DISCUSSION PAPER

Leibniz Institute of Agricultural Development in Transition Economies

Determinants of productivity and efficiency of wheat production in Kazakhstan: A Stochastic Frontier Approach

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DISCUSSION PAPER NO. 160

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ISSN 1438-2172

ABSTRACT

Agriculture plays an important role for Kazakhstan not only because of rural employment, but also because of the diversity it brings to its oil dependent economy. A considerable increase in grain exports was achieved during the recent years, however, there still is a large room for in-creasing productivity and efficiency to boost the agricultural potential of the country further. The government of Kazakhstan has introduced several policy packages in the past to boost productivity and efficiency, however, the impact of these reforms has not been yet analyzed quantitatively.

Micro level data collected from 200 farms in northern Kazakhstan in 2015 is used in the analysis, in order to fill this research gap. A mixture of evidences is found in terms of policy effect on productivity and efficiency. The results of the analysis showed that direct subsidy access reduced the efficiency, while access to supply chain infrastructure had the opposite effect and increased the efficiency. Therefore, the study concludes that the government should divert its policy support from direct subsidy payments to the improvement of agricultural infrastructure. This will influence positively not only productivity and efficiency, but also Kazakhstan's commitments towards international and regional trade agreements.

JEL: Q12, Q14, Q18, Q58, P13

Keywords: Productivity, stochastic frontier approach, wheat production, technical efficiency.

ZUSAMMENFASSUNG

DETERMINANTEN VON PRODUKTIVITÄT UND EFFIZIENZ DER WEIZENPRODUKTION IN KASACHSTAN:

EIN STOCHASTIC-FRONTIER-ANSATZ

In Kasachstan spielt die Landwirtschaft nicht nur als Arbeitgeber im ländlichen Raum eine wichtige Rolle, sondern diese trägt auch zur Diversifizierung der stark von Ölexporten abhängigen Ökonomie bei. Gerade die Getreideexporte haben in den letzten Jahren einen starken Anstieg verzeichnet. Jedoch gibt es noch Möglichkeiten das landwirtschaftliche Potenzial des Landes weiter auszuschöpfen. Die Regierung Kasachstans hat in den letzten Jahren mit einem ganzen Bündel an politischen Maßnahmen versucht, landwirtschaftliche Produktivität und Effizienz zu steigern. Die Wirksamkeit dieser Maßnahmen ist bisher noch nicht quantitativ analysiert worden.

Um diese Forschungslücke zu schließen, wurden 200 landwirtschaftliche Betriebe in Nordkasachstan im Jahr 2015 befragt. Die quantitative Analyse der Daten zeigt, dass sich der direkte Zugang zu Subventionen negativ auf die Effizienz auswirkt, wohingegen der Zugang zu Lieferketteninfrastruktur sich effizienzsteigernd auswirkt. Daraus läßt sich als Politikempfehlung ableiten, dass die Regierung sich weniger auf direkte Subventionszahlungen, als vielmehr auf die Verbesserung der landwirtschaftlichen Infrastruktur konzentrieren sollte. Dies wird sich positiv nicht nur auf Produktivität und Effizienz, sondern auch auf die Verpflichtungen des Landes gegenüber internationalen und regionalen Handelsabkommen auswirken.

