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ESTIMATING MANAGERIAL TRANSACTION COSTS ON DAIRY FARMS IN THE MOSCOW REGION

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To track changes in managerial transaction costs (MTC) on dairy corporate farms located in the Moscow oblast of Russia, the paper develops an estimator of such costs per unit of output. The estimator uses farm-level data on inputs, outputs and prices. The estimations are done using a non-parametric production frontier model. The estimates are consistent with theoretical predictions: improving allocative efficiency is achieved at the cost of growing dynamics of MTC, while within a cross section this correspondence is opposite; larger farms, as well as farms achieving higher technical efficiency, face higher MTC. In 2005-2007 the growth of MTC is likely to be driven by negative institutional changes, because no positive changes in the allocative efficiency is revealed during this period.

Key words: Managerial transaction costs, transaction costs function, production frontier, corporate farms, Russia, Moscow oblast, dairy production.

Institutional progress in Russian agriculture is a subject of many disputes. Existing literature considers the condition of internal farm institutions as a major cause of the slowdown of modernization [15]. These institutions remain underdeveloped, resulting in high transaction costs for agriculture and related parties [14, 16,25,26,27]. However, only a limited number of case studies [23] allows researchers to track a monetary dimension of institutional changes.

This study aims at partially filling the gap in the knowledge about presence or absence of institutional progress on Russian corporate farms, relying on the evidence from the dairy corporate farms located in the Moscow oblast. For this purpose, we develop a per-output managerial transaction costs estimator based on farm data on inputs, outputs and prices. We use the data of 1998 and 2005 to 2007. Using the obtained estimates, we address the following four hypotheses about the studied farms:

1) Managerial transaction costs (MTC hereafter) have not reduced since 1998;
2) MTC are higher on larger farms;
3) Low MTC help improving allocative efficiency;
4) Pursuing high technical efficiency increases MTC.

The first hypothesis inquires for time variation of MTC. It relies on the widely acknowledged incompleteness of agricultural reforms in Russia [15,27]. Year 1998 marked the end of a seven year period of rapidly declining agricultural production in Russia and therefore is chosen as a benchmark in this study.

The remaining hypotheses are static in nature.

The second hypothesis originates in R. Coase's [5] statement that reads '...apart from variations in the supply price of factors of production to firms of different sizes, it would appear that the costs of organising and the losses through mistakes will increase with an increase in the spatial distribution of the transactions organised, in the dissimilarity of the transactions, and in the probability of changes in the relevant prices'.

To motivate the third hypothesis, we take into consideration the heterogeneity of internal farm institutions, the heritage of incomplete transitional process. Under homogeneous institutions higher allocative efficiency is likely to be achieved at higher MTC, as more interactions are needed to stay closer to the optimum under volatile prices and changing technology. In case of the hypothesized institutional heterogeneity the situation is opposite. On farms with insufficient institutes high MTC retain low allocative efficiency. So, the third hypothesis, if accepted, enlightens incompleteness of transition processes regarding to the internal farm institutions.

The fourth hypothesis relies on contradiction between technical performance and allocative efficiency. The topmost technical perfection needs almost complete use of production capacity. As a consequence, the space for adjusting output allocation shrinks, pushing MTC up.

The proposed estimator and the developed analytical approach expand the ability of institutional studies to generate definite policy advice based on quantitative background. In addition to the aforementioned methodological relevance, an expected impact of this study is due to the contribution in objective evaluation of the institutional reforms pathway in Russian agriculture. Specifically, rejecting the first hypothesis would favor the existing institutional changes in the region. Rejecting the second hypothesis would support preserving prevalence of large-scale corporate farms. Testing the third and the fourth hypotheses is mainly of the theoretical relevance: if accepted, these hypotheses support adequacy of the theoretical model underlying this study.

The rest of the paper is organized as follows. Section 2 reviews literature that deals with quantifying transaction costs. Section 3 covers methodological issues, including a specification of MTC, constructing the estimator, the proposed approach to averaging MTC estimates and hypothesis testing procedures. Section 4 introduces empirical models and describes the data. The results follow in Section 5 and Section 6 concludes the paper.

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Literature on measuring transaction costs

The initial step to addressing the research hypotheses of this study is estimating MTC. An extensive review of relevant studies issued before 2000 can be found in Section 2.3 of Furubotn & Richter [11]. We extend this review with the recent literature addressing agricultural and related enterprises.

The majority of publications that deal with transaction costs can be classified on how these costs are revealed: *first*, by direct observation; *second,* by testing significance; *third,* via estimation from some relevant data.

The studies that belong to *the first group* usually rely on surveys[1]. Many studies use the data about transaction costs as exogenous variables of econometric models.

[1] McCann et al. (2005) consider three more data sources: government reports, financial reports and proposed budgets.

For instance, Peerlings and Polman [21] construct profit function of Dutch dairy farms and conclude that lower transaction costs enlarge the supply of wildlife and landscape services. In the study of Falconer et al. [7] a specific observable part of MTC, namely costs of administering environmentally sensitive areas in England, is an endogenous variable. It is assumed to depend on the area under agreement, the number of agreements, the policy scheme age and a set of area-specific characteristics. The model is used to determine factors that influence the administrative costs. A review in McCann and Easter [19] provides extensive information about many other studies that rely on directly observed components of transaction costs.

The studies belonging to *the second group* test the field data against estimates based on a pair of different theoretical models that assume either absence or presence of transaction costs. To the best of the author's knowledge, all such studies [3, 13] reject the specifications that ignore transaction costs.

The body of *studies under the third group* is relatively limited. Nevertheless, they are especially interesting for this study, which falls into this group as well. These studies quantify transaction costs (or their components) as unobservable parameters of specific empirical models. Vakis et al. [28] recovers market transaction costs from the observed choice among available marketplaces by Peruvian farmers. Park et al. [20] estimates market transaction costs from the parity-bounds model as observed price differences in pairs of Chinese grain markets. Svetlov [24] approaches per-output MTC using observed inputs and outputs of Russian corporate farms.

