [-0.07]	-0.012 [-0.40]	-0.003 [-0.09]
β^C	0.016 [1.12]	0.015 [1.55]	0.017 [1.08]	0.015 [1.53]
Constant	16347.692* [1.80]	3018.155 [0.23]		
θ	-0.16 [-6.97]	-0.16 [-8.53]	-0.15 [-6.3]	-0.16 [-8.56]
Observations	44	44	44	44
R-squared	0.37	0.41	0.38	
Adjusted R-squared	0.32	0.35	0.33	
Wooldridge test	2.75 (0.20)	2.75 (0.20)	2.75 (0.20)	2.75 (0.20)
White test (Prob > chi2)	(14.98) 0.09		(14.98) 0.09	

Note: For notes and sources, see table A 1 in the Appendix.

Table A 4. Estimations for sub-sample "East"

Coefficient	OLS	2SLS	OLS	2SLS
β^M	0.402*** [4.27]	0.397*** [4.86]	0.448*** [4.41]	0.422*** [5.14]
β^L	0.068 [1.20]	0.071 [1.32]	0.046 [0.73]	0.057 [1.05]
β^C	0.001 [0.20]	0.001 [0.16]	0.001 [0.16]	0.001 [0.26]
Constant	15197.223* [2.03]	20591.784 [1.55]		
θ	-0.14 [-6.34]	-0.14 [-7.38]	-0.13 [-5.43]	-0.14 [-7.03]
Observations	33	33	33	33
R-squared	0.44	0.44	0.46	
Adjusted R-squared	0.39	0.36	0.40	
Wooldridge test	6.50 (0.126)	6.50 (0.126)	6.50 (0.126)	6.50 (0.126)
White test (Prob > chi2)	(7.76) 0.559		(16.52) 0.057	

Note: For notes and sources, see table A 1 in the Appendix.

Table A 5. Estimations for sub-sample "South"

Coefficient	OLS	2SLS	OLS	2SLS
β^M	0.458*** [3.18]	0.443*** [4.83]	0.517*** [3.09]	0.436*** [4.69]
β^L	0.099* [1.78]	0.066 [0.97]	0.057 [1.08]	0.051 [0.79]
β^C	0.011 [0.95]	0.01 [0.84]	0.013 [0.86]	0.009 [0.80]
Constant	12576.444* [1.96]	3756.688 [0.60]		
θ	-0.13 [-3.77]	-0.13 [-6.07]	-0.12 [-2.89]	-0.13 [-6.07]
Observations	33	33	33	33
R-squared	0.57	0.65	0.58	
Adjusted R-squared	0.53	0.60	0.54	
Wooldridge test	31.72 (0.03)	31.72 (0.03)	31.72 (0.03)	31.72 (0.03)
White test (Prob > chi2)	(7.53) 0.58		(9.99) 0.35	

Note: For notes and sources, see table A 1 in the Appendix.

Table A 6. Estimations for sub-sample "West"

Coefficient	OLS	2SLS	OLS	2SLS
β^M	0.310*** [6.14]	0.305*** [4.30]	0.326*** [5.15]	0.284*** [4.01]
β^L	0.023** [2.54]	0.022* [1.72]	0.021** [2.23]	0.015 [1.31]
β^C	0.006** [2.06]	0.005** [1.98]	0.006** [1.92]	0.005** [1.82]
Constant	2369.468** [2.21]	1975.225 [1.14]		
θ	-0.17 [-13.67]	-0.17 [-9.82]	-0.16 [-10.67]	-0.17 [-10.11]
Observations	44	44	44	44
R-squared	0.36	0.38	0.36	
Adjusted R-squared	0.32	0.32	0.31	
Wooldridge test	61.60 (0.004)	61.60 (0.004)	61.60 (0.004)	61.60 (0.004)
White test (Prob > chi2)	(0.86) 1.00		(0.63) 1.00	

Note: For notes and sources, see table A 1 in the Appendix.