# Measuring institutional progress on Russian dairy farms (case of the Moscow oblast)

*Nikolai M. Svetlov*[1]

## 1. Introduction

Institutional progress in the transitional economies is a subject for many disputes. Existing literature suggests that the slowdown of modernization of Russian agriculture is mainly due to the institutions (e.g. Ciaian and Swinnen, 2006). In Russia they remain underdeveloped and induce high transaction costs despite long lasting reforms (Lerman, 2001; Liefert et al., 2003; Uzun, 2005; Svetlov, 2010). One of the casual problems is an insufficient feedback of institutional changes. At best, their consequences are accessed by means of case studies (e.g. Shagaida, 2007). An econometric routine that could help monitoring and qualifying institutional changes is still missing.

This study aims at filling this gap regarding to the institutional evolution of Russian corporate farms. For this purpose, per-output internal transaction costs (ITC hereafter) are estimated on dairy corporate farms located in the Moscow oblast using data of 1998 and 2005 to 2007. These estimations allow testing the following hypotheses:

1) Since 1998 the farm institutions did not improve;
2) The ITC are higher on the larger farms;
3) Lower ITC diminish allocative inefficiency;
4) Pursuing high technical efficiency increases ITC.

The first hypothesis relies on the widely acknowledged incompleteness of agricultural reforms in Russia. Liefert et al. (2003) state that ‘Failure to improve productivity by much if at all is largely due to the incomplete implementation of agricultural reform. Reforms are needed to improve farm-level organization and management, as well as to develop the physical and institutional infrastructure that supports agricultural production.’ Their arguments are still applicable to the majority of Russian corporate farms. Year 1998 is chosen as a benchmark, because it ends the seven year long period of fast decline of agricultural production in Russia. Many corporate farms cancelled their operation during that period. The survivals passed restructuring procedures and experienced many institutional changes. By 1998, the majority of the corporate farms faced severe financial problems and urgent need for technical renovation. In the consequent years, due to increased domestic and foreign demand for Russian agricultural production, these problems diminished. A limited number of corporate farms demonstrated the ability of successful business in agriculture; however, the majority either kept accumulating debts or remained dependent on direct political support (Uzun, 2005).

[1] Professor at the department of Economic Cybernetics, Russian State Agricultural University (former Moscow Timiryazev agricultural academy). E-mail Svetlov@timacad.ru. http://svetlov.value.da.ru

The second hypothesis originates in R. Coase's (1937) statement: ‘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, it is necessary to consider probable heterogeneity of internal farm institutions that is caused by the incomplete transitional process. If the institutions were homogenous, higher allocative efficiency must coincide with higher ITC, as more efforts are done to determine and achieve the efficient input-output allocation. In case of the hypothesized institutional heterogeneity the situation is different. The farms with insufficient institutes are expected to demonstrate both low allocative efficiency and high ITC that hamper improving the input-output allocation. So, the third hypothesis enlightens incompleteness of transition processes regarding to the internal farm institutions.

The fourth hypothesis seems to be self-evident.

The methodological contribution of the paper is an analytical framework that allows qualifying institutional changes. The empirical contribution is testing theoretical predictions about relations between ITC, farm size, technical and allocative efficiency. The practical importance consists of:

- Revealing the additional source of competitive advantages that farm managers can engage;
- Supplying regional policy makers with information about incompleteness of market transition of dairy farms in the Moscow oblast, which calls for the corresponding reaction at the policy level.

## 2. Methodology

### 2.1. Internal and external transaction costs: how to specify?

The general idea of transaction costs is clearly expressed by Coase (1937): ‘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.’ Since Coase, many verbal definitions of transaction costs appeared. The review of the definitions can be found in Section 2 of McCann and Easter (2004). These general definitions do not imply a comprehensive and unambiguous procedure of counting transaction costs. So, in the empirical studies they require further specifications. Such specifications raise questions that are unlikely to ever obtain a commonly acknowledged answer. E.g., should the 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 (2001, 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 *internal and external transaction costs* is based on the concepts of internal and external suppliers (e.g. Afuah, 2003). 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 external transaction costs (ETC hereafter). The costs incurred from interacting with the internal supplier are ITC.

Such definitions are sufficient for most of the theoretical and quantitative analyses. However, to use them directly, a researcher must access very rich data, which is very costly to collect. Consequently, the initial step towards the methodology of estimating ITC from microeconomic data is to specify ITC in a form that is convenient for consequent applications.