Two of the above listed papers mention the estimations of *transaction costs function.* Kanes and Ciaian [13] report two approaches for revealing transaction costs of farm (re) organization: (i) calculating productivity ratios from the production data; and (ii) estimating transaction cost functions. However, they consider the second approach as vulnerable on three reasons. First, it requires arbitrary assumptions of a specific functional form and estimation method. Second, it is influenced by the choice of explanatory variables. Third, it faces difficulties in accessing unobservable parts of transaction costs. Undoubtedly, two former objections can be attributed to any parametric econometric model. Svetlov [24] estimates local properties of farm-specific MTC functions from a non-parametric production frontier. This approach partially avoids the problems mentioned by Kanes and Ciaian [13] insofar as it does not require to specify the functional form of MTC function.

The majority of available literature assesses either market or overall transaction costs. The exclusions which are focused on MTC are Falconer et al. [7] and Svetlov [24]. The former explores the specific component of MTC that is relatively easy to observe, namely policy administrative costs. The latter attempts to measure total MTC relative to outputs, which is applicable for testing the hypotheses of this study and uses relatively accessible data. However, due to shortcomings in the methodology, which are criticized in Section 0, the reported results are biased upwards. This study inherits from Svetlov [24] the idea of estimating MTC via modeling production frontier but develops a more accurate theoretical framework and estimation procedure.

Methodology

Managerial and market transaction costs: how to specify?

The general idea of transaction costs is expressed by Coase [5]: 'The main reason why it is profitable to establish a firm would seem to be that there is a cost of using the price mechanism'. After Coase, many specifications of transaction costs appeared. Section 2 of McCann and Easter [19] provides an extensive list of such definitions, neither of which implies a comprehensive and unambiguous procedure of counting transaction costs. So, empirical studies require further specifications, which are often questionable. For example, should some opportunity costs (like the forgone effect of a contract that might be signed unless long lasting negotiations) be included in the transaction costs, as Makhura [17, p. 28] suggests? If yes, is there a rule that defines a part of opportunity costs that should be included in transaction costs? Is output transportation cost a part of production or transaction costs etc.?

The common definition of *managerial* and *market* transaction costs is based on the concepts of internal and external suppliers [1]. Given firm boundaries, an internal supplier is inside them and an external supplier is outside. The costs that the firm incurs from interacting with the external supplier are market transaction costs and those emerging from due to interaction with the internal supplier are MTC. Furubotn & Richter [11, p. 54-55] follow this principle and provide a list of costs to be reckoned as MTC. The definitions of such type are sufficient for most ofthe theoretical and straightforward quantitative analyses. The latter, unfortunately, require very rich data. Therefore, a methodology of estimating MTC from accessible microeconomic data needs another specification.

This paper proposes a specification of MTC that is based on their effect. When a firm makes expenses to interact with internal suppliers, it seeks the best allocation of inputs and outputs. While interacting with external suppliers, it seeks the best price. Thus, the ad hoc specification of MTC is *the costs of allocating inputs and outputs.* These costs include, in particular, data collection and processing, research, planning, negotiation and enforcement of the desired allocation. The implications of this specification are that (i) only those transportation costs are included in MTC that incur during input-output allocation; and (ii) only those opportunity costs are included in MTC that arise due to difference between the actual and desired output allocation. Actually, this ad-hoc definition matches all the components of MTC listed by *Furubotn & Richter* [11], but also includes the relevant part of opportunity costs.

Estimator of managerial transaction costs

The proposed concept of MTC estimator is essentially develops the concept of transaction as an activity introduced by *Foley* [10]. This theoretical framework allows separating transactions from other activities and, forth, transaction costs from costs and revenues from other activities. To develop the estimator, we start from the below listed set of assumptions about a firm.

First, the firm, ceteris paribus, is assumed to prefer higher profit from sales $\mathbf{w'y - v'x}$, where x is a non-negative vector of inputs, excluding inputs in the activities that form MTC; y is a non-negative vector of outputs; $\mathbf{v}$ is a non-negative input price vector; $\mathbf{w}$ is a non-negative output price vector. *Second,* all inputs, excluding those that form MTC, are fixed[1], so x is constant. *Third,* the firm is a price-taker, but different firms still may face different prices due to segmented markets. *Fourth,* the firm chooses an output mix from a projection of a production frontier *aF(x),* where a is a technical efficiency term such that $0 < a < 1$. The production frontier is a continuous, finite, convex and non-decreasing correspondence from x to a non-empty, continuous and convex set of output mixes $\{y \mid y \in F(x)\}$, none of which Pareto-dominates any other. It is provided that $F(\mathbf{0}) = \{\mathbf{0}\}$. However *(fifth*), a manager of the firm has no information about *F(x),* excluding a small

[1] Variable inputs would add some complexity to fonnulae below with no actual effect on implications.

vicinity of the current output mix **a.** *Sixth,* if the manager decides to change this output mix pursuing higher profit, the only available way to do so is to initiate transaction activities on the firm at the cost t_a(y). where y is a resulting output allocation. *Seventh,* t_a(y), hereafter called an ***MTC function,*** is continuous, positive, finite and smooth in all **y≠a,** and has a unique zero in point **a.** For any y≠**a** a directional derivative of $t_a(y)$ towards **a** is assumed to exist and be negative. In point **a** directional derivatives towards any direction exist and are non-negative[1]. *Eighth,* just as the production frontier, the MTC function is known to the manager only locally.

Under these assumptions the manager can make a rational choice only within a small vicinity of the current output allocation. Therefore, they increase profit in a step-by-step manner. The sequential step is made only when incremental profit exceeds incremental MTC. Formally, providing that Δ**y** is an infinitely small change in output allocation along the frontier's projection ***aF(x),*** the firm rests on a *trap* output allocation b ϵ ***aF(x)*** such that

$$\frac{\mathbf{w}'\Delta\mathbf{y}}{|\Delta\mathbf{y}|} \le (t_{\mathbf{b}}(\mathbf{b}))'_{\Delta\mathbf{y}} \tag{1}$$

for each **Ay,** where $(t_b(\mathbf{b})'_{\Delta\mathbf{y}}$ is a directional derivative of t_b**(b)** towards **Ay** and |Δ**y**| is an Euclidean norm of Δ**y.**

