RISK, TECHNICAL EFFICIENCY AND MARKET TRANSACTION COSTS IN DIFFERENT ORGANISATIONAL FORMS: EVIDENCE FROM THE OBLAST TATARSTAN

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Abstract

The paper investigates the significance of external and internal transaction costs and risk in agriculture in the Tatarstan Republic. The analysis is conducted for independent farms and farms which are members of agroholdings. The result indicates that external transaction costs are more marked in independent farms than in agroholding members. However, average prices do not differ among the organisational forms. With regard to internal transaction costs (or inefficiency) the result is the opposite. Inefficiency in agroholding members is considerably higher than in independent farms. However, the estimation suggests that this result is due to more intense risk management in agroholding members. Thus, members of a business group have a more intense use of inputs; however, these are rather allocated to reduce uncertainty of production than to increase production.

Keywords: Risk production function, internal and external transaction costs

JEL Classification: Q110, D220, P230

1 INTRODUCTION

Several studies have revealed that Russia's agricultural sector is lagging behind the development of other sectors of the economy (Voigt and Hockmann 2008). The reasons for this phenomenon are intensively discussed among economists and politicians. In this paper we will contribute to this debate and analyse the significance of risk and of external and internal transaction costs as well as their influence on agricultural development and production growth. The analysis will be conducted for the Tatarstan Republic. Agriculture in this republic is subject to massive administrative support. Thus, it is interesting to identify how political intervention may have contributed to agricultural development in this region by reducing the obstacles to growth.

External transaction costs result in allocative inefficiency and find their expression in the variation of prices among agricultural enterprises. Thus, analysing the variation of prices among farms provides information about market access and the significance of market transaction costs. Internal transaction costs determine the degree to which producers are able to exploit production possibilities. Thus, technical inefficiency can be regarded as an indicator of internal transaction costs. Risk leads to a variation of agricultural production around the average. This component basically results from the variation of natural conditions, e. g. weather. These indicators will be investigated for different organisational forms in order to assess whether productivity differences among agricultural enterprises are determined by the choice of technology or basically by ownership and governance structures in agricultural enterprises. Thus we will also contribute to the question whether the occurrence of horizontally and vertically integrated structures (often called agroholdings or business groups) have had a positive effect on agricultural production.[1] Moreover, we will identify which kinds of obstacles are mainly reduced when a farm becomes a member of an agroholding.

The central indicator in our analyses is revenue. In a first step we decompose its variation into the variation of its components. These are the variation of product prices, and the variation of production (technology, risk, inefficiency). While the variation of product prices can be directly taken from the data, the contribution of the further components has to be estimated using econometric techniques. In the second step, we therefore apply stochastic frontier analysis to determine how technology, risk and inefficiency affect agricultural production.

The paper is organised in five chapters. The next chapter deals with the decomposition of the variance of revenues into the contribution of prices and quantities. Differences in the level of

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[1] On this issue see for instance Kolnesnikov (2009), Wandel (2010) and Hockmann et al. (2009)

production (productivity) and prices will also be investigated. Chapter 3 discusses the theoretical background used for the stochastic frontier analysis. The results are presented in Chapter 4 where we discuss estimation results and the implication of the contribution of technology, risk and inefficiency to production. In Chapter 5, the findings from Chap. 2 and 4 are put together resulting in a coherent picture of the impact of market access, technology, risk and inefficiency.

2 REVENEUES AND QUANTITIY AND PRICE VARIATION

2.1 Data

We use accountancy data of agricultural enterprises in the Tatarstan Republic for the period of 2006-2008 (Rosstat data provided by VIAPI). The original data set contains more than 1000 observations. First, we excluded farms for which we had only one observation. Including these would have led to large changes in the data set in the individual years, and the entering and exiting of farms would have biased the results significantly. Second, we excluded observations with nonsense partial productivities, e. g. when land productivity or milk production per cows was 100 time larger than average. This cleaning resulted in a data set of 277 farms and 636 observations. The set contains 41 members of agroholdings; they account for 101 observations.

The data set contains detailed information on production structures, specialisation and factor input. Moreover, implicit firm specific product prices can be calculated from the data set using the quantities and sales of marketed products. In addition, the data provide information on organisational forms and thus governance structures.

In a first step, we took a closer look at production and product prices of the agricultural enterprises. Our data set allows conducting comparable analyses for grain, sugar beet, potatoes and milk. In order to assure that the comparisons are not biased by farm size, gross production is divided by an input unit. This unit represents the area planted with the corresponding crop and the number of cows in milk production. We first reveal information about different price and partial productivity structures of agroholding members and independent farms. In addition, we decompose the variance of output specific revenues in order to identify whether revenues by organisational form are differently affected by quantity and price variation. This analysis provides a first indication about the significance of external transaction cost in both organisational forms, and whether agroholding members are better positioned to avoid these costs.