This paper proposes the specification of ITC that is based on their effect. When a firm makes expenses to interact with internal suppliers, its aim is to urge them to provide the optimal (from the firm's point of view) allocation of outputs. When a firm interacts with external suppliers, it tends to get the best price. Thus, the ad hoc specification of ITC is *the transaction costs that are expended in order to justify and enforce the chosen output allocation*. In particular, this approach implies that:

- only those transportation costs are included in ITC that arise in the process of justifying and enforcing the output allocation;
- only those opportunity costs are included in ITC that arise due to difference between the actual and chosen output allocation.

Similarly, one can specify ETC as the transaction costs that are expended in order to seek the best price, to secure it in a contract and to enforce the contract. In this respect, output transportation costs that are born in order to get the output marketed are not a part of ETC (in contrast to Chavas et al., 2000; Hobbs, 1997). Although these costs are clearly a part of marketing costs, they have very limited relevance to Coase's costs of using *price mechanism*. Another consideration is a definition of a commodity by Debreu (1959), which implies that the production of a specific commodity is not complete unless it is delivered to its final destination.

### 2.2. Earlier approaches to measuring transaction costs

The majority of publications that deal with transaction costs can be classified with respect to one of the following sources of information about them: *first*, direct observation; *second*, testing significance; *third*, estimation from some relevant data.

The studies that belong to *the first group* commonly gather the data about the elements of transaction costs in kind via surveys[1]. McCann and Easter (1999) use a questionnaire to measure transaction costs components in full time equivalents (FTEs). At the next step FTEs are converted into the monetary measure. This allows the authors to compare different water protecting policies in terms of the emerging transaction costs. Another study aimed at policy comparison (Rørstad et al., 2007) investigates the comparative advantages of twelve agricultural policy schemes in Norway. It extends the procedure of McCann and Easter (1999) with accessing the role of point of policy application and investigating the effect of asset specificity on the (dis)advantages of a given policy.

[1] (McCann et al., 2005) consider three more data sources: government reports, financial reports and proposed budgets. However, these options are rarely used.



Many studies use the data about transaction costs as exogenous variables of econometric models. Such studies are also based on specially organized surveys aimed at observing transaction costs in kind, but they do not need to transform them into the monetary measure. The examples are Hobbs (1997), Bedi and Tunali (1999), Winter-Nelson and Temu (2005), Peerlings and Polman (2004). The first paper provides estimations of relative importance of various transaction costs and farm characteristic variables for the choice of a cattle marketing channel (either liveweight or deadweight sales). It makes use of tobit two-limited dependent variable analysis and data from a survey of UK farmers. The second paper explores Turkish farm labor market participation patterns as a function of observable transactions costs. The third paper uses a sample selection model in order to study effects of prices and transactions costs on input usage. The fourth paper constructs a profit function of Dutch dairy farm and concludes that lower transaction costs enlarge supply of wildlife and landscape services.

In the study of Falconer et al. (2001) a specific observable part of ITC, 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 scheme age and a set of area-specific characteristics. The model is used to determine factors that influence the administrative costs.

A review of earlier studies in McCann and Easter (2004) provides extensive information about many other studies that make use of direct observation of transaction costs.

Econometric models that include transaction costs variables measured in kind and some other variables measured in money are the most relevant to this study. Such models usually allow associating components of the transaction costs with corresponding shadow prices. Those make it possible to express the overall transaction costs in the monetary form.

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. All the known studies reject the specifications that ignore the transaction costs.

Benjamin and Phimister (1997) test significance of transaction costs in the financial markets that are accessible for French farms. The theoretical model they use supposes that investment and financial decisions are simultaneous in presence of the transaction costs, unlike in absence. Lence and Miller (1999) use a constant discount rate present value model to test presence of transaction costs on Iowa farmland market. Chavas and Thomas (1999) solve the similar problem by means of a dynamic model of land prices, which derives arbitrage asset prices under non-additive dynamic preferences, risk aversion, and presence of transaction costs. Meyer (2004) argues significance of transaction costs on pork market in Germany and in the Netherlands. A threshold vector error correction model is used. The author states that ‘threshold models can account for the effects of transaction costs in price transmission without directly relying upon information about these costs, which are often unavailable.’

Buduru and Brem (2007) show that transaction costs hamper the restructuring processes in a transitional economy. They use a specification of a hawk-dove game and the data from farms located in Bohemia (Czech Republic) to study interaction between managers and workers.

