Estimating internal transaction costs: the case of corporate dairy farms in Russia's Moscow oblast

Schätzung der internen Transaktionskosten: Das Beispiel von Milchviehbetrieben im Oblast Moskau

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Abstract

The paper develops a methodological framework for estimating internal transaction costs from observed input-output mixes and prices. The empirical model is a modified DEA. This framework is applied to corporate dairy farms located in Russia's Moscow oblast. The estimates provided that internal transaction costs significantly distort the allocation of marketable output and in addition hamper the evolution of more efficient farm structures. Cutting the internal transaction costs should be a priority of regional and federal agricultural development.

Key words

transaction costs; output allocation; milk; corporate farms; Russia

Zusammenfassung

Dieser Beitrag entwickelt eine Methode für die Schätzung der internen Transaktionskosten mit Hilfe von beobachteten Outputmengen und -preisen. Das empirische Modell ist ein modifiziertes DEA Programm. Berechnungen wurden für große Milchviehbetriebe im Oblast Moskau durchgeführt. Die Schätzungen ergaben, dass die internen Transaktionskosten extrem hoch sind und nicht nur zu signifikanten allokativen Verzerrungen führen, sondern darüber hinaus den strukturellen Wandel behindern. Die Verringerung der internen Transaktionskosten sollte von daher eine hohe Priorität in der regionalen und föderalen Agrarpolitik haben.

Schlüsselwörter

Transaktionskosten; Outputallokation; Milch; große bis mittelgroße Betriebe; Russland

1. Introduction

Many authors, e.g. LIEFERT et al. (2003), LERMAN (2001) and UZUN (2005), mention the presence of high transaction costs in Russian agriculture. However, there are only few studies that attempt to quantify them. One example is a case study by SHAGAIDA (2007) that explicitly calculates all observable costs and losses emerging during agricultural land transactions. SHAGAIDA concludes that high transaction costs on agricultural land markets are caused by actions of the federal government and are unlikely to be decreased only through actions of the particular farms. SHAGAIDA's study was conducted for a limited number of farms, however.

This paper introduces a non-parametric econometric framework that allows the estimation of *internal* transaction costs and makes use of a linear programming model representing technology available to sample farms as in data envelopment analysis (DEA).

Many authors, e.g. KANTARELIS (2007) and DIETRICH (1994), expand the understanding of transaction costs from Williamson's original 'costs of using price mechanism' to the costs of information gathering, negotiation, monitoring and enforcement, all of which may appear both inside and outside a firm.

External transaction costs include the costs of seeking a partner in the market that could pay or receive the best price, as well as contracting and enforcement costs. These costs are assumed to make up a smaller share of overall costs when sales are larger. *Internal* transaction costs (ITC) restrict the ability of a decision making unit (DMU) to react to price signals by performing transactions inside a firm.

In the presence of transaction costs, a competitive market equilibrium is not necessarily the most desirable state for all market participants. In other words, prices do not help allocate resources optimally. As a consequence, high transaction costs diminish the advantages of a market economy. Estimating transaction costs could help answer the question of why the results of agricultural reform in Russia are so limited.

This paper aims to test for the presence of high transaction costs on corporate dairy farms located in the Moscow oblast, with a scope limited to ITC only. The study consists of developing the methodological framework, estimating the level of ITC on the studied farms, and discovering the factors and impacts of ITC.

2. Theoretical framework

Let $\mathbf{x}$ be a non-negative input vector, $\mathbf{y}$ a non-negative output vector, $\mathbf{v}$ a non-negative input price vector, $\mathbf{w}$ a non-negative output price vector and $\mathbf{f}(\mathbf{x})$ a multi-component (vector) production function of a firm. Assume that the market is not perfect in the sense that it is not a market of one price, so price vectors consist of the best commodity prices that are accessible to the particular decision-making unit.

Under standard neo-classic assumptions about a firm (KANTARELIS, 2007), an optimal netput allocation is obtained from the model

(1) $\max_{\mathbf{x},\mathbf{y}}(\mathbf{wy} - \mathbf{vx} \mid \mathbf{y} \leq \mathbf{f}(\mathbf{x}))$.

To allow for technical inefficiencies that are not under the firm's control, (like accidental breakdowns), this specification can be rewritten as

(2) $\max_{\mathbf{x},\mathbf{y}}(\mathbf{wy} - \mathbf{vx} \mid \mathbf{y} \leq \alpha\mathbf{f}(\mathbf{x}))$,

where $0 \leq \alpha \leq 1$ is an *exogenous* technical efficiency score. If a firm is technically efficient, then $\alpha = 1$, so (2) is identical to (1). Hereafter ($\mathbf{x}_0$, $\mathbf{y}_0$) denotes the optimal netput allocation with respect to model (2).

In order to be introduced into the model, ITC costs can be represented as the costs of reaching some target netput allocation ($\mathbf{x}_T$, $\mathbf{y}_T$) subject to the present allocation ($\mathbf{x}$, $\mathbf{y}$). These costs are associated with locating the target, finding a particular trajectory, monitoring transposition, etc. If a DMU makes fewer efforts and, consequently, pays less ITC than necessary, it misses the target.