From inequality (1) it follows that if a firm's current output mix is a trap, information about **(w'Δy)/|Δy|,** if available, determines a lower boundary of $(t_b(\mathbf{b}))'_{\Delta y}$. In particular, assume that adjusting only one output is subjected to non-zero MTC. Given a single-output profit function

$$p(a_i) = \max_{y}\,(\mathbf{w}'\mathbf{y} - \mathbf{v}'\mathbf{x} \,|\, \mathbf{y} \in \alpha F(\mathbf{x}),\ y_i = a_i), \tag{2}$$

let **b** be such that

$$\mathbf{b} = \operatorname*{argmax}_{y}(\mathbf{w}'\mathbf{y} - \mathbf{v}'\mathbf{x} \,|\, \mathbf{y} \in \alpha F(\mathbf{x}),\ y_i = b_i)$$

and the corresponding Δ**y** be

$$\left(\lim_{\delta\to 0} \operatorname*{argmax}_{y}\,(\mathbf{w}'\mathbf{y} - \mathbf{v}'\mathbf{x} \,|\, \mathbf{y} \in \alpha F(\mathbf{x}),\ y_i = b_i + \delta)\right) - \mathbf{b},$$

where *S* is positive, vector y consists of **y**, and vector **b** consists of b_i. If a derivative d$p(b_i)/dy_i$ exists in the point **b,** its absolute value equals **(w'Δy)/|Δy|.** So, from inequality (1) it follows that

$$\frac{dp(b_i)}{db_i} \le \begin{cases} (t_{\mathbf{b}}(\mathbf{b}))'_{\Delta y} \text{ if } \dfrac{dp(b_i)}{db_i} \ge 0; \\ (t_{\mathbf{b}}(\mathbf{b}))'_{-\Delta y} \text{ otherwise.} \end{cases} \tag{3}$$

[1]A graph of the simplest function meeting all the requirements for $t_a(y)$ could be a cone with vertex **a.**

The same approach can be extended to the case of a multi-output profit function. The reservation should be made that, since *F(x)* is not necessarily smooth, *clp(b.)/clb.* may not exist for some **b.**

So, providing that the above formulated assumptions hold and subject to this reservation, the absolute value of $dp(b_i)/db_i$. which equals **(w'Δy)/|Δy|,** *estimates the lower boundary of the corresponding directional derivative of the MTC function.* It allows the burden of MTC to be attributed to the specific *i*-th output.

Thus, subject to validity of the assumptions made in the beginning of this section and presence of firm-level input-output and price data, one can estimate lower boundaries of directional derivatives of MTC function. Among them, those seem to be the most useful for economic analyses that characterize the MTC arising while adjusting just a single output (per-output MTC hereafter). The corresponding estimates are absolute values of $dp(b_i)/db_i$.

The same approach can be extended to the case of a multi-output profit function $p(b_m)$. where b_m is a vector of such outputs that cannot be adjusted without generating non-zero MTC. Such function enables us to address a more general case of non-zero MTC arising while adjusting more than one output. In this case, the corresponding estimate regarding to output z will be $\partial p(\mathbf{b}_m)/\partial b_i$.

Averaging transaction cost estimates

The absolute value of $\partial p(\mathbf{b}_m)/\partial b_i$ can be represented as a tangent of the slope of $p(\mathbf{b}_m)$ along the z-th axe. A priori such slopes can be assumed to be distributed uniformly over [0; π/2]. In this case the corresponding distribution of tangents has an infinitely large mean. As a consequence, any *sample* estimation of this mean is low-biased inasmuch as any sample will yield a finite estimate, excluding an infinitely small chance.

On this reason, the arithmetic mean of a finite number of the estimated absolute values of $\partial p(\mathbf{b}_m)/\partial b_i$ appears meaningless. The suggested workaround is to average slopes themselves (instead of their tangents) and then take a tangent of the result:

$$\tan\left(\frac{\sum_{k=1}^{n}\arctan(|\partial p(\mathbf{b}_{mk})/\partial b_{ik}|)}{n}\right), \tag{4}$$

where *n* is the number of firms, z is an index of an output and *κ* indexes firms, while *m* marks the vector including only those outputs that are subjected to non-zero MTC. Hereafter, the mean values computed using formula (4) are called *arctangential averages.* Any average value of per-output MTC estimates that appears in this paper below is an arctangential average.

Hypotheses testing procedures

The non-parametric Wilcoxon matched pairs test is used to address *the first research hypothesis* about non-diminished MTC during the studied period. It is rejected when (i) the aforementioned test rejects absence of significant difference in MTC estimates between two subsamples associated with years 1998 and 2007 and (ii) the arctangential average MTC in the earlier year exceeds that in the later year.

Testing the second hypothesis about higher MTC burden on larger farms requires a measure of farm size. This study is limited to only one farm size proxy, which is gross revenue from sales of agricultural production. Given per-output MTC estimates, we analyze the dependence of MTC per each output on this proxy. The *second hypothesis* is rejected in a given year if *any* of the following two conditions is fulfilled: (i) presence of significantly negative Spearman rank correlations between the estimated MTC per either output and total sales of agricultural production; or (ii) absence of significantly positive rank correlations. To test significance of Spearman rank correlations, Mest is applied.

The remaining hypotheses about correspondences of allocative and technical efficiency to MTC are also tested through Spearman rank correlations between per-output MTC estimates and the corresponding efficiency scores. The latter are discussed in [6]. Specifically, *the third hypothesis* is rejected, given the set of outputs, in case of either (i) absence of significantly negative Spearman rank correlations between per-output MTC estimates and allocative efficiency scores, or (ii) presence of at least one significantly positive correlation. *The fourth hypothesis* is rejected if (i) neither of Spearman rank correlations between per-output MTC estimates and technical efficiency scores is significantly positive, or (ii) at least one rank correlation is significantly negative.