Kancs and Ciaian (2010) study the role of transaction costs in bilateral trade of new EU member countries. They compare 'the observed equilibrium computed using the actual transaction costs with a hypothetical trade equilibrium computed using reduced transaction costs', which enables them 'to assess the importance of transaction costs of farm (re)organization and hence the distortions of the factor content of agricultural trade'. Henning and Henningsen (2007) conclude that transaction costs and, specifically, non-proportional transaction costs, significantly influence household behaviour in Midwest Poland. They use a two-stage estimation procedure, first estimating shadow values of labour and then output, consumption and labour functions. Transaction costs proxies (in kind) are used as exogenous variables at the first stage.

The body of *studies belonging to the third group*, which are especially interesting for our research, is relatively limited. These studies pretend to obtain a quantitative measure of the transaction costs (or their part) as unobservable parameters of specific empirical models. Vakis et al. (2003) recovers ETC from the observed choice among available marketplaces by Peruvian farmers. Park et al. (2002) estimates ETC from the parity-bounds model as observed price differences in pairs of Chinese grain markets. Svetlov (2009) appoaches per-output ITC using observed inputs and outputs of Russian corporate farms. Chavas et al. (2000) derive transaction costs per unit of sales from the dynamics of US soybean stocks. However, the negative sign of some estimates of the transaction costs makes doubt in the underlying theory. The authors' interpretation of this result also questions the validity of associating the obtained values with transaction costs.

Among the papers listed in this subsection, two mention estimations of *transaction costs function*. Kancs and Ciaian (2010) write that 'Generally, there are two approaches for how to infer transaction costs of farm (re)organization: (i) calculating productivity ratios from the production data; and (ii) estimating transaction cost functions.' However, they reject the option to estimate this function on the following reasons: it requires arbitrary assumptions of a specific functional form and estimation method, is influenced by choice of explanatory variables, faces difficulties in accessing unobservable parts of transaction costs. Svetlov (2009) estimates local properties of farm-specific ITC functions from a non-parametric production frontier. This approach partially avoids the problems mentioned by Kancs and Ciaian (2010), although the specific form of ITC function remains unknown.

To the best of our knowledge, the majority of the existing literature accesses either ETC or overall transaction costs. The exclusions which are focused on ITC are Falconer et al. (2001) and Svetlov (2009). However, Falconer et al. (2001) studies the specific component of ITC that is relatively easy to observe.

### 2.3. Theoretical model

Regarding to the methodology of estimating ITC, the existing literature provides the choice between Falconer et al. (2001) and Svetlov (2009). Although the former approach, if extended to overall ITC, could be much more precise, this study follows the latter. The reason is that it allows us to make use of official statistical data instead of conducting a special survey.



Consequently, the theoretical model that is used in this paper is very similar to Svetlov (2009). Compared to that, the following model uses a stronger assumption of strict convexity of ITC function and relaxes the technical inefficiency term. The first change allows proving a more powerful statement about ITC estimates, while the second just makes the model simpler and improves its generality without any effect on implications.

In the neo-classical view (particularly, in absence of transaction costs), an optimal netput allocation can be obtained from the model

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

where $\mathbf{x}$ is a non-negative input vector (some or all components of which may be fixed), $\mathbf{y}$ is a non-negative output vector, $\mathbf{v}$ is a non-negative input price vector, $\mathbf{w}$ is a non-negative output price vector and $\mathbf{f}(\mathbf{x})$ is a convex and increasing production frontier of a firm such that $\mathbf{f}(\mathbf{0}) = \mathbf{0}$ and there exists a unique optimum ($\mathbf{x}_0$, $\mathbf{y}_0$) of (1).

In order to be introduced into the model, *direct* ITC (i.e. ITC excluding opportunity cost components) can be represented as the costs of reaching a particular output allocation[1] $\mathbf{y}_T$. Unless the necessary ITC are expended directly, the target is missed and the corresponding opportunity costs arise, which add to the total ITC. If the incremental direct ITC exceed the expected forgone opportunity costs, the firm is assumed to make no efforts to reach $\mathbf{y}_T$.