Let $t(\mathbf{x}, \mathbf{y})$, hereafter called the *ITC function*, be an amount of ITC that is necessary to reach a fixed target ($\mathbf{x}_T$, $\mathbf{y}_T$) from ($\mathbf{x}$, $\mathbf{y}$). This function is assumed to be continuous and non-negative, have a unique zero in ($\mathbf{x}_T$, $\mathbf{y}_T$), be convex with the exclusion of an infinitely small vicinity of ($\mathbf{x}_T$, $\mathbf{y}_T$), and decrease with the decrease of any distance

(3) $|x_k - x_{Tk}|\ \forall k,\ |y_l - y_{Tl}|\ \forall l$,

such that x_{Tk} is a component of $\mathbf{x}_T$, x_k is a component of $\mathbf{x}$, y_{Tl} is a component of $\mathbf{y}_T$, and y_l is a component of $\mathbf{y}$. In general, different targets need different ITC functions. Hence, $t(\mathbf{x}, \mathbf{y})$ provides no information about the costs of leaping to any other target but ($\mathbf{x}_T$, $\mathbf{y}_T$).

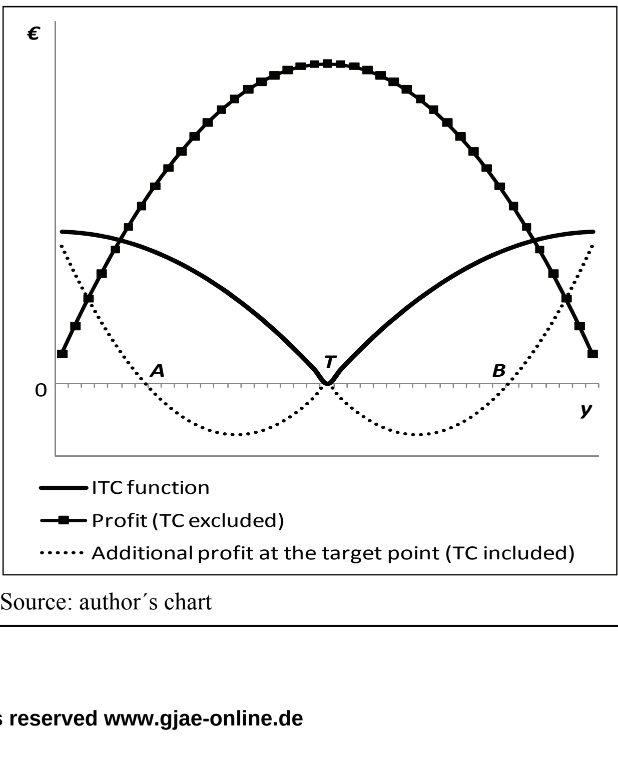
In order to enrich the model (2) with ITC function, the following assumptions are required:

- ($\mathbf{x}_T$, $\mathbf{y}_T$) is equal to ($\mathbf{x}_0$, $\mathbf{y}_0$) defined by (2);
- the nature of transaction costs associated with transposition from the present position to the target is outside the set of inputs represented by both $\mathbf{x}$ and $\mathbf{x}_T$. Thus, these vectors do not include specific inputs that appear only in the presence of transaction costs.

The ITC function is illustrated in figure 1. In the absence of ITC the most desired output quantity is T, which corresponds to an optimum of the profit function. However, moving to T from the present position y is costly. These costs are presented by the ITC function graph.

ITC are not always repaid by the additional profit that appears due to the shift from y to T. Inside the segment [A; B] the line representing the additional profit due to the leap to T lies below the output axis. So if the DMU for some reason rests within [A; B], it should no longer optimise its profit, unless either the profit function or the ITC function change so that the DMU's present output appears outside [A; B].

Figure 1. ITC function and optima in presence of internal transaction costs



Source: author´s chart

In the presence of costs $t(\mathbf{x}, \mathbf{y})$, the behaviour of a DMU is defined by the mathematical program

(4) $\max_{\mathbf{x},\mathbf{y}}(\mathbf{wy} - \mathbf{vx} - t(\mathbf{x}, \mathbf{y}) \mid \mathbf{y} \le \alpha\mathbf{f}(\mathbf{x}))$.

Given this, the optimal netput pair ($\mathbf{x}_1$, $\mathbf{y}_1$) exists such that the costs $t(\mathbf{x}_1, \mathbf{y}_1)$ associated with a shift from ($\mathbf{x}_1$, $\mathbf{y}_1$) towards ($\mathbf{x}_0$, $\mathbf{y}_0$) are no longer repaid with the increment of ($\mathbf{wy} - \mathbf{vx}$). In figure 1, ($\mathbf{x}_1$, $\mathbf{y}_1$) is not unique: both points A and C satisfy (4). The expression

(5) $(\mathbf{wy}_0 - \mathbf{vx}_0) - (\mathbf{wy}_1 - \mathbf{vx}_1 - t(\mathbf{x}_1, \mathbf{y}_1))$

measures the total value of allocative inefficiency (COOPER, SEIFORD and ZHU, 2004) of a firm experiencing ITC. Unless ($\mathbf{x}_1$, $\mathbf{y}_1$) = ($\mathbf{x}_0$, $\mathbf{y}_0$), this value is positive.