2.2 Prices and partial productivities

Table 1 provides information about partial productivities and prices received by farmers. The data show that marked price differences between organisational structures are observable. Basically, the same holds true for quantities. However, there is indication of higher yields per hectare for products where there is special activity of business groups (sugar beet). The results are quite astonishing. Often it is argued that prices received by agroholdings are only transfer prices and independent of market prices. The information in Table 1 provides no support of this view, since both groups receive, on average, the same prices. This precludes that agroholdings conduct special price strategies and the result presented in Table 1 is incidental only. This could be investigated further by comparing prices between agroholdings, however, these information was not available in our data. Although not as informative as holding specific prices, price variation between independent farms and group members may help to shed some light on this issue.

Table 1: Expected prices and quantities (per hectare)

	Independent farms					
	2006		2007		2008	
	E(y)	E(p)	E(y)	E(p)	E(y)	E(p)
Grain	25.3	0.26	25.7	0.38	33.7	0.44
Sugar beet	175.7	0.09	166.7	0.10	170.1	0.11
Potatoes	111.1	0.33	117.6	0.41	137.3	0.54
Milk	35.9	0.58	37.9	0.70	41.7	0.89
	Holding members					
	2006		2007		2008	
	E(y)	E(p)	E(y)	E(p)	E(y)	E(p)
Grain	23.8	0.27	23.2	0.38	26.7	0.42
Sugar beet	226.8	0.10	175.4	0.09	240.2	0.09
Potatoes	73.6	0.27	118.8	0.33	143.8	0.47
Milk	33.5	0.59	34.2	0.72	35.2	0.83

Notes: E(y) and E(p) denote the mean of production and prices, respectively.
Quantities are per input unit, e.g. crop production per hectare and milk production per cow.
Quantities are in 100kg and prices in 1000 Rouble per kg

Source: Own calculations.

Table 2 shows that the coefficients of variation (CV) of prices differ considerably among the two groups of farms. Generally, the indicator is smaller for members of a business group than for independent farms. Thus prices received by agroholding members are more homogeneous than the prices independent farms are facing. This suggests that agroholding members might be less flexible in using different marketing channels. Together with the results from Table 1, the higher homogeneity of prices indicates that members of a business group are obliged to largely use the channel offered by the holding, however, they are paid a price oriented towards the average price paid in the regions. This strategy can be assumed to lead to a reduction of transaction costs resulting from the use of the product market. On the other hand, the higher CV of prices given for independent farms imply that market transaction costs constitute a serious problem for this group. In addition, given the differences in the CV for various prices, market transaction cost may differ among the product markets.

Table 2: Coefficients of variation of prices and quantities by organisational form

	Independent farms					
	2006		2007		2008	
	CV(y)	CV(p)	CV(y)	CV(p)	CV(y)	CV(p)
Grain	35.6 %	9.3 %	36.1 %	7.8 %	28.6 %	9.2 %
Sugar Beet	28.1 %	17.5 %	29.7 %	8.7 %	28.5 %	4.0 %
Potatoes	37.1 %	10.5 %	39.3 %	9.5 %	34.6 %	9.9 %
Milk	33.4 %	6.7 %	31.3 %	8.3 %	27.9 %	5.7 %
	Holding members					
	2006		2007		2008	
	CV(y)	CV(p)	CV(y)	CV(p)	CV(y)	CV(p)
Grain	36.8 %	14.7 %	35.4 %	0.9 %	28.8 %	8.2 %
Sugar Beet	15.4 %	4.4 %	47.7 %	0.0 %	6.0 %	3.1 %
Potatoes	32.8 %	16.2 %	23.6 %	0.0 %	27.6 %	2.0 %
Milk	28.0 %	6.2 %	32.4 %	0.6 %	25.8 %	6.9 %

Notes: CV(y) and CV(p) denote the coefficient of variation of production and prices, respectively.
Quantities are per input unit, e.g. crop production per hectare and milk production per cow.

Source: Own calculations.

However, the extent to which transaction cost affect revenues may be rather marginal because this effect may be dominated by the variation of quantities. This conclusion cannot be denied ex ante, since the coefficient of variation of quantities is much more marked than the CV for prices.

2.3 Variance decomposition

In the following we discuss the contribution of the variance of prices and quantities to the variance of revenues. For this, we decompose the variance of revenues into the contribution of prices and quantities using a first order Taylor approximation:

$$(1) \qquad \text{var}(py) = (Ep)^2 \,\text{var}(y) + (Ey)^2 \,\text{var}(p) + c(y, p),$$

where p and y represent output prices and quantities and $c(y, p)$ contains the covariance structures between prices and quantities (See Appendix).