Empirical models and data

Non-pctrame trie production frontier

As it follows from *Fare et al.* [8], production frontier $F(x)$ in (2) can be represented as the supremum of the set of possible outputs subject to given inputs (output-oriented specification). For the purpose of this study, the non-parametric output-oriented specification [4] with variable return to scale [2] is used. The output-oriented specification is chosen because the aggregated inputs of the studied farms are virtually fixed in the short-term period (either by their nature or due to existing trade barriers). Assumption of variable return to scale is intended to capture farm scale effects, which otherwise might cause biased estimates. The resulting specification of production frontier /'(x) is as follows:

$$\sup Y_t(\mathbf{x}_{nt}),$$

$$\text{where} \qquad Y_t(\mathbf{x}_{nt}) = \{\mathbf{y} \mid \mathbf{y} + \mathbf{s}_y = \mathbf{Y}_t\boldsymbol{\beta};\ \mathbf{x}_{nt} = \mathbf{X}_t\boldsymbol{\beta} + \mathbf{s}_x;\ \mathbf{i}'\boldsymbol{\beta} = 1;\ \boldsymbol{\beta}, \mathbf{s}_x, \mathbf{s}_y \geq 0\} \tag{5}$$

where x_{nt} is a constant non-negative vector of observed annual inputs of farm n in year t; X_t is a constant matrix that consists of columns x_{nt}, $n \in N$: N is a set of all farms in the sample; Y_t is a constant matrix that consists of non-negative columns y_{nt}, each representing observed annual outputs of farm n, $n \in N$, in year t; $\boldsymbol{\beta}$ is a variable non-negative vector of weighting factors associated with each input-output pair (x_{nt}, y_{nt}); $\mathbf{i}$ is a vector of ones; s_x and s_y are vectors of variable residuals that represent unused amounts of inputs and outputs, respectively. The constraint $\mathbf{i}'\boldsymbol{\beta} = 1$ imposes variable return to scale.

Estimating overall technical and allocative efficiency

As it follows from Subsection 0, the tests for the first, third and fourth research hypotheses require estimates of either allocative or technical efficiency scores. According to the definition of technical efficiency [9] and the specification of the production frontier (5), a technical efficiency score a_{Tnt} of a farm n in year t can be estimated from the linear program

$$\min_{\alpha_{Tnt},\ \boldsymbol{\beta},\ \mathbf{y},\ \mathbf{s}_x,\ \mathbf{s}_y} \quad \alpha_{Tnt} + \varepsilon\mathbf{s}_x + \varepsilon\mathbf{s}_y$$
$$\text{subject to} \tag{6}$$
$$(1/\alpha_{Tnt})\mathbf{y}_{nt} = \mathbf{y};$$
$$\mathbf{y} \in Y_t(\mathbf{x}_{nt}),$$

where ε is a non-Archimedean element that is greater than zero but less than any real positive number [6] and the remaining symbols follow (5).

Charnes (1994) defines the allocative efficiency score as $o._{Ant} = a_{Ont} / a,_{Tnt}$, where a_{Ont} is overall efficiency score of a firm *n*. In turn, assuming fixed inputs, the definition of overall efficiency score *(ibid.)* can be rewritten in terms of (5):

$$\alpha_{Ont} = \frac{\mathbf{w}'_{nt}\mathbf{y}_{nt}}{\mathbf{w}'_{nt}\left(\underset{\mathbf{y}\in\sup Y_t(\mathbf{x}_{nt})}{\arg\max}\,(\mathbf{w}'_{nt}\mathbf{y} - \varepsilon\mathbf{s}_x - \varepsilon\mathbf{s}_y)\right)} \tag{7}$$

where w_{nt} is a vector of *n*-th farm's output prices in year *t.* while other notations follow (5) and (6). In this expression the numerator is a constant and the denominator is obtained by maximizing $(\mathbf{w}_{nt}\mathbf{y} - \varepsilon\mathbf{s}_x - \varepsilon\mathbf{s}_y)$ subject to the linear constraint $y \in Y_t(\mathbf{x}_{nt})$.

Estimating MTC

Per-output MTC estimates are obtained through the specification of multi-output the profit function $p(\mathbf{b}_m)$, which is introduced in Subsection 0, based on the empirical production frontier (5):

$$\max_{\alpha,\ \boldsymbol{\beta},\ \mathbf{y},\ \mathbf{s}_x,\ \mathbf{s}_y} \quad \mathbf{w}'_{nt}\mathbf{y} - \varepsilon\mathbf{s}_x - \varepsilon\mathbf{s}_y$$
$$\text{subject to} \tag{8}$$
$$(1/\alpha)\mathbf{y}_{nt} = \mathbf{y};$$
$$\mathbf{y} \in Y_t(\mathbf{x}_{nt}).$$

In this linear program *a* is an efficiency term (whose optimal value always equals a_{Tn}) and the remaining symbols follow (5) - (7). The vector of observed outputs y_{nt} is assumed to be a trap, in which the *n*-th farm has been stuck in year *t* due to MTC that make further adjustment of output mix unprofitable. So, it matches h_m in Subsection 0. The term **vx** in formula (2) is constant (since inputs **x** are assumed to be fixed) and thus does not need to be specified in (8). In the case of the studied sample the assumption of fixed inputs should be adopted, as the majority of farms in the sample persistently involve inputs in the production process even though making losses (see Table 1 below). The terms εs_x and εs are explained in Cooper et al. [6].

Insofar as the optimal solution of the linear program (8) matches the optimal solution of the problem (6) the linear program (8) could have little value by itself, unless the corresponding dual problem is set and solved. Let \ be a vector of $\partial p/\partial yi$, $\boldsymbol{\lambda}_x$ be a vector of $\partial p/\partial x_{int}$, $\boldsymbol{\lambda}_y$ be $\partial p/\partial(\mathbf{i}'\boldsymbol{\beta})$ and λ_{0y} be a vector of $\partial p/\partial y_{int}$, where *p* is optimal profit in problem (8). Moreover, let y_i and y_{int} be components of y and $\boldsymbol{y}_{nt}$ correspondingly, x_{jnt} be a component of x_{nt}, i be a vector of ones. Then the linear program