JEL: Q12, Q14, Q18, Q58, P13

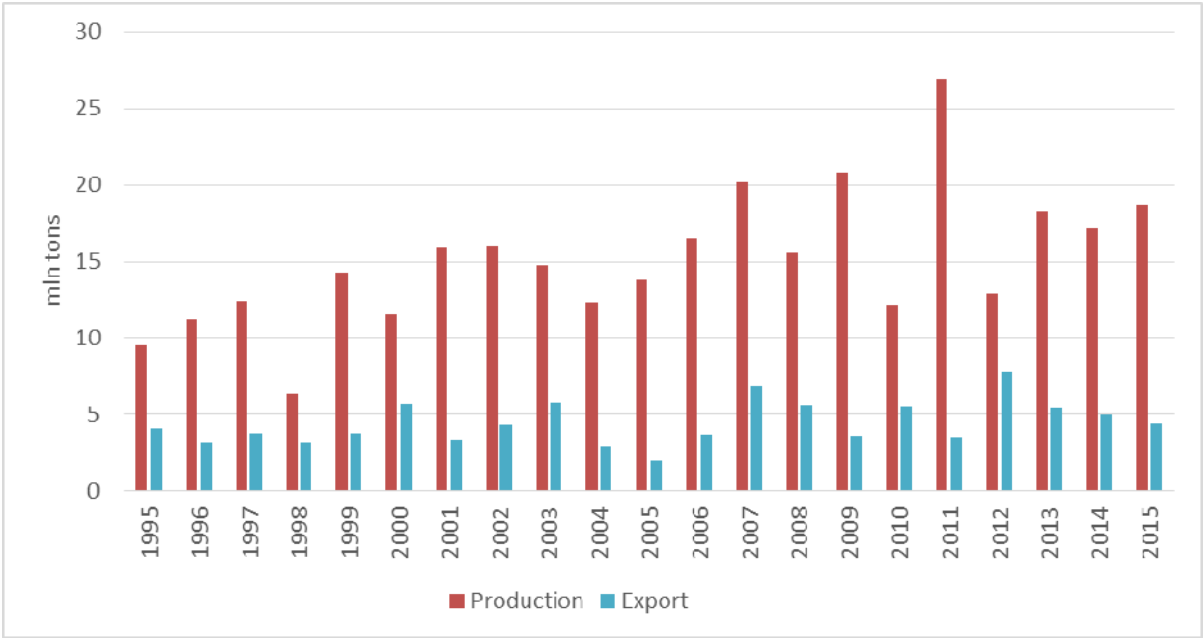
Schlüsselwörter: Produktivität, Stochastic-Frontier-Ansatz, Getreideproduktion, technische Effizienz.

1 INTRODUCTION

Central Asia consists of five former Soviet Union countries: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. The total population of Central Asia is around 68 million people, of which nearly 60 % live in rural areas (POPULATION OF CENTRAL ASIA, 2016). Of the 400 million hectares of land covered by these five Central Asian countries, only 20 % is suitable for farming, and the rest are deserts and mountains. Nevertheless, agricultural production from that limited area is extremely important for the region, it makes significant contribution to the economies of Central Asian countries. (BUCKNALL et. al., 2003). The five Central Asian countries are highly agrarian, with around 60 % of the total population living in rural areas. Moreover, agriculture accounts for over 45 % of total employment and nearly 25 % of GDP on average (DJALALOV and BABU, 2006).

In the case of Kazakhstan, agriculture plays an important role not only because of rural employment, but also because of the diversity it brings to its oil dependent economy. As it can be seen from Figure 1, the production of grain has increased during the last 20 years.

Figure 1: Production and export of grain in Kazakhstan between 1995-2015 years



Source: COMMITTEE OF STATISTICS OF THE MINISTRY OF NATIONAL ECONOMY OF THE REPUBLIC OF KAZAKHSTAN, 2015.

Thus, Kazakhstan became one of the most important producers and exporters of high-quality wheat in the global market. (LIEFERT et al., 2010; LYDDON, 2013). The annual production of wheat in Kazakhstan amounts to nearly 13 million tons. Most of the wheat, around 75 percent, is produced in three-regions: Kostanai, Akmola, and North Kazakhstan. The annual export of wheat varies between 2 and 8 million tons, and goes mainly to destinations in Europe, northern Africa, and Central Asia (UNITED STATES DEPARTMENT OF AGRICULTURE, 2010).

In spite of the developments in the sector, wheat production in Kazakhstan still has not reached its pre-independence levels (URAZALIYEV, 2003). Although there are several studies which mention the possibility of increasing the production potential of Kazakhstan (LIEFERT et al., 2010; PETRICK et al., 2014; FEHER et al., 2017), this could be achieved via increasing productivity and efficiency in agricultural production (WORLD BANK, 2015). A large area in Kazakhstan is still not utilized and remains marginal due to the lack of infrastructure

and the high production costs associated with low efficiencies. (BABU and RHOE, 2001; COULIBALY and THOMSEN, 2016; THE ECONOMIST GROUP, 2016).

Thus, by using the resources more efficiently, Kazakhstan can potentially reduce production costs and increase the level of wheat production at least to the levels experienced during the Soviet Union time. The need of increasing productivity and efficiency is considered an important challenge in policy maker levels and several reforms were aimed at tackling these issues. Increasing farm sizes by joining small scale farmers into cooperatives (SEDIK et al., 2015; KAZAGRO, 2015), increasing farm subsidies (PETRICK and POMFRET, 2016), giving free agricultural education to farm managers (RAHIMBEKOV, 2016), providing concessional credits to farmers under the umbrella of Kazagro (PETRICK and POMFRET, 2016), ensuring direct supply to procurement enterprises and contract farming (OSHAKBAYEV, 2012) could be considered as import milestones in agricultural reforms aimed at mobilizing the agricultural potential of Kazakhstan. However, up to now there is a limited knowledge about the impact of these reforms on productivity and efficiency in agricultural production. Therefore, current research is aimed at fulfilling this gap by assessing the agricultural total factor productivity in the case of the sample of Kazakhstani farms, thus contributing to the regional literature on agricultural efficiency.