Let $t(\mathbf{y})$, hereafter called the *ITC function*, be an amount of direct ITC that is necessary to reach a fixed target output allocation $\mathbf{y}_T$ from $\mathbf{y}$. This function is assumed to be continuous and non-negative, have a unique zero in $\mathbf{y}_T$, be strictly convex with the exclusion of an infinitely small vicinity of $\mathbf{y}_T$ and decrease towards $\mathbf{y}_T$. The latter means that in a closer vicinity of $\mathbf{y}_T$ the management has more helpful information for locating and reaching this target than in a wider vicinity.

In order to enrich the model (1) with ITC function, the following assumptions are required:

- $\mathbf{y}_T$ is equal to the optimal output allocation $\mathbf{y}_0$ defined by (1);
- the components of $\mathbf{x}$ are such that none of them changes when direct ITC arise. E.g. if bearing ITC needs an additional input of fuel, this fuel is represented separately from the fuel that is used in the production process and is not accounted in the corresponding component of $\mathbf{x}$.

The resulting model is

$$\max_{\mathbf{x},\mathbf{y}}(\mathbf{wy} - \mathbf{vx} - t(\mathbf{y}) \mid \mathbf{y} \le \mathbf{f}(\mathbf{x})), \quad (2)$$

As $\mathbf{f}(\mathbf{x})$ is convex and $\mathbf{wy} - \mathbf{vx} - t(\mathbf{y})$ is strictly concave with exclusion for $\mathbf{y}_0$, the optima of (2) can only be found in:

1) the point ($\mathbf{x}_0$, $\mathbf{y}_0$);

[1] This target allocation must not be necessarily known *a priori*. At least, a procedure should exist that is able to unambiguously locate the target allocation from the data that the management can access in a due time.

2) a Kuhn-Tucker point of the Lagrangean function

$$\mathbf{wy} - \mathbf{vx} - t(\mathbf{y}) - \boldsymbol{\lambda}(\mathbf{y} - \mathbf{f}(\mathbf{x})), \quad (3)$$

where $\boldsymbol{\lambda}$ consists of the Lagrange multipliers. Due to the non-concavity in ($\mathbf{x}_0$, $\mathbf{y}_0$), this point must not be unique.

So, if (2) is a true model of a firm experiencing ITC then its netput allocation ($\mathbf{x}_1$, $\mathbf{y}_1$) should match first-order conditions for this Lagrangean function. In particular, providing that $\mathbf{y}$ consists of $y_i$, $\mathbf{w}$ consists of $w_i$ and $\boldsymbol{\lambda}$ consists of $\lambda_i$, the equation

$$w_i - \frac{\partial t(\mathbf{y})}{\partial y_i} - \lambda_i = 0 \quad (4)$$

should hold for each output $i$ such that $y_i \neq 0$. So, providing that $w_i$ is known, $\lambda_i$ is estimable and ($\mathbf{x}_1$, $\mathbf{y}_1$) does not match ($\mathbf{x}_0$, $\mathbf{y}_0$), ($w_i - \lambda_i$) equals to a tangent of the slope of $t(\mathbf{y})$ in the point ($\mathbf{x}_1$, $\mathbf{y}_1$). This tangent is a local property of the ITC function, which indicates heaviness of the ITC burden and enables intertemporal comparisons of internal farm institutions.

In order to estimate the unknown $\lambda_i$, the following model is considered:

$$\max_{\mathbf{x},\mathbf{y}}(\mathbf{wy} - \mathbf{vx} \mid \mathbf{y} \le \mathbf{f}(\mathbf{x}), \mathbf{y} = \mathbf{y}_1). \quad (5)$$

As this problem is convex (not necessarily strictly convex), all its optima are located in the Kuhn-Tucker points of the Lagrangean function

$$\mathbf{wy} - \mathbf{vx} - \boldsymbol{\lambda}(\mathbf{y} - \mathbf{f}(\mathbf{x})) - \boldsymbol{\mu}(\mathbf{y} - \mathbf{y}_1), \quad (6)$$

where, among others, the first order conditions

$$w_i - \lambda_i - \mu_i = 0 \quad (7)$$

are satisfied providing that $\boldsymbol{\mu}$ consists of $\mu_i$, $\mathbf{y}_1$ consists of $y_{1i}$ and $y_{1i} \neq 0$. Another set of first order conditions, namely

$$\mathbf{v} - \boldsymbol{\lambda}\mathbf{J}_f = \mathbf{0}, \quad (8)$$

where $\mathbf{J}_f$ is a Jacobian matrix of $f(\mathbf{x})$, is the same for (3) and (6). Hence, providing that rank($\mathbf{J}_f$) = $m$, where $m$ is number of outputs[1], $\boldsymbol{\lambda}$ is the same in both (4) and (7), which implies $\frac{\partial t(\mathbf{y})}{\partial y_i} = \mu_i$. So, $\mu_i$ is an estimator for $\frac{\partial t(\mathbf{y})}{\partial y_i}$ that is the per-unit ITC of the output $i$.