$$\begin{aligned}
&\min_{\boldsymbol{\lambda}_y, \boldsymbol{\lambda}_{0y}, \boldsymbol{\lambda}_x, \lambda_s} \quad \lambda_s + \mathbf{x}'_{nt}\boldsymbol{\lambda}_x \\
&\text{subject to} \\
&\mathbf{y}'_{nt}\boldsymbol{\lambda}_{0y} = 0; \\
&\boldsymbol{\lambda}_{0y} - \boldsymbol{\lambda}_y \geq \mathbf{w}_{nt}; \\
&\mathbf{Y}'_t\boldsymbol{\lambda}_y + \mathbf{X}'_t\boldsymbol{\lambda}_x + \lambda_s \geq \mathbf{0}; \\
&\boldsymbol{\lambda}_y \leq \varepsilon \mathbf{i}; \ \boldsymbol{\lambda}_x \geq -\varepsilon \mathbf{i}
\end{aligned} \tag{9}$$

is a dual problem for the problem (8). Optimal values of the components of the vector $a_{Tnt}\boldsymbol{\lambda}_{0y}$ match the term $\partial p(\mathbf{b}_m)/b_i$ introduced in Subsection 0 inasmuch as the vector y_{nt} is assumed to be a trap output allocation that satisfies the condition (1). Hence, absolute values of the components of $a_{Tnt}\boldsymbol{\lambda}_{0y}$ estimate per-unit MTC subject to the reservation that problem (9) may have alternative solutions regarding to $\boldsymbol{\lambda}_{0y}$.

Chart illustrates the estimation procedure. Point *A* represents actual farm's output data in a space defined by two outputs. The polygon *EF* is a production frontier and *GH* is the location of farms that achieve a technical efficiency score $a = |0A|/|0B|$, including the farm *A*. Point *B* is an efficient projection of *A*. Adding a differential ∂y_1 to the first output of the farm *A* results in a new efficient projection *C* and a corresponding α-efficient location *D*. Let *p(X)* be a profit of a farm whose outputs match point *X;* then *p(C) - p(B)* matches $\boldsymbol{\lambda}_{0y1}$, providing that the vector λ_{0y}, which appears in the problem (9) consists of $\boldsymbol{\lambda}_{0y1}$. Correspondingly, the difference *p(D)-p(A),* which equals *a(p(C)-p(B)),* matches $\partial p(A)/\partial y_1$ as defined in expression (3). If this difference is positive then the per-unit MTC that retain the farm *A* from moving towards *D* are either larger or at least equal. If the difference is negative then the same per-unit MTC hamper evolution in the opposite direction.

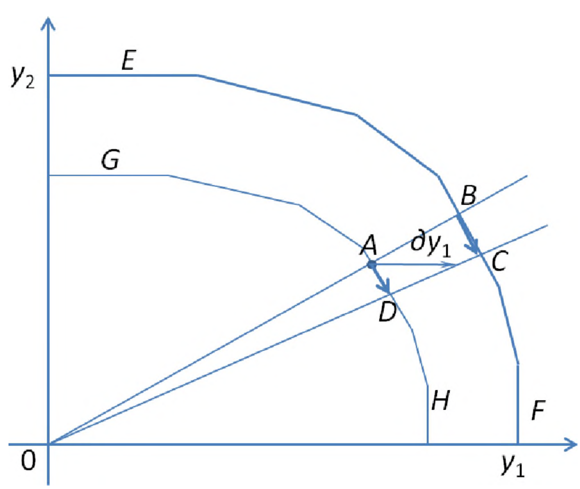

Illustration of obtaining MTC estimator from the problem

Presence of alternative solutions corresponds to possible non-existence of the estimator that has been admitted in Subsection 0. In particular, this always happens when a_{Ant} equals one. On this reason, the estimator has not been computed for allocatively efficient farms. In interpretation, it is reasonable to assume per-unit MTC in such farms close to zero, as these costs do not actually diminish their allocative efficiency. As for the cases $a_{Ant}<1$, absence of alternative solutions can be empirically tested by varying y_{nt} in a vicinity of its observed value.

The test is passed if λy remains unchanged. In this study this test has been applied to 40 randomly selected observations and found no cases of alternative solutions.

Summing up, to empirically estimate the lower bound of per-unit MTC, the following procedure is suggested: (i) set and solve problems (6) and (7); (ii) compute allocative efficiency scores using the results of the previous step; (iii) sort out allocatively efficient farms; (iv) set and solve problem (9), use the absolute value of the resulting vector λ_{0y} as the estimate. The procedure is repeated for each observation. Linear programming problems have been solved using Sunset XA software for Microsoft®) Excel®). Routines written in VBA by the author have been applied to perform remaining computations.

Data

In this study we use annual data of 1998 and 2005-2007 from the Registry of large and medium corporate farms located in the Moscow oblast of Russia (compiled by Russian federal statistical agency). Year 1998 is of special interest as a base for tracking MTC changes because of the radical turn in Russian agricultural production dynamics, which has also spanned the Moscow oblast.

For the research purposes we compose the sample that consists of the farms matching the set of criteria listed below. First, they gain at least 1/3 of total revenue from sales of dairy milk. This share focuses this study on dairy milk production on the diversified corporate farms, which are typical for the region. Second, the sample farms sell less than 14 tons of milk per dairy cow. This way we sort out resellers and possible data errors. Third, the farms have at least 0.2 hectares of farmland per dairy cow and have neither pigs nor poultry. This condition excludes agricultural firms of industrial type, whose technologies are not applicable on a typical diversified farm that extensively uses farmland and rely on self-sufficiency in fodder. The resulting number of cases in the sample is 210 in 1998, 206 in 2005, 130 in 2006 and 167 in 2007.

In this study the set of outputs, which defines the components of y_{nt}, includes dairy milk, animal output excluding milk and crop output. All outputs are measured in thousand roubles. The monetary values are inflated to 2007 using agricultural production price indices from Goskomstat [12] and Rosstat [22]. Only a marketed production is reckoned as output.

In accordance to the theoretical model we rely on, the MTC are isolated from the profit function and do not affect its value. On this reason, the set of fixed inputs in the empirical specification is such that it avoids the inputs falling into the definition of MTC suggested in Subsection 0 *(i.e.*. the costs of allocating inputs and outputs) insofar as the available data allow. In particular, neither component of management and organizational costs is included in this set. Each vector x_{nt} consists of arable land in use (hectares), hayland and grassland (hectares), number of dairy cows, number of agricultural workers, depreciation (thousand roubles) as a proxy for fixed production assets, production and marketing costs excluding labour costs and depreciation (thousand roubles) as a proxy for floating assets. The monetary values are inflated to 2007 using industrial production price indices from Goskomstat [12] and Rosstat [22].