2 LITERATURE REVIEW

The analysis of productivity and efficiency in agricultural production is the most visited subject in the agricultural economics domain. Both in micro and macro level, studies investigate the effects of different factors such as the education of the farmer, the size of the farm, access to credits, use of government subsidies, formal participation in supply channels, contract farming and cooperative membership on the farm productivity and efficiency.

While the positive impacts of some policies like formal participation in supply chains, contract farming and cooperative membership on agricultural productivity and efficiency can be clearly observed from the existing literature (PRAKASH, 2000; SHARMA, 2007; DI FALCO et al., 2008; BURKI and KHAN, 2011; BARRETT et al., 2012; ABEBAW and HAILE, 2013), the effects of other policies on agricultural productivity and efficiency might differ according to the used methodology and region under study. According to specific characteristics of the region, the same policy might lead to different results in different countries.

For example, researchers like MATHIJS and VRANKEN (2001), ALENE and HASSAN et al. (2003), ASADULLAH and RAHMAN (2009) and KARIMOV (2014) found that farmers' education positively affect farmers' efficiency levels. On the other hand, LLEWELYN and WILLIAMS (1996) and CHIRWA (2007) did not observe any significant relationship between farmers' education and efficiency.

Furthermore, while many scholars such as THAPA (2007), MASTERSON (2007), VU T.H. et al. (2012) and LADVENICOVA and MIKLOVICOVA (2015) support the stylized fact of inverse relationship between farm size and agricultural efficiency, others like HASANOV and AHMED (2011) and KARIMOV (2014), find a positive connection.

DE SILVA and HEMACHANDRA (2015) studied the impacts of credit access on the agricultural productivity in the case of paddy cultivation in the Akmeemana Division of the Galle District in Sri Lanka, and did not observe any significant relationship. Moreover, BRUMMER and LOY (2000) also did not find any significant impact of governmental cheap credit program on agricultural efficiency in the case of Northern Germany dairy farms. In contrast, GUIRKINGER and BOUCHER

(2008), NOSIRU (2010), and BUTLER and CORNAGGIA (2011) found that access to external finance in terms of credits improve farmers' efficiencies.

The results of the studies about the effects of governmental subsidies on agricultural productivity are also two-fold. While KUMBHAKAR and LIEN (2010), ZHU and LANSINK (2010), BOJNEC and LATRUFFE (2013), and RIZOV et al. (2013) found negative impacts of agricultural subsidies on farm efficiency, others like MCCLOUD and KUMBHAKAR (2008), DENNING et al. (2009) and KAZUKAUSKAS and NEWMAN (2014) claim that subsidies increase farm efficiencies.

Thus, the review of the existing studies from different countries of the word indicates that there is no uniquely defined effect of farm characteristics, institutions and policy reforms. Therefore, general conclusions cannot be made in case of Kazakhstan from the existing literature and, therefore, empirical analysis needs to be done.

Moreover, although the issues of productivity and efficiency have been widely analyzed across different countries of the world, in the case of Central Asian countries, very limited research is found in the existing literature. One such work is conducted by KARIMOV (2014), who identifies factors affecting efficiency in the case of cotton producers in Khorezm region of Uzbekistan. Karimov found a positive relationship between farm size and efficiency, the larger farms showed better performance in terms of efficiency. Additionally, he observed that farmers who have specialized agricultural education tend to manage their farms more efficiently, compared to non-educated ones. Another similar research in the case of the farmers of Zarafshan Valley of Uzbekistan was done by HASANOV and AHMED (2011). The findings of this work come in line with the results of KARIMOV (2014), where they conclude that nowadays' smaller farmers are less efficient, compared to larger "kolkhoz" (state farms) farms that used to be in the Soviet time. SWINNEN and VRANKEN (2010) studied the agricultural reforms and productivities of former Soviet Union countries from 1989 to 2005. During the first half of the observed time period, almost all countries experienced a decrease in productivities, which was followed by a steady increase in productivity levels during the second half. The depth and length of the decrease in productivity levels, however, differs significantly between countries, mainly due to different technology use and reforms. One of the limitations of these studies is that the analysis of policy implication in productivity and efficiency growth is scarce. A further research is needed to examine the effects of agriculture-oriented government policy reforms on the agricultural efficiency in the case of the Central Asian countries. Therefore, the goal of this work is to fill the gap in the literature by assessing agricultural efficiency in the case of a Central Asian country, and to contribute to the ongoing debates regarding the impacts of agricultural policies on farm efficiency. The next section provides detailed information about the empirical methodology and data used in the analysis.