The condition rank($\mathbf{J}_f$) = $m$ can be provided by an empirical specification of (5). The condition $\mathbf{y} > \mathbf{0}$ (which follows from requiring $y_i$ to be non-zero) can be met by excluding the unmatched cases from the sample.

[1] Svetlov (2009) misses this condition. As a consequence, in that study the components of $\boldsymbol{\mu}$ are treated as lower estimates of ITC.



### 2.4. Averaging transaction cost estimates

The $\mu_i$ estimated from (7) is a tangent of the slope of $t(\mathbf{y})$ along the $i$th axe. In absence of any empirical data the *slopes* can be supposed as distributed uniformly over [0; $\pi$/2]. In this case the corresponding distribution of *tangents* can be shown to have an infinitely large mean. So, *any* sample estimation of this mean would be low biased. In this respect, the arithmetic mean of $\mu_i$ is meaningless. The valid procedure is to find an arithmetic mean of slopes and then to calculate the tangent of the mean:

$$\tan\left(\frac{\sum_{i=1}^{n}\arctan(\mu_i)}{n}\right). \quad (9)$$

Hereafter, the mean values computed using (9) are called arctangential averages. Any average value of ITC estimates that can be found in this paper is an arctangential average.

### 2.5. Hypotheses testing procedures

It follows from (2) that $\partial t(\mathbf{y})/\partial y_i$ increases towards $\mathbf{y}_0$. So, decreased ITC do not necessarily witness improved institutions. They can also reduce in case of drop of allocative efficiency due to changes in either prices or technologies. This is represented by the increased distance between $\mathbf{y}_1$ and $\mathbf{y}_0$ subject to the unchanged $t(\mathbf{y})$. In this regard, the first hypothesis that relates to absence of institutional progress can be rejected when two changes coincide:

- Allocative efficiency scores (Färe et al, 1994; Cooper et al., 2004) significantly increase;
- ITC significantly decrease (at best regarding to all outputs, at least regarding to the major output).

To reject absence of the mentioned changes, a non-parametric Mann-Whitney test of differences between 2007 and 1998 is engaged both for the allocative efficiency scores and ITC.

The second hypothesis about higher ITC on larger farms is rejected in a given year when: (i) Spearman rank correlation between revenue from sales of agricultural production and the estimated ITC of either output is significantly negative; or (ii) when none of these correlations is significantly positive. The similar procedure with respect to other size proxies (like number of workers, number of cows etc.) is used to obtain specific conclusions about relation between particular aspects of 'farm size' concept and ITC.

The third hypothesis about positive dependence of allocative inefficiency on ITC in a given year is rejected when none of the Spearman rank correlations between ITC estimates for each output and allocative efficiency scores is significantly negative or when at least one is significantly positive.

The fourth hypothesis about negative dependence of technical inefficiency on ITC in a given year is rejected when none of the Spearman rank correlations between ITC estimates for each output and technical efficiency scores is significantly positive or when at least one is significantly negative.

# 3. Empirical specification and data

### 3.1. Non-parametric production frontier

In this study the non-parametric production frontier is used as an empirical model of the unobserved function **f**(**x**) that defines the production set in (5). In general, a production frontier, as it follows from Färe et al. (1994), is defined by either the infimum of the set of possible inputs subject to given outputs (input-oriented specification) or the supremum of the set of possible outputs subject to given inputs (output-oriented specification). The most common application of the non-parametric production frontier is a branch of the efficiency analysis that is known as data envelopment analysis (Charnes, 1994).