Descriptive statistics of the data set can be found in Appendix. As for 2007, a typical sample farm obtains circa a million Euro from sales of milk, which makes 74% of total sales. On average, profits amount to 14% of total sales. They are gained mostly due to crop output. However, 78% of farms, mostly smaller ones, make losses. The production resources are the dairy herd as large as 630 cows and farmland as large as 2824 hectares, of which 2320 hectares are actually used arable lands. So, the typical farm yields only 359 Euro of total revenue per hectare and 1608 Euro per cow. The revenue per worker, which is 8414 Euro, largely increased (by 4500 Euro) in comparison to 1998 due to both outflow of labour force and risen total revenues. For the reference, by the end of 2007 one Euro equals 35.93 Russian roubles.

Results

As soon as per-unit MTC estimation procedure does not provide estimates for allocatively efficient farms, this section discusses subsample of farms experiencing allocative inefficiencies. Table 1 characterizes this subsample. Wilcoxon matched pairs test examines significance of differences between 1998, on one hand, and 2005 to 2007, on another. To test changes in number of allocatively inefficient farms, we code efficient farms with 1 and others with 0. Throughout the tested differences, the minimal number of matched pairs is 63.

The decreased share of allocatively inefficient farms (by 15.9 percent points) is not significant, as the test considers matched pairs only. So, this large difference is mostly due to the composition of the sample: many farms that were inefficient in 1998 cancelled operation by 2007. As for 2007, no evidence is found of significant changes in production and marketing costs since 1998, while their 8.6% growth since 2005 appears significant. Increased revenue since 1998 suggests improved efficiency. Average losses reduced by 281 thousand Euro per annum since 1998. However, each Euro of sales still brings 35 cents of losses, in contrast to the whole sample, which includes allocatively efficient farms, therefore being profitable on average. Large progress in dairy herd productivity increased milk sales almost twice during the period 1998 to 2007 despite significantly decreasing number of dairy cows.

The data of Table 2 *do not reject the first research hypothesis* of this study about non-diminished MTC during the studied period. Since 1998 MTC per unit of two out-

Table 1

Characteristics of allocatively inefficient farms in the sample

	Years				2007 to 2005*	2007 to 1998*
	1998	2005	2006	2007		
Percent of allocatively inefficient farms	91.9	84.0	70.8	76.0	-7.9	-15.9
Average production and marketing costs, thousand roubles**	51992	53411	50428	58016	108.6%	111.6%
Average revenue from sales of agricultural production, thousand roubles	26726	37423	35527	42832	114.5%	160.3%
Average short-term profit**, thousand roubles	-25266	-15988	-14901	-15184	+804	+10082
Average number of dairy cows	664	520	636	589	113.2%	88.7%
Average dairy milk sales, thousand roubles	16962	27711	27034	32942	118.9%	194.2%

* Significant differences at or = 0.05 are printed in **bold** (Wilcoxon matched pairs test). The remaining differences are insignificant at *a* = 0.1.

** Depreciation is excluded from costs.

All monetary values are inflated to 2007.

Source: author's calculations.

Table 2

Efficiency scores and per-unit MTC estimates in allocatively inefficient sample farms

	Years				2007 to 2005*	2007 to 1998*
	1998	2005	2006	2007		
Average efficiency scores						
Overall	0.36	0.60	0.69	0.64	+0.05	**+0.28**
Technical	0.49	0.70	0.80	0.80	**+0.10**	**+0.31**
Allocative	0.75	0.85	0.86	0.81	**-0.05**	**+0.06**
Average MTC (roubles per rouble of an output, arctangential average)						
Milk	0.07	0.12	0.09	0.13	+0.00	**+0.05**
Animal production excluding milk	0.17	0.30	0.21	0.37	+0.07	**+0.19**
Crop production	0.21	0.19	0.23	0.20	**+0.01**	-0.01

* Significant differences at or = 0.05 are printed in **bold** and those at or = 0.1 are printed in *italic* (Wilcoxon matched pairs test).

Source: author's calculations.

puts out of three significantly increased. It should be noted that one of these two outputs is dairy milk, which is the major output of the studied farms. In turn, the decrease of MTC per unit of crop production does not significantly differ from zero. During a shorter period from 2005 to 2007, in opposite, the MTC associated with animal products remain almost unchanged (no statistically significant difference), while those associated with crop production significantly increase within the set of matched pairs of farms. It should be noted, however, that the number of matched pairs of MTC per unit of crop production is limited: 34 while matching 1998 and 2007 and 49 while matching 2005 and 2007.

Further insight bases on the idea that improved allocative efficiency likely pushes MTC up, because it is more costly to fit into the narrow surrounding of an efficient output allocation. Indeed, a statistically significant growth of allocative efficiency since 1998 is observed, largely as a consequence of disbanding the least competitive farms. However, during 2005-2007 the allocative efficiency was significantly degrading without cutting down per-unit MTC. Such situation rather suggests regressive evolution of internal farm institutions during this period.

As it follows from Table 2, the major reason for the developments demonstrated by Table 1 is the significant progress in technical efficiency. The contribution of diminished allocative inefficiency is secondary. The remaining resource of avoiding allocative inefficiencies could improve total revenue by 19% at unbelievable best, which is still insufficient to achieve profitability. Even completely overcome overall inefficiency could only result in 133 roubles of short-term profit per one thousand roubles of sales. Further developments require either different technology or different prices.

It is expected that the institutional environment for internal transactions favours the major output. The per-unit MTC of milk, which is the major output of the studied farms, are continuously the lowest among the three outputs. The marginal level of milk MTC amounts to 13% of revenue from milk sales, which does not make the topmost problem for the studied farms. Savings on these costs cannot largely reduce the level of losses.

However, the farms are not homogeneous with respect to the level of per-unit MTC. Table 3 addresses this issue and reveals the background of soaring MTC during the period from 1998 to 2007.