3 DATA AND METHODOLOGY

For the purpose of the current study, a cross-sectional data from 200 farms by farm surveys in the Akmola Region of Kazakhstan has been used. The survey was conducted in the second half of 2015 and captures the data for the agricultural year of 2015. Akmola is one of the largest wheat producing regions in Kazakhstan. Three regions in the north: Akmola, North Kazakhstan and Kostanai produce nearly 75 % of all wheat production in the country. Using the multistage sampling technique, a random sample of 200 farms from four districts in Akmola region has responded to the questionnaire. 138 farms are used in the further analysis, since the remaining farmers did not grow wheat in the survey year of 2014 or had some missing values that could distort the analysis.

The Stochastic Frontier Analysis (SFA) was used to estimate agricultural efficiency in the region. This method was originally introduced by AIGNER et al. (1977) and MEEUSEN and VAN DEN BROECK (1977). Since then, SFA models became very popular among scholars and have been widely used in the economics literature (ALVAREZ and ARIAS, 2004; KWON and LEE, 2004; TASHRIFOV, 2006; VILLANO et al., 2006; ODECK, 2007; NKENGNE, 2010; and KARIMOV, 2014).

Half-Normal distributed, output-oriented stochastic production frontier model for cross-sectional data can be specified as:

$$n\, y_t = ln\, y_t^* - u_t, \qquad u_t \geq 0, \tag{1}$$

$$ln\, y_t^* = f(x_t;\beta) + v_t \tag{2}$$

$$u_t \sim i.i.d.N^+(0,\sigma_u^2),$$

$$v_t \sim i.i.d.N(0,\sigma_v^2)$$

Where y_t is the actual output quantity for the i^{th} farm, x_i and $\beta$are the vector of input variables and their corresponding parameters respectively, v_t is a random error with mean level of zero and u_t is a non-negative error term that captures production inefficiency. Equation (2) defines the stochastic production frontier function, given x, it gives y_t^*, the maximum possible level of output. It is stochastic because of the v_t, random error term. Because of the non-negative u_t error term, the observed output, y_t, is always lower than the frontier output, y_t^*. Error terms u_t and v_i are distributed independently from each other (KUMBHAKAR et al., 2015).

The log difference between the maximum possible level of output and the actual output can be denoted by the term u_t, from the equation (1). The term u_t, therefore, shows the portion of output that is lost because of inefficiency. Thus, the value of u_t being closer to zero means that the farm is operating at the level close to full efficiency. Rearranging equation (1), we can have the following relationship:

$$\exp(-u_t) = \frac{y_t}{y_t^*} = TE \tag{3}$$

Where $\exp(-u_t)$ is the ratio of actual output to the maximum possible output, and can be denoted as technical efficiency of the i^{th} th farm. The value of $\exp(-u_t)$ is always between 0 and 1, with 1 meaning full technical efficiency and 0 meaning full technical inefficiency (KUMBHAKAR et al., 2015).

The relationship between explanatory variables and inefficiencies can be expressed with the following equation:

$$u_t = \delta_0 + \sum_m \delta_m Z_{t,m} + \varphi_t \tag{4}$$

Where u_t represents technical inefficiency of the i^{th} farm, $Z_{t,m}$ is the vector of explanatory variables, φ_t is the non-negative random error term, and δ_0 and δ_m mare the inefficiency coefficients to be estimated.

The analysis was conducted on the basis of Cobb-Douglas Production Function, using the STATA "sfmodel" package by KUMBHAKAR et al. (2015) and Frontier 4.1 software package by COELLI (1996).