In practice, $t(\mathbf{x}, \mathbf{y})$ is unknown. However, the assumption that (4) is a true model of a firm implies that the *observed* netput pair ($\mathbf{x}_2$, $\mathbf{y}_2$) of the firm must be either:

A) *equal to* ($\mathbf{x}_1$, $\mathbf{y}_1$); or

B) *an inner point of a segment* from ($\mathbf{x}_1$, $\mathbf{y}_1$) to ($\mathbf{x}_0$, $\mathbf{y}_0$).

The latter could happen due to reasons such as failure to attain the target, e.g. due to underfinancing ITC or because of the profit function's instability. The second reason is especially likely in transitional economies.

First, we need to examine the case of (A). Consider the model

(6) $\max_{\mathbf{x},\mathbf{y},\alpha}(\mathbf{wy} - \mathbf{vx} \mid \mathbf{y} \le \mathbf{f}(\mathbf{x}),\ \mathbf{x} = \mathbf{x}_1,\ \alpha\mathbf{y} = \mathbf{y}_1)$,

where α is endogenous and ($\mathbf{x}_1$, $\mathbf{y}_1$) is obtained from (4). This model is constructed so as to have the following properties:

- the same optimal values of $\mathbf{x}$ and $\mathbf{y}$ as in (4), specifically $\mathbf{x}_1$ and $\mathbf{y}_1$;
- each Lagrange multiplier λ_k of the constraint $x_k - x_{1k} = 0$ relates to $t(\mathbf{x}, \mathbf{y})$ as follows: $\partial t(\mathbf{x}_1, \mathbf{y}_1)/\partial x_k = \lambda_k\ \forall k$, where x_{1k} is a k-component of $\mathbf{x}_1$;
- each Lagrange multiplier μ_l of the constraint $\alpha y_l - y_{1l} = 0$ relates to $t(\mathbf{x}, \mathbf{y})$ as follows: $\partial t(\mathbf{x}_1, \mathbf{y}_1)/\partial y_l = \mu_l\ \forall l$ (see Appendix for proof).

By means of (6), given the following:

- a firm behaves in accordance to (4);
- $t(\mathbf{x}, \mathbf{y})$ is unknown;
- $\mathbf{f}(\mathbf{x})$ is known;
- $\mathbf{x}_1$ and $\mathbf{y}_1$ are observable,

it is possible to estimate $\partial t_i(\mathbf{x}_1, \mathbf{y}_1)/\partial x_k$ and $\partial t_i(\mathbf{x}_1, \mathbf{y}_1)/\partial y_l$, which characterise the unknown $t(\mathbf{x}, \mathbf{y})$ at the point ($\mathbf{x}_1$, $\mathbf{y}_1$). To perform the estimation one should derive Lagrange multipliers from (6) by means of any numerical mathematical programming application.

In (B), the following inequalities occur: $\partial t(\mathbf{x}_1, \mathbf{y}_1)/\partial x_k \ge \lambda_k$ $\forall k$ and $\partial t(\mathbf{x}_1, \mathbf{y}_1)/\partial y_l \ge \mu_l\ \forall l$. So, in this case λ_k and μ_l are the *lower* estimates of the respective derivative of the ITC function. Such estimates are still of interest for many applications, as they allow the classification of ITC as 'definitely high' when these Lagrange multipliers are large in comparison to corresponding netput prices.

The estimates of ITC are measured in monetary units per unit of a netput, like prices. Since the estimates are only valid in an infinitely small vicinity of ($\mathbf{x}_1$, $\mathbf{y}_1$), they do not allow the measurement of gross transaction costs. However, they do make it possible to compare:

- relative burden of ITC in different firms;
- relative impact of ITC on the allocation of particular inputs or outputs;
- ITC and commodity prices.

The estimates are sensitive to the composition of vectors **x** and **y**. In this regard, the set of components of **f**(**x**) manifests a convention about measuring ITC. Such a convention ascertains which costs should be calculated as ITC. Specifically, the estimates obtained from (6) assume that ITC are the costs of getting over any existing constraint *that is not explicitly present* in the inequality $\mathbf{y} \le \mathbf{f}(\mathbf{x})$, but still affects the actual netput allocation. Thus, in order to exclude an impact from a list of sources of ITC, one should implement a corresponding constraint in the model.

3. Empirical specification and data

To access ITC on Moscow oblast dairy farms, a linear specification of (6) is used. Production function **f**(**x**) is specified as in the case of data envelopment analysis (DEA) (CHARNES, 1994) by means of the following linear program:

$$\max_{\alpha,\boldsymbol{\beta},\mathbf{y}} \mathbf{w}_n\mathbf{y} - \mathbf{c}\boldsymbol{\beta}$$

subject to

$$(7) \qquad \mathbf{y} = \mathbf{Y}\boldsymbol{\beta},\ \mathbf{x}_n \ge \mathbf{X}\boldsymbol{\beta},\ \mathbf{y} = \frac{1}{\alpha}\mathbf{y}_n,$$