Table 3 suggests that the covariances between prices and quantities are fairly irrelevant for explaining the variance of prices. Indeed, the price and quantity variance accounts on average for about more than 90 % of the variation of revenues. Moreover, the covariance effects are positive in most cases. This implies a positive correlation between quantities and prices. This result suggests that products are not just sold to prevailing market conditions but that farms to some extent are able to negotiate better prices in case they are providing higher quantities. This again indicates that market transaction costs are a relevant phenomenon on agricultural markets in Tatarstan [2].

The calculations provide that the by far dominant share results from quantity; price variance contributes only little to the variance of revenues. In addition there are marked differences between the significance of price variation between members of a business group and independent farms. However, a uniform statement regarding the shares is not possible. For some products, the contribution of price variance in the group of independent farms is larger, for some products we observe the opposite.

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[2] Svetlov (2009) and Svetlov and Hockmann (2007) investigated the role of external transaction cost in agriculture in Moscow oblast. Using a different approach (DEA) they also found that this cost significantly affects agricultural holdings.

Table 3: Contribution of price and quantity variance to revenue variance

	Independent farms								
	2006			2007			2008		
	Share explained	Share of prices	Share of quantities	Share explained	Share of prices	Share of quantities	Share explained	Share of prices	Share of quantities
Grain	97.7 %	6.4 %	93.6 %	94.5 %	4.5 %	95.5 %	99.8 %	9.5 %	90.5 %
Sugar Beet	85.5 %	28.0 %	72.0 %	102.8 %	7.9 %	92.1 %	91.1 %	2.0 %	98.0 %
Potatoes	122.1 %	7.5 %	92.5 %	100.3 %	5.6 %	94.4 %	134.8 %	7.6 %	92.4 %
Milk	89.4 %	3.9 %	96.1 %	87.4 %	6.7 %	93.3 %	91.0 %	4.0 %	96.0 %
	Holding members								
	2006			2007			2008		
	Share explained	Share of prices	Share of quantities	Share explained	Share of prices	Share of quantities	Share explained	Share of prices	Share of quantities
Grain	82.7 %	13.8 %	86.2 %	80.5 %	8.4 %	91.6 %	81.3 %	7.5 %	92.5 %
Sugar Beet	110.4 %	7.7 %	92.3 %	102.5 %	2.8 %	97.2 %	54.6 %	21.6 %	78.4 %
Potatoes	79.8 %	19.7 %	80.3 %	150.7 %	7.4 %	92.6 %	109.7 %	0.5 %	99.5 %
Milk	92.0 %	4.7 %	95.3 %	96.4 %	5.5 %	94.5 %	83.8 %	6.8 %	93.2 %

Note: Quantities are per input unit, e.g. crop production per hectare and milk production per cow
Source: Own calculations.

The dominant role of product variation requires taking a more detailed look behind the sources of its variation. In principle, we distinguish between four effects: size, productivity, risk and technical efficiency. Our main intention is to identify the contribution of risk and technical inefficiency (as an indicator of internal transaction cost) to output variance. The next two sections deal with this problem. First, we introduce the theoretical background. Following that we will present the results.

3 THE SOURCES OF QUANTITY VARIATION: THEORY

3.1 Methodological considerations

In the analysis of the production structures we apply an extended version of the conventional production function, e. g. the risk production function. Compared to the conventional procedure this model is able to consistently indentify the impact of individual inputs on risk and efficiency separately. This concept was originally introduced by Just and Pope (1978) and extended by Kumbhakar (2002):[3]

(2) $y = f(\mathbf{x}) + g(\mathbf{x})v - q(\mathbf{x})u$, with $v \sim N(0,1)$ and $u \sim N^{+}(0,\sigma_u)$.

$f(\boldsymbol{x})$ mean production function

$g(\boldsymbol{x})$ risk function

$q(\boldsymbol{x})$ inefficiency function

Thus we decompose the variation in production into three components. First there is technology or the mean production function *f*, which represents the average impacts of inputs (***x***) on production. The second component *g* is assumed to capture the effects of risk on production. Due to poor or favourable weather conditions actual output can be lower or higher than its average level. Thus, it is straightforward to connect the risk function with a two-sided error

[3] In the following, bold symbols indicate vectors or matrices; all other variables are scalars. Subscripts will be omitted in order to improve readability.

component (v). The function q captures the impact of factor use on the exploitation of the production possibilities or the efficiency of production. This function transforms the one-sided error term u.

For the empirical analysis we make the following assumption about the functional forms. The natural logarithm of the production function is a translog production function.

(2a) $$\ln f(\mathbf{x}) = a_0 + a_m m + (a_t + .5a_t t + a_{tm} m)t + (\mathrm{a} + \mathbf{a}_t t + \mathbf{a}_m m)'\ln \mathbf{x} + \frac{1}{2}\ln \mathbf{x}'\mathbf{A}\ln \mathbf{x}$$

In this representation we assume that the constant and the first order effects may change over time (t) and with organisational structure (m). The former is supposed to capture the impact of technical change, while the latter is introduced in order to test whether membership in an agroholding had a significant impact on the production structures.