The Cobb-Doulas production function is constructed in a form of farm revenue dependent on labor, land, variable inputs and capital. Additionally, the dummy variable for cooperation is included in the production function to assess the effect of cooperation among farmers on

their productivities. In the existing literature, there are evidences of positive relationship between cooperatives and the farm productivity. In his work, PRAKASH (2000) says that agricultural cooperatives increase productivity by ensuring better farm guidance. The research article by (DI FALCO et al., 2008) find positive effect of cooperatives on agricultural productivity of wheat producers in Southern Italy. Another study by (ABEBAW and HAILE, 2013) find that by accelerating the adoption of agricultural technologies cooperatives have significant positive influence on productivity. However, to the best of our knowledge, no single work has been done on the effects of agricultural cooperatives on farm productivity in the case of Kazakhstan. The role of cooperatives in Kazakhstan is increasing. The government is making attempts to join small scale farms into agricultural cooperatives. In this regard, analyzing the effect of cooperatives on productivity is of high importance.

In the inefficiency model, we include the policy variables like farm size, farm experience, number of machinery, distance to the plot, membership in agro holdings, use of insurance, use of subsidies, access to credits, educational characteristics and access to supply chains.

3 RESULTS AND DISCUSSION

Farm characteristics and endowments

Table 2 illustrates a descriptive statistics of output, inputs and explanatory variables involved in the production function. Output, which is denoted by the variable OUTPUT, is the agricultural income from grain production earned for the surveyed year. Average income of farms in the sample is equal to 66,2 mln KZT.

Four input variables such as labor, land, variable input costs and capital costs were used in the study. LABOR stands for the total cost of labor and is measured in thousands of KZT. Average labor costs per farm was equal to 10.4 mln KZT. LAND represents the total cultivated area and is measured in hectares.

On average, farmers cultivated around 2865 hectares of land. VARINPUTS includes costs of raw materials, seeds, fertilizers, pesticides, etc. used in the production of grain. The average variable input costs resulted to 31.7 mln KZT. Variable CAPITAL includes costs of machinery, veterinary, advisory services from outside suppliers and depreciation. On average, farmers spent around 508 thousand KZT on capital costs.

According to their features, explanatory variables are divided into three groups: farm characteristics, educational characteristics and supply characteristics.

Starting from farm characteristics, Variable SIZE captures the total farm area in ha. The average size of the farms is 3554 hectares. Variables AGE and MACHINES illustrate the number of years the farms have been operating so far and the total number of machines that the farms are using respectively. The average experience of the farm and the number of machines used by the farm are 9 years and 7 machines respectively. Variable DISTANCE shows the distance between the most distant cropland and the farm, which, on average, is equal to 26 km. Within the sample of resnpodent farms, 4 % belong to some parental organizations (AGROHOLDING-MEMBER), 38 % use insurance (INSURANCE) to secure their agricultural activities. On average, 13 % of farmers had access to credits (CREDIT) and the average amount of subsidies (SUBSIDIES) received by farmers amounted to 127280 KZT. To diversify the economy of the country and to increase the role of agriculture, policy makers in Kazakhstan introduced Agribusiness 2020 Program. For the purposes of this program 3.1 trillion KZT was allocated from the national budget, of which 42 % were to be spent on agricultural subsidies of different forms.

Furthermore, under the umbrella of Kazagro, the government provides concessional credits to farmers to finance their short term and long term investments. (PETRICK and POMFRET, 2016).

Table 2: Descriptive statistics

	Units	Akmola (n=138 observations)			
		Mean	Std. Dev.	Min	Max
Output variable					
OUTPUT	KZT ('000)	66200	158000	720	1370000
Production Variables					
LABOR	KZT ('000)	10400	21600	600	165000
LAND	hectars	2865.16	7650.07	20	62000
VARINPUTS	KZT ('000)	31700	71900	23	561000
CAPITAL	KZT ('000)	508.22	615.17	8	5400
Farm characteristics					
SIZE	hectars	3553.92	9258.4	20	62000
AGE	years	9.40	6.31	1	23
SQRAGE	years	127.89	141.01	1	529
MACHINES	numbers	6.63	5.98	0	54
DISTANCE	km	26.14	80.23	2	870
AGROHOLDINGMEMBER	Dummy	0.04	0.19	0	1
COOPERATION	Dummy	0.16	0.37	0	1
INSURANCE	Dummy	0.38	0.49	0	1
SUBSIDIES	KZT ('000)	127.28	794.96	0	9146
CREDIT	Dummy	0.13	0.34	0	1
Educational characteristics					
EDUB	Dummy	0.37	0.48	0	1
EDUU	Dummy	0.71	0.46	0	1
EDUC	Dummy	0.20	0.40	0	1
Supply characteristics					
SUPPLY_CH1	Dummy	0.19	0.40	0	1
SUPPLY_CH2	Dummy	0.43	0.50	0	1
SUPPLY_CONTRACT	Dummy	0.78	0.42	0	1

Note: KZT (Kazakhstani tenge) – Currency used in Kazakhstan.