$$\mathbf{i}\boldsymbol{\beta} = 1,$$

$$0 \le \alpha \le 1, \boldsymbol{\beta} \ge \mathbf{0}.$$

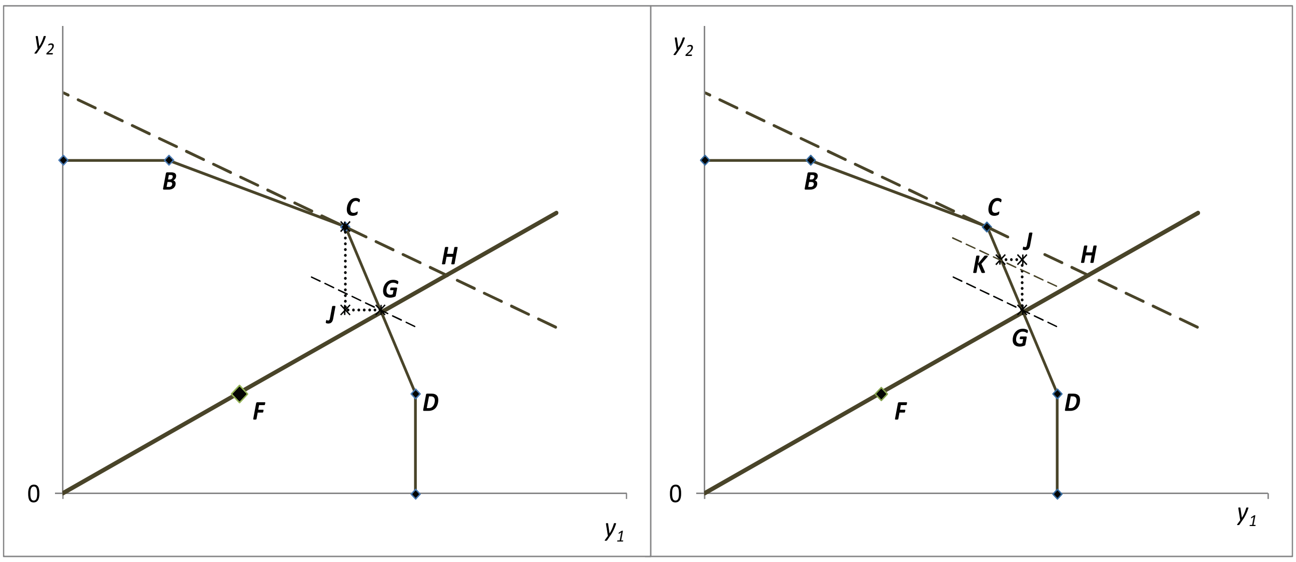
Here, $\mathbf{x}_n$ and $\mathbf{y}_n$ are non-negative vectors of observed annual inputs and outputs of farm n; $\mathbf{w}_n$ is a vector of farm-specific output prices; **c** is a vector of short-term production costs that are observed on each farm in the sample; **X** is a matrix that consists of columns $\mathbf{x}_n$; **Y** is a matrix that consists of columns $\mathbf{y}_n$; **y** is a non-negative vector of modelled outputs; α is a technical efficiency score if the production is profitable, or 1 otherwise; $\boldsymbol{\beta}$ is a non-negative vector of variable weights associated with each netput pair ($\mathbf{x}_n$, $\mathbf{y}_n$). The constraint $\mathbf{i}\boldsymbol{\beta} = 1$ imposes variable returns to scale.

The difference between $\mathbf{y}_n$ and the technically optimal value $(1/\alpha)\mathbf{y}_n$ is presumed to be accidental. Therefore, it should not be taken into account as evidence of ITC. For this purpose, variable α absorbs the impact of technical inefficiency on actually observed $\mathbf{y}_n$. Constraint $\mathbf{y} = (1/\alpha)\mathbf{y}_n$ implements the condition $\alpha\mathbf{y} = \mathbf{y}_1$ in theoretical model (6). The Lagrange multipliers of the constraint $\mathbf{y} = (1/\alpha)\mathbf{y}_n$ are the estimates of ITC per unit of the corresponding output.

The nature of the estimator is illustrated by figure 2. Consider four DMUs, *B*, *C*, *D* and *F*, which produce two outputs, y_1 and y_2, using the same amount of input. A polyline *BCD* is a production frontier. The dashed lines are isorevenues. The DMUs *B*, *C* and *D* are technically efficient, but only *C* demonstrates overall efficiency. *F* is inefficient: its technical efficiency score is 0*F* / 0*G*, and allocative efficiency score is 0*G* / 0*H*. The allocative inefficiency, which is caused by the presence of ITC, corresponds to the forgone revenue represented by the gap between *C*-isorevenue and *G*-isorevenue. By neglecting technical inefficiency for the purpose of estimating ITC, we assume that *F* would be located at point *G*.

The proposed estimator of ITC associated with y_1 is the incremental revenue due to a small change in y_1 (left chart on figure 2). Assume that the output mix is allowed to change and y_1 is changed by a unit, which is represented by *GJ*. Then the rest of output mix (y_2 in this case) should change by *JC* to provide the maximal technical efficiency.

Figure 2. Estimates of ITC per unit of output



Source: author's chart

This increases the revenue from *G*-level to *C*-level. Since *F* does not change the output mix, ITC that are associated with the change are greater than or equal to this increment. In this example the lower estimate of ITC per unit of y_1 exceeds the price of this output.

The right chart demonstrates ITC estimator per unit of y_2. Here, y_2 shifts by a unit, which is represented by *GJ*. This allows y_1 to adjust by *JK*. The revenue increases from *G*-level to *K*-level. This increment is a lower estimate of ITC per unit of the output y_2.