The risk function is assumed to consist of two parts. First there is generic risk. This component captures the effects of overall weather condition and affects all farms similarly. In the empirical analysis we follow Bokusheva and Hockmann (2006) and consider this kind of risk by a constant and dummy variables for the years 2006 and 2008 (d_{06}, d_{08}). The second part of g is farm-specific or idiosyncratic and depends on the intensity and structure of input use. We assume that the idiosyncratic component can be represented by a Cobb Douglas functional form. Thus we have

(2b) $$\ln g(\mathbf{x}) = \gamma_0 + \gamma_{06} d_{06} + \gamma_{08} d_{08} + \gamma'\ln \mathbf{x} + \gamma_m m$$

For the inefficiency function h we also assume a Cobb Douglas functional form:

(2c) $$\ln q(\mathbf{x}) = \boldsymbol{\theta}'\ln \mathbf{x} + \theta_m m$$

3.2 Estimation procedure

The following considerations represent the workhorse of conventional stochastic frontier analysis: A production function f is given by

(3) $$y = f(\mathbf{x}) + \varepsilon^*, \text{ with}$$

$$\varepsilon^* = v^* - u^*,\ v^* \sim N(0,\sigma_v) \text{ and } u^* \sim N^+(0,\sigma_u).$$

The error terms have the same properties as those in (2). Kumbhakar and Lovell (2000) showed that the density function (f) corresponding to (2) is given by:

(4) $$\mathrm{f}(\varepsilon^*) = \int_0^\infty \mathrm{f}(\varepsilon^*, u^*)du^* = \frac{2}{\sigma}\phi\left(\frac{\varepsilon^*}{\sigma}\right)\Phi\left(-\frac{\varepsilon^*\lambda}{\sigma}\right)$$

$$\text{with } \sigma = \sqrt{\sigma_u{}^2 + \sigma_u{}^2} \text{ and } \lambda = \frac{\sigma_u}{\sigma_v}$$

where ϕ and Φ are the standard normal density and cumulative distribution functions. Optimal parameter estimates can be computed by maximizing the log likelihood associated with (4). Moreover, besides parameter estimates, estimates of expected efficiency can be obtained. According to Jondrow et al. (1982) the expected value of u* is:

(5) $$E(u^* \mid \varepsilon^*) = \frac{\sigma_u{}^2\sigma_v{}^2}{\sigma^2}\left(\frac{\phi(\varepsilon^*\lambda/\sigma)}{1-\Phi(\varepsilon^*\lambda/\sigma)} - \frac{\varepsilon^*\lambda}{\sigma}\right)$$

The risk production function used in this paper is more flexible than the conventional production function approach; however, it can be transformed to fit the requirements of the standard estimation procedure:

(6) $y = f(\mathbf{x}) + g(\mathbf{x})v - q(\mathbf{x})u$

$$\varepsilon = \frac{y - f(\mathbf{x})}{g(\mathbf{x})} = v - h(\mathbf{x})u \text{ with } h(\mathbf{x}) = \frac{q(\mathbf{x})}{g(\mathbf{x})}$$

and $v \sim N(0,1)$ and $u \sim N(0, \sigma_u)$.

The assumption $\sigma_v = 1$ results from the introduction of the idiosyncratic component into the risk function. Without this assumption, the model could not be identified.

The density of ε in (6) is given by:

$$\mathrm{f}(\varepsilon) = \int_0^\infty \mathrm{f}(\varepsilon, u)|J|du = \frac{2}{\sigma g(x)}\phi\left(\frac{\varepsilon}{\sigma}\right)\Phi\left(-\frac{\varepsilon\lambda}{\sigma}\right)^4, \text{ with } J = \frac{\partial\varepsilon}{\partial y} = \frac{1}{g(x)},$$

with $\sigma = \sqrt{1 + h(\mathbf{x})^2 \sigma_u{}^2}$ and $\lambda = h(\mathbf{x})\sigma_u$

which implies the following log likelihood function:

(7) $$\ln L = \text{constant} - \sum_{t=1}^{T}\sum_{n=1}^{N} \ln\left(\sigma_{it}\, g(\mathbf{x_{it}})\right) + \sum_{t=1}^{T}\sum_{n=1}^{N} \ln\left[\Phi\left(-\frac{\varepsilon_{it}\lambda_{it}}{\sigma_{it}}\right)\right] - \frac{1}{\sigma_{it}{}^2}\sum_{t=1}^{T}\sum_{n=1}^{N} \varepsilon_{it}{}^2$$

Similar to (4), the expected value of u can be computed by:

(8) $$E(u_{it} \mid \varepsilon_{it}) = \frac{h(\mathbf{x_{it}})^2 \sigma_u{}^2}{\sigma_{it}{}^2}\left(\frac{\phi(\varepsilon_{it}\lambda_{it}/\sigma_{it})}{1 - \Phi(\varepsilon_{it}\lambda_{it}/\sigma_{it})} - \frac{\varepsilon_{it}\lambda_{it}}{\sigma_{it}}\right)$$

4 THE SOURCES OF QUANTITY VARIATION: ESTIMATION RESULTS AND FURTHER INTERPREATIONS

4.1 Data

We applied the same data set which we had already used for the variance decomposition. Inputs comprise land (Lan), labour (Lab), capital (Cap) and materials (Mat). The first and second are given by used agricultural area and the number of workers, respectively. Capital input was approximated by depreciation. We constructed the variable by adding depreciation of capital use in crop and animal production, each deflated by the corresponding regional price indices for machinery. Materials comprise all expenses for variable inputs. The data base provided only information in current prices. Volumes were constructed by (a) weighting the individual components (seed, fertilizer, feedstuff ...) by corresponding regional price indices and (b) adding up the individual volumes.

Our output variable represents the volume of gross production. This variable was constructed in several steps. First, gross production in current price was estimated by adding the product of gross production in physical terms and firm specific product prices. We distinguish between nine categories of production. Crop production includes cereals, sugar beet, sunflower, potatoes and vegetables. Regarding animal production we distinguish between beef, pork, lamb, poultry, milk, meat, egg, wool and dairy production. Firm specific product prices were calculated from the data set through the relation of sales and the amount of marketed products. In a second step, we calculated firm specific multi-lateral consistent price indices using

[4] J is the Jacobian. The Jacobian has to be applied because of the transformation from ε to y (DeGroot 1989). In the standard workhorse the Jacobian can be omitted because the differential is equal to one.

the approach developed by Caves et al. (1982).[5] In doing so, we used firm specific product prices and firm specific revenue shares. Finally, in the third step, we deflated gross production in current values by the firm specific output price indices.

All variables were normalized by their geometric mean. Due to this procedure, the parameter estimates for the first order terms can be directly interpreted as the production elasticities at the sample mean.

4.2 Estimation results

Parameter estimates of the risk production function are given in Table 4. Most parameters in the mean production as well as the risk and inefficiency functions are highly significant. Thus, it can be concluded that the omission of the two latter would have produced biased estimates for the production function.

The mean production function fulfils the monotonicity requirement (α_i, for i = A, L, C, V). An increase in input use results in an increase of production. This holds for independent farms as well was for the members of agroholdings. The mean production function does not exhibit quasi-concave requirements in all inputs. We found that materials and capital follow the "law" of diminishing returns ($\alpha_{ii} + \alpha_i^2 - \alpha_i < 0$, for i = C, V) for independent farms, though land and labour showed increasing returns ($\alpha_{ii} + \alpha_i^2 - \alpha_i > 0$, for i = A, L) at the sample mean. Without the consideration of risk these results could hardly be explained. However, the estimates indicate that the implementation of management techniques cannot be denied. These techniques may be responsible for the unexpected results.

Materials (α_V) are the most important input. The estimates suggest that about 49 % of revenues are used for the remuneration of variable inputs. This result is consistent with the expectation given the importance of purchased material inputs for modern agricultural production. The production elasticity of labour (α_L) is rather low and only significant at the 10 % level. Land and capital receive about 32 % and 18 %, respectively. Agroholding membership affects the production structures. However, estimates are significant for labour and materials only (α_{AM}, α_{VM}). The impact on land is positive, while its effect on material input is negative.

Elasticity is defined as the relation of marginal and average productivities. Thus, the estimated values can be used to deduce more conclusions regarding differences of marginal productivities and factor use by organisational form. Since the normalisation average productivities at the sample mean are equal to one, the estimated values provide direct information about the marginal products. Thus, the low estimate of labour suggests that on average, independent farms might operate with a suboptimal and high labour input and thus are putting on average a relatively high weight to their social function in rural areas[6]. Agroholding membership increases the marginal product of labour significantly. Since the "law" of diminishing returns holds for agroholdings, this suggests labour input is considerably lower in agroholdings than in independent farms. This result supports the often heard proposition that agroholdings are more profit-oriented; they release underemployed labour, and thus are fulfilling the social function of farms less satisfactory than independent agricultural enterprises.

The results also support the view that agroholdings have a better access to material inputs than independent farms. Marginal products in agroholdings are significantly lower than in independent farms. Again, the law of diminishing returns implies that agroholding members apply material inputs more intensively than independent farms. Similar conclusions can be deduced for land and capital input, though the corresponding estimates are not significant.

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5 Assuming a translog aggregator function, the result is a Törnquist-Theil Index. Basically, by this approach each observation is compared to the average in the sample.