Finally, the variable COOPERATION is a dummy variable, used to identify if the observed farm is member of any formal cooperative. Of the total grain producers surveyed, 22 farms conduct cooperative operations with the other farms in the region formally. It is an important policy variable, because the government of Kazakhstan provides several opportunities to develop the functions of cooperatives in the country. (SEDIK et al., 2015; KAZAGRO, 2015)

If we come to the educational characteristics, 37 % of all farm managers have specialized agricultural education. (EDUB). Furthermore, while 71 % of all farm managers have university level degrees (EDUU), 20 % of them have only college level education (EDUC). The government tries to increase this statistics further, by giving free agricultural seminars to farm managers across Kazakhstan. For this purpose, the government allocated 1 bln. KZT from the national budget. Seminars will be held by The National Chamber of Entrepreneurs of the Republic Kazakhstan "Atameken". They plan to hold around 660 seminars across country and teach nearly 10 thousand farm managers. (RAHIMBEKOV, 2016 August 08; BNEWS.KZ, 2016 July 29).

Moreover, starting from 2017, studying at Kazakhstani colleges on technical specialties, including agriculture, will be absolutely free. (ROMASHKINA, 30 November 2015).

Lastly, more than 60 % of all farms supply their outputs directly to agro-processing (18.8 %) (SUPPLY_CH1) and procurement enterprises (42.7 %) (SUPPLY_CH2) and almost 78 % of all supplies are conducted under special contractual agreements (SUPPLY_CONTRACT).

In accordance with the law of Republic of Kazakhstan "On Grain", the government, through the "KazAgro" agro holding, buys grain from farmers at the pre-stated prices and quantities. This policy measure enables farmers to better plan their production in advance and protects them from unexpected decreases in market prices (OSHAKBAYEV, 2012).

Econometric analysis results

Table 3 represents the maximum likelihood estimates of the frontier production function. The output elasticities of all inputs are positive and statistically significant

Table 3: Maximum Likelihood Estimates of the stochastic frontier production function

loutput	Coef.	Std. Err.	z	P>z
frontier				
LABOR	0.241***	0.060	4.00	0.000
LAND	0.202***	0.074	2.72	0.007
VARINPUTS	0.328***	0.061	5.32	0.000
CAPITAL	0.116*	0.059	1.96	0.050
COOPERATION	0.742***	0.152	4.89	0.000
_cons	5.587	1.115	5.01	0.000

Note: Significance level at 10 % *, 5 % **, 1 % ***

The highest elasticity accounts for variable input (0.33), followed by labor (0.24), labor (0.20) and capital (0.12). Furthermore, the statistically significant and positive relationship is observed between the cooperatives (COOPERATION) and productivity. The sum of all coefficients is 0.89, suggesting decreasing returns to scale.

Table 4: Estimation of inefficiency effects

	Coef.	Std. Err.	z	P>z
usigmas				
SIZE	3.641**	1.692	2.15	0.031
AGE	2.123	1.906	1.11	0.265
SQRAGE	-0.235	0.162	-1.46	0.146
MACHINES	-3.864*	1.722	-2.24	0.025
DISTANCE	-12.495**	7.146	-1.75	0.080
AGROHOLDINGMEMBER	31.207**	15.607	2.00	0.046
INSURANCE	-12.383**	5.882	-2.11	0.035
CREDIT	-18.601*	11.071	-1.68	0.093
SUBSIDIES	0.004*	0.002	1.91	0.056
EDUB	-6.353**	3.080	-2.06	0.039
EDUU	-27.468*	15.862	-1.73	0.083
EDUC	-28.421*	16.911	-1.68	0.093
SUPPLY_CH1	-22.629*	12.242	-1.85	0.065
SUPPLY_CH2	-15.577*	8.341	-1.87	0.062
SUPPLY_CONTRACT	-1.205	2.006	-0.60	0.548
_cons	50.203	32.375	1.55	0.121