A linear program that accesses technical efficiency scores in DEA commonly maximises α. The specific feature of (7) is a monetary objective function, as it is required by (6). This feature makes it necessary to explicitly constrain α to be no greater than one. This constraint implies that an unprofitable farm cannot avoid losses (due to the presence of ITC).

The particular benefit of DEA-like specification is that, due to its numerous variables, it diminishes the risk of alternate optima in the dual linear program.

In this study the components of **y** are as follows: dairy milk, animal output excluding milk and crop output. Only sales are reckoned as outputs, while intermediate products are not taken into consideration. Vector $\mathbf{x}_n$ consists of arable land, hayland and grassland, number of agricultural workers, depreciation as a proxy for fixed production assets, short-term production costs as an indicator of variable inputs and number of dairy cows. Descriptive statistics of the sample data are presented in table 1.

The 2006 Registry data of large and medium farms located in Moscow oblast are employed for the estimation. The source of these data is the State Statistical Committee of Russian Federation ROSSTAT (2007). The studied sample includes the farms that have:

- nonzero sales;
- nonzero dairy cow population;
- no pigs or poultry;
- at least 50% of revenue received from sales of dairy milk;
- at least 0.5 ha of farmland per dairy cow;
- less than 14 tons of sold milk per dairy cow.

The purpose of the selection is to decrease the heterogeneity of the sample, exclude resellers and farms that are about to go bankrupt.

Additionally, the initial run of the model was used to identify such technically efficient farms that their technology is never used as a reference technology. These farms are likely to largely differ from others in the technical sense. To avoid biased estimates of ITC, they were also removed from the sample. The number of farms remaining in the sample after applying all these filters is 89.

4. Results

On average, the estimated ITC of outputs on the studied farms are:

- 8.86 thousand roubles per ton of dairy milk (111% of the average milk price);
- 2.90 roubles per rouble of other animal production;
- 1.75 roubles per rouble of crop production.

The correlation between farm-specific ITC of the three outputs is dissimilar. The Spearman rank correlation between the ITC of milk and other animal production is 0.616. In the case of milk and crop production, it is 0.422. Both values significantly differ from zero at α=0.001. However, the ITC of other animal production and of crop production display a Spearman rank correlation amounting only to 0.154, which does not significantly differ from zero even at α=0.1. This is likely due to the composition of the sample. Milk is the major output for all the farms in the sample, so the factors forming its transaction costs are likely to influence transaction costs of secondary outputs as well.

The lowest relative transaction costs are those of dairy milk. This matches the theoretical expectation that ITC per rouble of the major output should be the lowest. All three estimates exceed the corresponding output prices, indicating a very heavy ITC burden. More detailed analysis shows that this conclusion should be limited to a relatively small subset of farms where ITC of an output are larger than its price. In the case of milk, there are 23 such farms (25.8% of the sample). In the case of other animal production, their number is 35 (39.3% of the sample). In the case of crop production, the number of such farms is also 35.

The farm-specific values of milk ITC are distributed asymmetrically. The sample average is larger than the average transaction costs in the fourth farm group (of five) for milk ITC (table 2).

The majority of farms are not likely to bear the actual expenses due to such large ITC. Instead, it can be reasonably presumed that they avoid these costs by not optimising their output allocation. Such behaviour is theoretically expected in the case of (B) described in section 2, when a farm is located between $(\mathbf{x}_0, \mathbf{y}_0)$ and $(\mathbf{x}_1, \mathbf{y}_1)$. However, a part of ITC is still likely to be expended. Such expenses may

Table 1. Descriptive statistics of the source data

Variables	Minimum	Mean	Maximum	Standard deviation
Sales of milk, tons	2 126	25 800	88 064	18 093
Revenue from sales, thousand roubles:				
milk	1 641	20 977	68 710	15 228
other animal production	307	3 849	10 694	2 633
crop production	0	2 464	25 025	3 658
Arable land, ha	0	2 277	6 634	1 510
Hayland and grassland, ha	0	553	2 815	497
Workers	5	105	308	62.0
Depreciation, thousand roubles	0	1 962	15 030	2 205
Total costs, thousand roubles	2 019	39 297	161 341	25 766
Cows	81	607	2 372	389

By the end of 2006, €1=34.70 roubles.

Source: author's calculations

Table 2. Internal transaction costs of milk on dairy corporate farms located in Moscow oblast (year 2006)

Group number	Range of ITC of milk	Number of farms	Average ITC of milk	
			thousand roubles per ton	roubles per rouble of revenue
1	0.1…1.2	17	0.6	0.07
2	1.2…2.5	18	2.0	0.24
3	2.5…4.8	18	3.5	0.47
4	4.8…9.5	18	6.9	0.90
5	9.5…76.6	18	31.0	3.89
Whole sample	0.1…76.6	89	8.86	1.11

By the end of 2006, €1=34.70 roubles.

Source: author's calculations

partially explain the large losses that the farms in the sample are characterised by.

From table 3 it follows that the existing relations between milk ITC and farm characteristics are, as a rule, non-linear. Particularly the Kruskal-Wallis test, a non-parametric alternative to the Fisher *F*-test, rejects the hypothesis that the difference of the median dairy cow population in groups by ITC per unit of milk is not significant (at α=0.1). Nevertheless, the Spearman rank correlation between milk ITC and number of dairy cows is not significantly different from zero. The average number of cows is the largest in group 2, followed by groups 3, 5, 1 and 4, respectively. Farms with the largest herds tend (rather weakly) to not have very high milk ITC, ranging from 1.2 to 2.5 thousand roubles per ton. This amounts to 15 to 30% of farm-gate milk price. Farms with relatively small herds are more likely to have either very low or very high milk ITC.