6 See Koester (2005) for more details on this issue.

Table 4: Parameter estimates of the risk production function

	Variable	Symbol	Estimate	Std.-Error	t-ratio
mean production function	Constant	α_0	0.0369	0.0255	1.4470
	Tim	α_T	-0.0046	0.0138	-0.3309
	Tim*Tim	α_{tT}	0.0362	0.0374	0.9675
	Lab	α_A	0.0438	0.0272	1.6138
	Lan	α_L	0.3222	0.0313	10.3110
	Cap	α_C	0.1812	0.0157	11.5320
	Mat	α_M	0.4886	0.0268	18.2150
	Lab*Tim	α_{AT}	0.0410	0.0241	1.7048
	Lan*Tim	α_{LT}	0.0639	0.0288	2.2164
	Cap*Tim	α_{CT}	-0.0263	0.0149	-1.7698
	Mat*Tim	α_{VT}	-0.0450	0.0271	-1.6585
	Lab*Lab	α_{AA}	0.0713	0.0146	4.8701
	Lan*Lan	α_{LL}	0.2714	0.0758	3.5811
	Cap*Cap	α_{CC}	0.0755	0.0128	5.9138
	Mat*Mat	α_{VV}	0.2035	0.0557	3.6543
	Lan*Lab	α_{AL}	0.0787	0.0299	2.6367
	Lan*Cap	α_{AC}	-0.0300	0.0116	-2.5796
	Lan*Mat	α_{AM}	-0.0693	0.0242	-2.8669
	Lab*Cap	α_{LC}	-0.0720	0.0303	-2.3741
	Lab*Mat	α_{LV}	-0.1867	0.0487	-3.8343
	Cap*Mat	α_{CV}	0.0037	0.0194	0.1892
	Mem	α_M	-0.2024	0.0530	-3.8169
	Tim*Mem	α_{TM}	-0.0452	0.0421	-1.0752
	Lab*Mem	α_{AM}	0.1736	0.0401	4.3343
	Lan*Mem	α_{LM}	-0.0096	0.0894	-0.1078
	Cap*Mem	α_{CM}	-0.0456	0.0386	-1.1809
	Mat*Mem	α_{VM}	-0.1413	0.0675	-2.0952
risk function	Con	γ_0	-1.6110	0.0657	-24.5220
	Dum06	γ_{06}	0.0536	0.0795	0.6735
	Dum08	γ_{08}	-0.0209	0.0897	-0.2331
	Lab	γ_A	0.1977	0.0846	2.3383
	Lan	γ_L	-0.7574	0.0943	-8.0357
	Cap	γ_C	0.2073	0.0653	3.1736
	Mat	γ_V	0.9579	0.0744	12.8820
	Mem	γ_m	0.2622	0.1123	2.3341
inefficiency function	Lab	θ_A	0.2043	0.1978	0.0335
	Lan	θ_L	1.7257	0.2383	10.4220
	Cap	θ_C	-0.0150	0.1596	-1.3932
	Mat	θ_V	-0.3667	0.2068	-6.4048
	Mem	θ_m	-0.7275	0.5624	-1.7597
	Sig_U	σ_u	0.1118	0.0254	4.4082

Note: t-ratios of 1.66, 2.04, and 2.72 are the critical values for the 1 %, 5 % and 10 % levels of significance, respectively.

Source: Own estimations.

Average economies of scale are given by the sum of the production elasticities. The results show that independent farms as well as agroholdings operate at almost constant returns to scale. In addition, in the period under investigation we neither find a significant impact of neutral technical change (α_T and α_{TT}) nor a special impact of agroholding membership on technical change (α_{TM}). However, the estimates suggest that technical change was strongly biased (α_{iT}, i = A, L, C, M). It was labour and land using and capital and material input saving.

All inputs except land had a risk increasing effect. In addition, the estimates were highly significant. From the fact that inputs do not have the same sign it can be concluded that the farms apply some kind of risk management technique, however, the information we have does not allow to go into deeper detail. Agroholding membership appears to increase production risk. This result is consistent with the more intense use of purchased inputs in this organisational structure. In addition, the results with regard to the generic risk imply that the overall weather conditions in the years did not differ too much.

Moreover, the estimate of the constant implies that generic risk is more important than generic inefficiency (σ_u). The estimate of -1.611 implies a standard deviation of the two-sided error term of about 0.2.[7] This is almost two times higher than the standard deviation of the efficiency distribution. According to our estimates efficiency is significantly affected by all inputs except capital. Labour and land input increase efficiency while materials tend to decrease efficiency. The effect regarding labour is consistent with the conclusion derived for the mean production function where differences in labour input were justified by the different perception of social function in independent farms and agroholding members.

In addition, the results suggest that group members were better positioned than independent farms regarding the exploitation of production possibilities. This result is consistent with the findings of Hockmann et al. (2009) who pointed out that agroholdings usually change the managerial structure and adopt modern management structures that allow for better monitoring of production processes.