Note: Significance level at 10 % *, 5 % **, 1 % ***

Table 4 presents the inefficiency effects of fifteen efficiency variables. As technical inefficiency is a dependent variable, in this case, negative coefficients mean a positive impact (i.e. inefficiency is reduced) on efficiency and vice versa. Twelve variables out of fifteen demonstrate statistically significant relationships with efficiency, nine of them having positive and three of them having negative connections. Farm size (SIZE) has a positive and statistically significant effect, meaning that the scale of the operations is very important for the efficient use of resources. The larger the size of the farm, the less efficiently it tends to use its resources. This relationship once more supports the previous finding that farmers have decreasing returns to scale and that the sizes of farms should be reduced to their optimal levels. The inverse relationship between farm size and efficiency has been proved by many scholars such as THAPA (2007), MASTERSON (2007), VU T.H. et al. (2012) and LADVENICOVA and MIKLOVICOVA (2015) and has become almost a stylized fact in the economics theory. The agricultural experience, represented by variables *(AGE)* and *(SQRAGE)* do not have any significant impacts on efficiency. It is quite intuitive, because age can have both a positive and a negative impact on efficiency, and the effects are not always straightforward. While some farmers might perform more efficiently because they have more experience and expertise, other older farms might perform less efficiently because of old machinery, equipment, etc., or just because of their conservative approaches that prevent them from having new ideas and innovations. Farms with more machines under their use are, generally, more efficient compared to the ones that have lesser machines. This statement is proved with the variable *(MACHINES),* which has a significant negative sign, which means positive effect on efficiency. Surprisingly, the variable *(DISTANCE)*, which is the distance of the most distant cropland from the farm, is positive and significant, meaning that the more the distance of the cropland from the farm, the more

efficient the farm is. This connection can hardly be explained intuitively and, thus, requires a further research, including more time frame and observations. One possible explanation, however, could be offered by transportation costs and driving costs to the field. Farmers may try to use labor and machinery more efficiently, since going back and forth to distant locations may be expensive.

Being part of a parental organization such as an agro holding, variable *(AGROHOLDINGMEMBER)*, seems to have a significant negative effect on efficiency. It might be explained by the fact that the members of parental organizations have higher transaction costs compared to non-members. Another explanation could be provided by the fact that they get inputs from the parent organization and give the outputs to them. Thus, they might not be highly motivated to use resources efficiently. Studies done by GATAULINA et al. (2006) and HOCKMANN and KOPSIDIS (2007) have similar findings, suggesting that members of agro holdings have lower efficiencies compared to non-members.

Agricultural subsidies *(SUBSIDIES)* provided by the government to stimulate agricultural production tend to have a significant negative effect on farmers' efficiency. This result is supported by the findings of the majority of the researchers in the literature who studied the relationship between agricultural subsidies and farm efficiency and found a significant negative connection (KUMBHAKAR and LIEN, 2010; ZHU and LANSINK, 2010; BOJNEC and LATRUFFE, 2013; RIZOV et al., 2013). Thus, the results of this study therefore question the appropriateness of providing direct subsidies since it has a negative effect on efficiency. Another reason for Kazakhstan to reduce direct subsidy levels is the commitments to the WTO. Since July 2015, Kazakhstan became a member of the WTO, which implies certain commitments, like keeping support levels for domestic agricultural producers below 8.5 % of the year's value of production. Prior to joining the WTO, for many agricultural products domestic support used to be higher than 8.5 %. (PETRICK and POMFRET, 2016).

A significant positive relationship was observed between farmers' access to credit *(CREDIT)* and efficiency. Farmers who have an access to credits perform better in terms of efficiency, compared to the ones who do not have an access to credits. The finding is in line with the results of researchers who found the similar relationship between access to credits and farm efficiency. (GUIRKINGER and BOUCHER, 2008; NOSIRU, 2010; BUTLER and CORNAGGIA, 2011).

The results of the current study suggest that the use of insurance by farmers (INSURANCE) increases their efficiency levels. A significant positive relationship was observed, which supports the findings of AGAHI et al. (2008), where they also reveal a positive impact of crop insurance on efficiency in tropical and temperate regions of Kermanshah province in Iran. In the case of Kazakhstan, HEIDELBACH (2007) discusses the shortcomings of insurance policies in Kazakhstan and their lack of popularity. However, our study shows that farmers who purchase insurance still have better efficiencies regardless of problems existing at macroeconomic levels. Thus, more information about the benefits from insurance need to be conveyed to the farmers simultaneously with improvement of the insurance industry.