The Kruskal-Wallis test rejects the indifference of median values of farm-gate milk prices in groups by ITC per unit of milk at α=0.05. The corresponding Spearman rank correlation is found to be negative and significantly different from zero at α=0.05. Although the revealed correspondence is uneven, it is likely that better price conditions allow the financing of better management. Another possible explanation is that both imperfections in output allocation and complicated access to markets may result from the same source.

The new institutional theory concludes that ITC must positively correlate to size of a firm (WILLIAMSON, 1967). This study provides a weak support of this conclusion for the case of the studied sample. Neither herd size nor production costs display a monotonic relation to milk ITC. The only size indicator that positively correlates (in terms of ranks) with milk ITC is revenue. The Spearman rank correlation is low and significantly differs from zero only at α=0.1. The only reliable conclusion that can be made is that larger farm size does not decrease ITC per unit of milk.

Analysis of ITC per unit of other animal production and of crop production is restricted by missing data on prices. However, the Lagrange multiplier of a constraint binding these output quantities to their observed amount can be interpreted as a ratio of ITC to the price of this output. This allows a comparison of ITC burden among outputs.

From table 4 it follows that ITC per rouble of other animal production are even larger than in the case of milk. These shares are 0.10 compared to 0.07 in the lower groups, 11.27 versus 3.89 in the upper groups and 2.90 versus 1.11 on average, respectively. Like in the case of milk, the ITC of other animal products are asymmetrically distributed among farms; their average value falls into the range of group 5.

Similar to the case of milk, ITC per rouble of other animal production depends on the number of dairy cows. However, the nature of this dependence is different: in the case of milk it could only be discovered by means of the Kruskal-Wallis test, while in the case of other animal production, Spearman's rank correlation significantly differs from zero at α=0.05 (table 5). In contrast to the predictions of institutional theory, larger transaction costs are associated with smaller herds. However, such a result does not show up in the correlation of ITC per rouble of other animal production to other farm size indicators. In this respect, the confusing

Table 3. Relation between milk transaction costs and farm characteristics (year 2006)

Group number	Number of dairy cows	Production costs, thousand roubles*	Gross revenue, thousand roubles**	Profitability ***, %	Milk price, thousand roubles per ton
1	512	34 456	20 467	-13.5	8.55
2	811	45 501	31 378	-12.7	8.25
3	539	34 523	22 061	-10.9	7.50
4	542	36 899	27 351	-0.4	7.66
5	626	44 837	31 805	-8.5	7.95
Whole sample	607	39 297	26 681	-9.2	7.98
Kruskal-Wallis *p*	*0.0905*	0.1718	0.1271	0.3760	**0.0168**
Pairwise Kolmogorov-Smirnov *p* for groups 1 and 5	>.1	>.1	**<0.025**	>.1	**<0.025**
Spearman rank correlation to ITC of milk	-0.0487	0.1512	*0.1987*	0.1211	**-0.2716**
Significance of Spearman rank correlation	-0.6504	0.1572	*0.0619*	0.2582	**-0.0100**

* Depreciation is not included.
** Only sales of agricultural production are accounted.
*** Gross margin to costs ratio (depreciation is accounted). Only sales of agricultural production are accounted.
By the end of 2006, €1=34.70 roubles.
Values printed in bold are significantly different from zero at α=0.05. Values printed in italic are significantly different from zero at α=0.1.

Source: author's calculations

Table 4. Internal transaction costs of animal production (excluding milk) on dairy corporate farms located in Moscow oblast (year 2006), roubles per rouble of revenue

Group number	Range of ITC of other animal production	Number of farms	Average ITC of other animal production
1	0.00…0.25	17	0.10
2	0.25…0.50	18	0.34
3	0.50…0.96	18	0.78
4	0.96…2.75	18	1.86
5	2.75…33.5	18	11.27
Whole sample	0.00…33.5	89	2.90

By the end of 2006, €1=34.70 roubles.

Source: author's calculations

relation to herd size may be rather due to differences in management practices between farms having different livestock number than due to an impact of farm size itself.

Relative ITC per rouble of crop production (table 6) are close to those of other animal production (table 4) and larger than in the case of milk. These costs are driven by amount of crop sales (table 7). As a consequence, the rank correlation between gross revenue and ITC of crop production is also significant. These dependencies are mainly caused by the fact that many small dairy farms do not produce marketable crops at all. Nevertheless, neither production costs nor profitability significantly correlate to the ITC per rouble of crop production.

5. Discussion and outlook

This section outlines a range of theoretical extensions and practical applications of the methodology developed in the paper.

An important extension of this study is to supplement ITC estimations by estimating allocative efficiency based on the common methodological framework. This extension shields the results from possible misinterpretation of high ITC. Providing that farm outputs are allocated closely to optima, there is no reason to take these costs into account. This study is affected by this problem to a limited extent, because large losses of the sample farms ensure that the non-optimal output allocation is dominant.