4.3 Variance decomposition

In this section we discuss how the parameter estimates affect the contribution of production, risk and efficiency to the variance of inputs. First, an overview of the expected values and the relative importance of the variances of the three sources of variation are provided (Table 5).

Agroholdings are considerably larger than independent farms as indicated by the expected values of mean production. Moreover, somewhat unexpected their inefficiency is also more marked. At the first glance, this contradicts the conclusion derived from Table 4. However, that table only considers the generic part of inefficiency. In Table 5, the idiosyncratic component is included. Since inefficiency is considerably affected by the intensity of factor use and the impact of inefficiency, increasing inputs are higher than the coefficient of inefficiency reducing input, the level of inefficiency will increase with farm size. Thus, because agroholdings are larger, their average level of inefficiency is larger as well.

The coefficients of variation of mean production are quite similar among the two organisational forms. Thus, both groups can be similarly regarded as homogeneous (or heterogeneous). However, regarding inefficiency the spread among independent farms is larger than among agroholding members. Moreover, the coefficient of variation for inefficiency is more marked than for mean production. This suggests that inefficiency influences average total production stronger than differences in the structure of inputs. The highest coefficient of variation was computed for the risk component. On one hand, this result is a consequence of the definition of the two-sided error term, i. e. the fact that both organisational forms have a mean risk of about zero. On the other hand, the values indicate that production risk is an important feature of production that should not be neglected when analysing production structures.

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7 The assumptions in (6) and the functional forms in (2) provide $\sigma_v = e^{\gamma_0}$.

Table 5: Statistical indicators for mean production, risk, and efficiency

	Coefficient of variation			Expected value		
	Independent farms					
	2006	2007	2008	2006	2007	2008
Mean production	0.96	1.02	0.97	1.09	1.20	2.04
Risk	29.50	-48.13	94.97	0.01	-0.00	0.00
Inefficiency	1.60	2.48	2.14	0.11	0.12	0.23
	Agroholding members					
	2006	2007	2008	2006	2007	2008
Mean production	0.99	0.97	0.83	3.09	3.66	4.27
Risk	199.58	-69.18	5.46	0.00	-0.01	0.21
Inefficiency	1.51	1.35	1.15	0.31	0.32	0.35

Source: Own estimations.

Table 6: Decomposition of the variance of total production

	Independent farms		
	2006	2007	2008
Share explained	128.9 %	134.8 %	153.4 %
Mean production	83.3 %	116.1 %	133.7 %
Land productivity	*32 %*	*23 %*	*18 %*
Size (hectare)	*79 %*	*73 %*	*108 %*
Risk	19.9 %	10.3 %	11.0 %
Inefficiency	25.3 %	7.5 %	8.4 %
	Agroholding members		
	2006	2007	2008
Share explained	136.7 %	119.8 %	121.9 %
Mean production	128.0 %	111.2 %	108.1 %
Land productivity	*26 %*	*20 %*	*19 %*
Size (hectare)	*95 %*	*82 %*	*92 %*
Risk	5.5 %	6.9 %	12.3 %
Inefficiency	3.1 %	1.6 %	1.4 %

Note: Mean production was decomposed using equation (1). The contributions are calculated in relation to the total variance of mean production.

Source: Own estimations.

Table 6 contains our results regarding the variance decomposition of total production. As we did with the procedure for revenues, we concentrate on the variances only and ignore the covariance structures. The first lines for the organisational forms indicate how much of the variance of production is explained by the variance of the individual factors. First, in most years, considering variances only would overestimate the variance of total production. Furthermore, in most of the years the variance of mean production function is already larger than the variance of production. This implies that the covariances between mean production, risk and inefficiency have a homogenizing effect on the variation of total production. Second, covariances appear to be much more important than in the decomposition of revenues. On average, they account for about 30 % of the production variance.

Third, not surprisingly, the by far major part of production variance stems from mean production. This result simply underlines the importance of farm size and the implied effects on specialisation and input intensities. The size effect accounts on average for more than 80 % of the variance of mean production. The differences in productivity play only a minor role and explain only about one fourth of the variance of mean production. However, the variation of partial productivities is far more important than the variation of risk and inefficiency.

Compared to inefficiency, production risk is far more important for the variance of production. Interestingly, the impact of risk in agroholdings is lower than the impact in independent farms. At first glance this is surprising since Table 4 reports that agroholding membership has a positive impact on risk (γ_m). This was explained by the higher intensity of input use, in particular, purchased inputs. Table 6 implies that this intensity effect on risk was more than compensated by employing risk management techniques. Their successful adoption leads to a considerable reduction of uncertainty in production. However, it appears that this benefit was bought at the cost of higher input use which induces a lower level of efficiency (see Table 5). This effect also overcompensates the positive influence of agroholding membership effects on the generic impact of inefficiency which was discussed in the context of Table 4.