The knowledge indicators *(EDUU)* and *(EDUC)* have a significant positive effect on efficiency, meaning that farmers' educational background like a college-level education or university-level education positively impacts the farmers' efficiency. Moreover, farm managers with specialized agricultural education *(EDUB)* tend to manage farms more efficiently compared to others. This statement is supported by many scholars such as MATHIJS and VRANKEN (2001), ALENE and HASSAN et al. (2003), ASADULLAH and RAHMAN (2009) and KARIMOV (2014) who found the positive relationships between farmer education and efficiency.

Significant positive relationships were observed between supply variables and efficiency. Farms that can supply their products directly to agro-processing enterprises (SUPPLY_CH1) or procurement enterprises (*SUPPLY_CH2*) tend to be more efficient compared to other farms. This result comes in line with the findings of BURKI and KHAN (2011), where they observe a positive impact of formal participation in supply chains on technical efficiency. The role of FCC (Food Contract Corporation) of Kazakhstan plays a significant role in this regard. One of the key goals of the corporation is to maintain food security in the country and to stabilize grain prices on the domestic market. Through large-scale purchases of grains for the state-reserves in the seasons of high yields and lower domestic prices and through large scale sales of grains from the state-reserves in the seasons of low yields and higher domestic prices, FCC maintains stable grain prices in the country. Moreover, farmers in Kazakhstan can sign forward contracts for the sale of wheat with FCC. By doing so, wheat producers can get funds for their wheats earlier and plan their levels of production in advance (GALIAKPAR, 2011). As the results of our analysis show, direct participation in these supply chains leads to a higher efficiency among producers. Therefore, the role of the government should be to maintain and to further improve these supply chain mechanisms by involving more and more farmers into it.

Finally, supplying products under special contractual agreements (*SUPPLY_CONTRACT*) does not seem to have a significant effect on farm efficiency. The results of the analysis reveal a statistically non-significant relationship.

Although this study demonstrates a significant impact of policy measures and supply chain access, there are several directions for further improvement. First of all, the sample size used in the analysis is relatively small and a larger sample needs to be considered, especially including more regions from Kazakhstan. Second of all, the time effects are not considered in the analysis, since cross sectional data is used. Panel dataset needs to be collected in the further analysis to consider the residual effect of the policies and supply chain access. Third of all, endogeneity and causality issues between subsidy allocation and efficiency need to be investigated in more detail.

4 CONCLUSIONS

In Kazakhstan, agriculture plays an important role not only because of rural employment, but also because of the diversity it brings to its oil dependent economy. Although tremendous achievements have been obtained in the grain sector, there is still large room for developing productivity and efficiency. Moreover, the effects of agricultural policies held in Kazakhstan such as: increasing farm sizes by joining small farms into cooperatives, increasing subsidies for farmers, providing concessional credits to farmers, providing free agricultural education to farm managers, ensuring direct supply to procurement enterprises and contract farming are yet to be studied.

The current article aims to fill this gap in the literature by conducting a total factor productivity analysis in the case of 138 wheat producers from Akmola Region in Kazakhstan.

The study provides several empirical findings: we found a positive relationship between cooperating and productivity. The results show that the farmer who cooperates with other farms and producers can significantly increase his productivities.

In the analysis, we found the inverse relationship between farm size and efficiency, which became a stylized fact in the economics literature, was proved by results of the current study. However, this contradicts the main policy priorities in Kazakhstan, which usually support large

scale farms. Therefore, the possibility to support small scale farms needs to also be considered in the future.

Furthermore, producers with farm managers that have specialized agricultural education, university or college level education tend to be more efficient than others. Being part of a parental organization, in contrast, seem to decrease efficiency levels of farmers.

Moreover, while the use of insurance, having access to credits and participation in the procurement mechanisms significantly improve farm efficiency levels, using government subsidies, on the other hand, seems to negatively affect the efficiency levels of farmers.

To conclude, the results of the current study reveal that the policy reforms implemented by Kazakhstan's government to increase efficiency in agricultural sector have different implycations. Policy reforms in the future need to consider covering small farms as well, since those showed higher level efficiencies than large ones. Policies related to the program providing free agricultural education and concessional credits to farmers seem to be fulfilling their objective, since positive effects are found. Furthermore, ensuring participation in government procurement mechanism also was found to be a successful policy, as it provides positive impact on efficiency. Moreover, the governmental programs for supporting insurance mechanisms should also be considered in the future, as insurance use increases the efficiencies of farmers. Lastly, current subsidy programs provided by the government should be reconsidered, since a negative impact of subsidies on farm efficiency was observed.

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