The theoretical model (4) defines ITC per unit of output precisely. However, any attempt to measure them is limited to a finite number of inputs and outputs. Thus, any empirical model would fail to completely refine ITC from other costs. Future studies and theoretical debates are expected to help develop empirical specifications that are little affected by this problem.

A vulnerability of the theoretical model (4) is that in practice, a DMU does not know the amount of ITC. Hence, they cannot be expected to behave in precise concordance with this model. In this respect, the estimates obtained based on this theoretical framework recover the ITC that are *expected* by decision-makers. Therefore, the recommendation to avoid them could be redundant, as the actual problem may rest on the human factor. Thus, formal estimations of ITC should be combined with case studies and questionnaires to be fully credible, unless the purpose of a study is to reject the significance of these costs.

Table 6. Internal transaction costs of crop production on dairy corporate farms located in Moscow oblast (year 2006), roubles per rouble of revenue

Group number	Range of ITC of crop production	Number of farms	Average ITC of crop production
1	no crop output	22	—
2	0.005…0.30	13	0.17
3	0.30…0.90	18	0.56
4	0.90…2.00	18	1.35
5	2.00…16.6	18	6.61
Whole sample	0.005…16.6	89	2.32

By the end of 2006, €1=34.70 roubles.

Source: author's calculations

Table 5. Relation between animal production (excluding milk) transaction costs and farm characteristics (year 2006)

Group number	Number of dairy cows	Production costs, thousand roubles*	Gross revenue, thousand roubles**	Profitability***, %
1	590	43 206	26 513	-6.9
2	758	41 147	28 723	-5.5
3	576	32 153	22 556	-8.5
4	536	31 526	21 011	-15.4
5	576	48 671	34 595	-9.4
Whole sample	607	39 297	26 681	-9.2
Spearman rank correlation to ITC of other animal production	**-0.2115**	0.0470	0.0790	-0.0122
Significance of Spearman rank correlation	**-0.0467**	0.6621	0.4618	-0.9097

* Depreciation is not included.
** Only sales of agricultural production are accounted.
*** Gross margin to costs ratio (depreciation is accounted). Only sales of agricultural production are accounted.
By the end of 2006, €1=34.70 roubles.
Values printed in bold are significantly different from zero at α=0.05.

Source: author's calculations

Table 7. Relation between crop production transaction costs and farm characteristics (year 2006)

Group number	Sales of crop production, thousand roubles	Production costs, thousand roubles*	Gross revenue, thousand roubles**	Profitability***, %
1	0	26 088	18 378	-13.9
2	1 677	53 756	31 471	-8.4
3	1 489	41 594	27 893	-11.0
4	1 733	41 365	28 057	-8.6
5	4 738	40 634	30 783	-2.6
Whole sample	2 464	39 297	26 681	-9.2
Spearman rank correlation to ITC of other animal production	**0.5845**	*0.1913*	**0.2094**	*0.1756*
Significance of Spearman rank correlation	**0.0000**	*0.0725*	**0.0489**	*0.0941*

* Depreciation is not included.
** Only sales of agricultural production are accounted.
*** Gross margin to costs ratio (depreciation is accounted). Only sales of agricultural production are accounted.
By the end of 2006, €1=34.70 roubles.
Values printed in bold are significantly different from zero at α=0.05. Values printed in italic are significantly different from zero at α=0.1.
Source: author's calculations

Another consideration of the applied methodology is that in practice the target ($\mathbf{x}_0$, $\mathbf{y}_0$) is likely to vary while a DMU attempts to locate it. So, $t(\mathbf{x},\mathbf{y})$ may change while making and implementing the decision and, hence, its properties might not be accessed. However, ex-post estimations do not face this problem, because unlike the DMU, a researcher has sufficient data about *the latest* target, which defines the unique $t(\mathbf{x},\mathbf{y})$. ITC estimates sufficiently reflect the costs that arise in case of changing decisions due to the elusive target.

One of the possible casual factors of large ITC in the studied sample is that farm owners are not motivated to invest or attract investors to cut these costs. The investment rating of Russian agriculture is low in comparison to other investment opportunities (ZELDNER, 2005), so investments in cutting ITC are unlikely. This problem may slow down a positive impact of economic reforms and cause a sceptical attitude on the part of both the rural population and farm managers with respect to the transitional process. Thus, studies on the links between investments in developing human capital, modern management systems, reengineering and improving decision-making processes, and the level of ITC are promising extensions of this research.

Another causal factor of large ITC that should be tested is that the existing agricultural policies tend to protect Russian farms from foreign competition. This situation decreases the motivation to cut ITC. Regardless of this particular reason, competition in regional agriculture needs to be improved. However, the current situation is such that stronger competition can cause the bankruptcy of the whole dairy milk sector rather than of a few outsiders. Consequently, each step in improving competition should be undertaken after a thorough analysis.

6. Conclusions

This study reveals high internal transaction costs on corporate dairy farms located in Russia's Moscow oblast. Only in 40% of the sample farms is the ITC of milk less than 1/3 of its sales price. In a quarter of the sample farms, ITC exceeds the price.

The farms do not necessarily bear these costs. It is more likely that they avoid such expenditures fully or partially. This distorts the allocation of marketable output and causes (together with other factors) the spread of unprofitable operations.

The presence of high ITC conforms to an earlier study (SVETLOV and HOCKMANN, 2007), which concluded that allocative inefficiency dominates other sources of inefficiency on the corporate farms located in the Moscow oblast.