5 CONCLUSION AND INTERPRETATION

In this paper we analyse the significance of risk and external and internal transaction costs on agricultural development and production growth. The analysis is conducted for the Tatarstan Republic. We use accountancy data of agricultural enterprises for the period of 2006-2008. The data set contains 277 farms and 636 observations; 41 farms are members of agroholdings and account for 101 observations.

First, we investigated production and product prices. Our data set allows conducting corresponding analyses for grain, sugar beet, potatoes and milk. Marked differences between organisational structures are not observable, neither for prices nor for quantities. However, prices received by agroholding members appear to be more homogeneous than the prices received by independent farms. This indicates that members of a business group are obliged to use the channels offered by the holding company, however, they are paid a price oriented towards the average price paid in the regions and benefit from a reduction of transaction cost.

Second, the determinants of production variance were estimated using a risk production function with an inefficiency component. The parameter estimates confirm that all effects are highly important. Moreover, agroholding membership significantly affects the production structures. The results support the view that these companies have a better access to purchased inputs and use them more intensively than independent farms. Labour input is lower in holding members suggesting that this group pays less attention to the social function of farms in rural areas. In addition, both organisational forms seem to operate under constant returns to scale. Technical change was strongly biased, e. g. labour and land use as well as capital and material input saving. Neutral technical change was insignificant.

All inputs except land had a risk increasing effect. The different signs for the inputs indicate that the farms apply some kind of risk management techniques in production. Consistent with the more intense use of inputs, agroholding membership appears to have a higher (generic) production risk. However, the idiosyncratic effects imply that agroholdings apply risk management techniques more intensively than independent farms. This results in a lower contribution of the risk component to total production variance. Moreover, this result confirms findings from earlier studies which highlight the change in management and the adoption of modern management strategies observed for agroholdings.

For inefficiency we found almost inverse results. Generic inefficiency in agroholdings is significantly smaller than for independent farms. However, the idiosyncratic component changes the relation leading to higher inefficiency for group members. The estimation suggests that this result is due to more intense risk management in agroholding members. Thus, members of a business group use inputs more intensively; however, these are rather allocated to reduce uncertainty of production than to increase production.

The estimates provide further that risk is of higher relevance for the variation of production than inefficiency. This found its expression not only in the generic but also in the idiosyncratic component. Moreover, for independent farms risk and inefficiency explain about the same amount of production variance than technology differences. Thus, risk and internal transaction costs appear to be much more important than external transaction cost. The latter conclusion is also relevant for holding members. However, it has to be emphasised that compared to independent farms these variances are on a relatively low level indicating that differences in technology are more pronounced in this group.

In sum the results suggest that all three components, e. g. risk, external and internal transaction, significantly affect agricultural production. Thus, for improving the conditions, agricultural policy is required to tackle all the issues using a mix of appropriate policy measures. One option would be the support of holding membership. Our data show that this would reduce the costs associated with using the market mechanism and the costs resulting from volatile production. However, these benefits come at the cost of higher inefficiency. However, the determinants are not necessarily substitutes. A system of measures needs to be defined which improves all indicators. In this sense, fostering membership in agroholdings can be only regarded as a second best solution.

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APPENDIX

A first order Taylor approximation of a product (*p y*) around the means of the variables (p_0,y_0) is given by:

$$py = p_0 y_0 + (p - p_0)y + (y - y_0)p$$

Applying the definition of the variance provides:

$$\mathrm{var}(py) = \mathrm{E}\left[py - (py)_0\right]^2 = \mathrm{E}\left[p_0 y_0 - (py)_0 + (p - p_0)y_0 + (y - y_0)p_0\right]^2$$

Expanding the bracket and putting the expectation operator through provides:

$$\mathrm{var}(py) = \mathrm{E}\left(p_0 y_0 - (py)_0\right)^2 + {y_0}^2\mathrm{E}(p - p_0)^2 + {p_0}^2\mathrm{E}(y - y_0)^2 + 2p_0 y_0 \mathrm{E}(p - p_0)(y - y_0).$$

In this expression we already simplified by using $\mathrm{E}(p - p_0) = 0$ and $\mathrm{E}(y - y_0) = 0$. Applying the definition of the variance and covariance yields:

$$\mathrm{var}(py) = -[\mathrm{cov}(p, y)]^2 + (\mathrm{E}y)^2\,\mathrm{var}(p) + (\mathrm{E}p)^2\,\mathrm{var}(y) + 2\,\mathrm{E}p\mathrm{E}y\,\mathrm{cov}(p, y).$$

Putting the terms containing covariances into the function *c(p,y)* provides:

$$\mathrm{var}(py) = (Ep)^2\,\mathrm{var}(y) + (Ey)^2\,\mathrm{var}(p) + c(y, p).$$