In 1998 MTC per unit of milk amounted to less than 5% of sales on more than a half of the studied farms. So, these costs affected the adjustment of milk production to a very limited extent. The group of farms that could consider the MTC burden as a severe problem (more than 25% of revenue) included only 5.6% of the allocatively inefficient farms. By 2007 the situation changed: the share of farms exercising less than 0.05 roubles of MTC per rouble of sold milk reduced by 34.3 percent points. As for the group above 0.25 roubles per rouble, it grew by 6.6 points, amounting to 12.4%. The situation with MTC per other outputs is similar: during the studied period the groups with higher MTC grew.

In a few farms the revealed per-output MTC exceed revenue. Surely, such large MTC are not actually exercised. Instead, the farms just avoid possible gains that are available by improving allocative efficiency at such high costs.

Table 3

Percent of MTC estimates that do not exceed the threshold

MTC, roubles per rouble of output	Years			
	1998	2005	2006	2007
Milk				
< 1	100.0	100.0	100.0	100.0
< 0.5	98.3	96.9	98.8	97.6
< 0.25	94.4	89.4	95.3	87.8
< 0.1	75.1	55.3	64.0	55.3
< 0.05	51.4	19.3	18.6	17.1
Other animal production				
< 5	100.0	100.0	100.0	100.0
< 1	96.1	94.0	100.0	99.0
< 0.5	91.1	59.0	83.1	43.4
< 0.25	77.2	29.9	25.4	17.2
< 0.1	51.7	8.5	5.1	4.0
Crop *production*				
< 5	100.0	99.0	100.0	100.0
< 1	100.0	97.1	95.2	97.1
< 0.5	92.2	72.5	72.6	67.6
< 0.25	49.4	44.1	41.9	26.5
< 0.1	12.3	18.6	16.1	11.8

Allocatively efficient farms are omitted.
Source: author's calculations.

Table 4 provides insight into the remaining hypotheses of this study. Having applied the procedure described in Subsection 0, *the second hypothesis* about higher MTC burden on larger farms *cannot be accepted in 2006 but holds in years 1998, 2005 and 2007.* The situation in three of the four studied years can be explained by the considerations of Coase [5], as discussed in Introduction. The decreased variation of sizes is a likely reason for the diminishing evidence of the expected correspondence: the variance coefficient of sizes changed from 1.0 in 1998 down to the minimum of 0.63 in 2006.

Table 4

Rank correlation of per-unit MTC estimates

	Years			
	1998	2005	2006	2007
Revenue from sales of agricultural production with:				
MTC of milk	**0.469**	**0.165**	0.012	**0.393**
MTC of other animal production	**0.510**	**0.256**	-0.046	**0.403**
MTC of crop production	**0.654**	-0.025	0.192	0.080
Allocative efficiency scores with:				
MTC of milk	0.101	**-0.206**	-0.012	**-0.249**
MTC of other animal production	-0.018	**-0.302**	**-0.413**	**-0.590**
MTC of crop production	**-0.229**	**-0.499**	-0.249	-0.238
Technical efficiency scores with:				
MTC of milk	**0.448**	**0.404**	**0.223**	0.106
MTC of other animal production	**0.644**	**0.573**	0.235	**0.410**
MTC of crop production	**0.795**	**0.377**	**0.350**	**0.320**

Allocatively efficient farms are omitted.

Significant correlations (at *a* = 0.05, t-test) are printed in bold. The remaining correlations are insignificant at a=0.1.

Source: author's calculations.

The third hypothesis reads that low MTC help improving allocative efficiency. *The estimates in Table 4 reject this hypothesis in neither year.* At least one per-unit MTC measure significantly and negatively correlates with allocative efficiency scores each year in absence of opposite situations. This result supports the supposition that the internal farm institutions are heterogenous due to incomplete institutional transition, as it is argued in Section 1.

The fourth hypothesis states that pursuing higher technical efficiency enlarges MTC by shrinking the spread for adjusting to market changes and adding complexity to managerial decision making. *Table 4 provides no evidence of opposite.* In each year we find at least two significantly positive correlations between technical efficiency scores and per-unit MTC estimates. Negative correlations are not observed.

Conclusions and outlook

In this paper we develop a procedure of estimating per-output MTC from microeconomic data on inputs, outputs and prices. The performed estimations show that the burden of MTC on dairy corporate farms in the Moscow oblast of Russia is moderate on average. It does not exceed 37% of revenue throughout the studied outputs and 13% regarding only dairy milk, on which the farms of the studied sample specialize. Thus, this burden does not belong to the list of topmost problems of the regional dairy sector in the sense that it does not seem to be a large resource for economies. However, the share of farms facing really outlying MTC above 50% of revenue from sales of secondary outputs grows overtime.

Although the relevance of this result to the economies on MTC is limited to part of the sample and mostly to secondary outputs, its theoretical relevance seems important. The estimated MTC per secondary outputs are sufficiently high to hamper market forces to allocate these outputs optimally in the neoclassical sense. As a consequence, the competitiveness of the whole sector in the global markets falls. Therefore, the presence of relatively high MTC per unit of secondary outputs is rather a sectoral problem than a problem of a farm. A political impact may be needed to help solving it.

The research hypotheses that are formulated in Section 1 are not rejected, with the exception of the second hypothesis in the case of year 2006. Acceptance of the first hypothesis complies with the observed growth of allocative efficiency. However, during the short period 2005-2007 there is an evidence in favor of degrading internal farm institutions. Acceptance of the second hypothesis confirms (with the reservation for year 2006) the theoretical prediction that larger farms bear higher MTC. Thus, it suggests relevance of the new institutional theory to the studied farms. Moreover, it substantiates the policies that make it easier to establish smaller farms, although the effect of such policies can be diminished by significant market transaction costs revealed by Svetlov [26]. Acceptance of the third hypothesis means that, on average, lowering MTC can help the farms achieve higher allocative efficiency. This result demonstrates that, as it is argued in Introduction, the condition of internal farm institutions is not uniform throughout the studied sample. Hence, the field for institutional development still exists in some of the farms. Finally, the supported fourth hypothesis ensures that the farms tend to bear higher MTC for the sake of technical improvements. The observed correspondence between MTC, size and efficiency matches theoretical expectations, thus contributing into credibility of the theoretical model and the developed methodology as a whole.