In the presence of high transaction costs, price signals from the market are not the foremost factor of market output allocation. Indeed, they are unable to drive farm business to discover the most efficient use of available inputs and thereby become more competitive. Hence, the competitive market fails to play the role it is intended to play, thereby diminishing the value of economic reform in agriculture.

This may explain the current trend of institutional development in the Moscow oblast, which is characterised by the increasing role of non-market regulators of agricultural production. Political forces and external financing increasingly influence agricultural business. The implementation of the national project 'Development of agro-industrial complex' in 2006-2007 established a new phase in the progress of non-market regulations.

The theoretically predicted positive correlation between farm size and ITC is not revealed, probably due to the inclusion of only corporate farms in the sample. It is likely that a comparison of ITC among farms of different types (corporate farms, family farms and household plots) may show this dependence.

The outcome of this study supports the position that any developments aimed at reviving agriculture in the Moscow oblast should consider investments to lower ITC. In particular, the projects aimed at improving farm organisation, introducing less expensive and more efficient management, training existing staff and employing trained staff should, as a rule, precede other investments in the studied farms.

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Appendix

Lagrange functions Λ_1 and Λ_2 of problems (4) and (6) take the following form:

$$(8)\quad \Lambda_1(\mathbf{x},\mathbf{y},\boldsymbol{\kappa}) = \mathbf{wy} - \mathbf{vx} - t(\mathbf{x},\mathbf{y}) - \boldsymbol{\kappa}(\mathbf{y} - \alpha\mathbf{f}(\mathbf{x})),$$

$$(9)\quad \Lambda_2(\mathbf{x},\mathbf{y},\alpha,\boldsymbol{\kappa},\boldsymbol{\lambda},\boldsymbol{\mu}) = \mathbf{wy} - \mathbf{vx} - \boldsymbol{\kappa}(\mathbf{y} - \alpha\mathbf{f}(\mathbf{x})) - \boldsymbol{\lambda}(\mathbf{x}_1 - \mathbf{x}) - \boldsymbol{\mu}(\alpha\mathbf{y} - \mathbf{y}_1),$$

where $\boldsymbol{\lambda}$ is a vector of λ_k, $\boldsymbol{\mu}$ is a vector of μ_l, $\boldsymbol{\kappa}$ is a vector of Lagrange multipliers for the constraint $\mathbf{y} - \alpha\mathbf{f}(\mathbf{x}) = \mathbf{0}$, other notations follow Section 2.

Let $(\mathbf{x},\mathbf{y},\alpha,\boldsymbol{\kappa},\boldsymbol{\lambda},\boldsymbol{\mu})$ be a Kuhn-Tucker point for (9). Then Kuhn-Tucker conditions for (8) are satisfied for $(\mathbf{x},\mathbf{y},\boldsymbol{\kappa})$ providing that $\partial t(\mathbf{x},\mathbf{y})/\partial x_k = \lambda_k$ and $\partial t(\mathbf{x},\mathbf{y})/\partial y_l = \mu_l\,\alpha$. Giving as an example the conditions $\partial\Lambda_2/\partial x_k \le 0$ and $x_k \cdot (\partial\Lambda_2/\partial x_k) = 0$, one obtains from (9)

$$(10)\quad \begin{aligned} &\frac{\partial\Lambda_2}{\partial x_k} = -v_k + \alpha\boldsymbol{\kappa}\left(\frac{\partial\mathbf{f}(\mathbf{x})}{\partial x_k}\right) - \lambda_k \le 0,\\ &x_k \cdot \frac{\partial\Lambda_2}{\partial x_k} = x_k \cdot \left(-v_k + \alpha\boldsymbol{\kappa}\left(\frac{\partial\mathbf{f}(\mathbf{x})}{\partial x_k}\right) - \lambda_k\right) = 0. \end{aligned}$$

The corresponding Kuhn-Tucker condition derived from (8) is

$$(11)\quad \begin{aligned} &\frac{\partial\Lambda_2}{\partial x_k} = -v_k - \frac{\partial t(\mathbf{x},\mathbf{y})}{\partial x_k} + \alpha\boldsymbol{\kappa}\left(\frac{\partial\mathbf{f}(\mathbf{x})}{\partial x_k}\right) \le 0,\\ &x_k \cdot \frac{\partial\Lambda_2}{\partial x_k} = x_k \cdot \left(-v_k - \frac{\partial t(\mathbf{x},\mathbf{y})}{\partial x_k} + \alpha\boldsymbol{\kappa}\left(\frac{\partial\mathbf{f}(\mathbf{x})}{\partial x_k}\right)\right) = 0. \end{aligned}$$

From (10) it follows that (11) is satisfied given $\partial t(\mathbf{x},\mathbf{y})/\partial x_k = \lambda_k$. Validity of the remaining Kuhn-Tucker conditions for (8) in $(\mathbf{x},\mathbf{y},\boldsymbol{\kappa})$ can be demonstrated in a similar way.

Consequently, λ_k and μ_l obtained from (6) are valid estimators of $\partial t(\mathbf{x},\mathbf{y})/\partial x_k$ and $\partial t(\mathbf{x},\mathbf{y})/\partial y_l$ in any Kuhn-Tucker point, including optima of (4) and (6).