This study implies the message to policy makers in the Moscow oblast that the market transition of the dairy sector did not finish with privatization and allowing competition in the markets. The roadmap to keep MTC under control includes the policies that favor and facilitate restructuring of the farms, developing infrastructure for accumulating and accessing managerial and operational knowledge (particularly, rethinking the mission of regional extension service in compliance with this task), avoiding policies that stimulate soaring MTC.

Although the methodology presented in this paper has shown itself to be appropriate, it still leaves open questions. First and the foremost, the deterministic theoretical model has limited relevance to agriculture. Speaking informally, it ignores both indispensable uncertainties (like weather conditions) and good luck of a manager. The presence of uncertainties implies that the efficient output mix cannot be secured regardless to the expenses on internal transactions, while a best practice farm could merely make lucky errors. This obstacle hampers the accuracy of the performed estimations and calls for improving the methodology. This consideration is of special harm insomuch as the estimation procedure will result in positive estimates in presence of noisy data, even when actually neither MTC exist. Second, the assumption of fixed technical efficiency, which is crucial for the estimation procedure, is not really maintainable. We can only accept it as an ad hoc measurement convention. Third, difficulties that add extra noise to the estimates concern data limitations (which makes us to leave variable inputs aside), asset specificity problem and restrictions on output allocation, such as membership in agroholdings. These methodological flaws need to be addressed in future studies. Forth, a more detailed analysis of farms with an outlying high level of per-output MTC may enrich the knowledge about specific institutional imperfections. It can be extended to specific case studies when appropriate.

Appendix

Descriptive statistics of the data set used in this study

	Dairy milk, MR*	Animal output excluding dairy milk, MR	Crop output, MR	Arable land in use, hectares	Hayland and grassland, hectares	Number of dairy cows	Number of agricultural workers	Depreciation, MR	Production and marketing costs**, MR
1998: minimum	0.4	0.2	0.0	138	0	58	25	0.0	1.4
median	11.7	2.7	1.3	2252	614	600	178	6.6	29.4
average	17.9	4.2	5.9	2340.8	762.7	659.8	199.1	8.0	35.5
maximum	190.4	42.3	102.8	5951	4739	2602	844	53.7	190.3
std. deviation	20.9	5.5	14.0	1241.4	639.9	393.3	121.9	6.3	26.7
2005: minimum	0.9	0.0	0.0	0	0	53	5	0.1	1.8
median	22.1	5.0	0.9	2006	442	479	107	1.6	31.8
average	31.5	6.5	4.9	2153.6	548.0	554.0	126.8	2.7	40.0
maximum	240.3	34.0	77.8	11842	2876	3688	659	24.2	330.3
std. deviation	32.7	5.9	10.2	1444.9	502.5	434.6	85.1	3.3	40.0
2006: minimum	0.8	0.3	0.0	0	0	81	5	0.0	0.7
median	26.3	4.7	0.6	1977	431	538	103	1.8	32.1
average	31.2	6.8	4.2	2384.1	539.7	642.0	121.6	2.8	39.0
maximum	232.9	51.0	57.1	11436	2815	3900	640	28.9	296.0
std. deviation	30.6	7.4	8.8	1730.8	500.5	505.8	87.7	3.8	36.7
2007: minimum	0.4	0.0	0.0	0	0	30	20	0.0	3.3
median	29.2	4.8	0.7	1885	383	495	105	1.9	33.8
average	36.4	7.9	4.9	2320.3	503.6	629.9	120.4	3.9	42.2
maximum	242.4	119.6	89.8	30650	2313	3900	605	40.8	247.4
std. deviation	35.8	14.3	11.9	2657.4	481.3	504.8	82.8	5.4	38.3

* Million roubles of 2007.
** Excluding labor costs and depreciation.

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ОЦЕНКА УПРАВЛЕНЧЕСКИХ ТРАНСАКЦИОННЫХ ИЗДЕРЖЕК МОЛОЧНЫХ ХОЗЯЙСТВ МОСКОВСКОЙ ОБЛАСТИ

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В статье разработана методика оценивания размера управленческих трансакционных издержек в расчете на единицу выпускаемой продукции, использующая микроэкономические данные об объемах использованных ресурсов, произведенной продукции и ценах. Методика основывается на концепции «трансакция как активность». Эмпирическая модель непараметрической границы производственных возможностей, используемая для оценивания, включает в себя три вида продукции: молоко, другую продукцию животноводства и продукцию растениеводства. Она применена для проверки гипотез о совокупности сельскохозяйственных организаций Московской области, специализирующихся на производстве молока: в динамике — о неснижении трансакционных издержек в периоды с 1998 и с 2005 по 2007 г. (первая гипотеза); в статике — об их положительной зависимости от размера организации (вторая) и от технологической эффективности (третья); об их отрицательной зависимости от аллокативной эффективности (четвертая). Первая гипотеза проверена с помощью теста Уилкоксона для связных выборок, относящихся к сопоставляемым годам; остальные — при помощи t-теста значимости корреляции рангов по Спирмену для каждого года и вида продукции в отдельности. Ни одна из гипотез не отвергается по результатам тестов, что согласуется с теоретическими ожиданиями и служит подтверждением корректности выбранной теоретической модели и основанной на ней процедуры оценивания. Рост управленческих трансакционных издержек в период с 1998 по 2007 г. связан с возрастанием аллокативной эффективности в динамике, однако с 2005 по 2007 г. аллокативная эффективность не возросла, а управленческие трансакционные издержки повысились, что указывает на регрессивную эволюцию внутрихозяйственных институтов. По итогам исследования сделан вывод, что значительные резервы сокращения управленческих трансакционных издержек присущи лишь меньшей части организаций совокупности, в связи с чем экономическая мотивация к их снижению недостаточна. Однако в целом по совокупности бремя управленческих трансакционных издержек снижает конкурентоспособность молоч-

ной отрасли Московской области, препятствуя реагированию на рыночные сигналы и достижению оптимальной структуры продаж. Как следствие имеются основания для разработки мер аграрной политики, содействующих снижению управленческих трансакционных издержек.

Ключевые слова: управленческие трансакционные издержки, функция трансакционных издержек, граница производственных возможностей, сельскохозяйственные организации, Россия, Московская область, производство молока.

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