For the purpose of this study, the output-oriented specification is chosen with variable return to scale (see Charnes (1994) for details):

$$\sup Y(\mathbf{x}_n), \text{ where } Y(\mathbf{x}_n)=\{\mathbf{y}\mid\mathbf{y}=\mathbf{Y}\boldsymbol{\beta};\ \mathbf{x}_n+\mathbf{s}_x=\mathbf{X}\boldsymbol{\beta};\ \mathbf{i}\boldsymbol{\beta}=1;\ \boldsymbol{\beta},\mathbf{s}_y,\mathbf{s}_x\geq\mathbf{0}\}. \tag{10}$$

In this definition $\mathbf{x}_n$ is a constant non-negative vector of observed annual inputs of farm $n$; **X** is a matrix that consists of columns $\mathbf{x}_n$, $n \in N$, $N$ is a set of all farms in the sample; **Y** is a matrix that consists of columns $\mathbf{y}_n$, $n \in N$; $\boldsymbol{\beta}$ is a variable non-negative vector of weights associated with each input-output pair ($\mathbf{x}_n$, $\mathbf{y}_n$); **i** is a vector of ones; $\mathbf{s}_x$ is a vector of variable residuals that represent the unused amount of inputs. The constraint $\mathbf{i}\boldsymbol{\beta} = 1$ imposes variable return to scale.

The output-oriented specification is chosen because the majority of inputs of the studied farms are fixed in the short-term period either by their nature or due to constrained market entries. The variable return to scale specification (Banker et al., 1984) is assumed to achieve wider generality and precision in presence of scale effects, which truly exist in the studied farms (Svetlov, 2010).

### 3.2. Estimating overall, technical and allocative efficiency

Given the specification of the production frontier (10) and the definition of technical efficiency (Farrell, 1957), the technical efficiency score $\alpha_{Tn}$ of a farm $n$ can be estimated from the linear program

$$\min_{\alpha_{Tn},\boldsymbol{\beta},\mathbf{y},\mathbf{s}_x,\mathbf{s}_y} \alpha_{Tn}+\varepsilon\mathbf{s}_x+\varepsilon\mathbf{s}_y \quad \text{subject to} \quad \mathbf{y}_n=\alpha_{Tn}\mathbf{y}+\mathbf{s}_y,\ \mathbf{s}_y\geq\mathbf{0};\quad \mathbf{y}\in\sup Y(\mathbf{x}_n)), \tag{11}$$

where $\mathbf{s}_y$ is a vector of residuals that represent the excess amount of outputs; $\mathbf{y}_n$ is a non-negative vector of observed annual outputs of farm $n$; $\varepsilon$ is a non-Archimedean element that is greater than zero but less than any real positive number (see Cooper et al., 2004) and the remaining symbols follow (10).



Given (10), the definition of overall efficiency (e.g. Färe et al., 1994) and assumption of fixed inputs, the overall efficiency score $\alpha_{On}$ of a farm $n$ is defined as

$$\alpha_{On}=\frac{\mathbf{w}_n\mathbf{y}_n}{\mathbf{w}_n\left(\operatorname*{argmax}_{\mathbf{y}\in\sup Y(\mathbf{x}_n)}(\mathbf{w}_n\mathbf{y})\right)}, \tag{12}$$

where $\mathbf{w}_n$ is a vector of farm-specific output prices and other notations follow (10). In this expression the numerator is a constant and the denominator is obtained by maximizing ($\mathbf{w}_n\mathbf{y}_n - \varepsilon\mathbf{s}_x$) subject to the linear constraint $\mathbf{y} \in Y(\mathbf{x}_n)$. Finally, Färe et al. (1994) suggests that when $\alpha_{On}$ and $\alpha_{Tn}$ are both known, the allocative efficiency score is defined as $\alpha_{An}=\alpha_{On}/\alpha_{Tn}$.

### 3.3. Estimating ITC

The specification of (5) that is used for accessing the estimator $\mu_i$ defined in the previous section uses the frontier sup $Y(\mathbf{x}_n)$ defined in (10) in the following way:

$$\max_{\alpha,\boldsymbol{\beta},\mathbf{y}} \mathbf{w}_n\mathbf{y}-\mathbf{c}\boldsymbol{\beta}-\varepsilon\mathbf{s}_x-\varepsilon\mathbf{s}_y \quad \text{subject to} \quad \mathbf{y}\in\sup Y(\mathbf{x}_n),\quad \mathbf{y}_n=\alpha_n\mathbf{y}+\mathbf{s}_y,\ \mathbf{s}_y\geq\mathbf{0},\ \alpha_n\leq 1. \tag{13}$$

In this linear program **c** is a vector of short-term production costs that are observed on each farm in the sample, $\alpha_n$ is an inefficiency term and the remaining symbols follow (10)…(12). The objective function reflects a short-term profit like in (5), and the equation $\mathbf{y}_n = \alpha_n\mathbf{y} + \mathbf{s}_y$ is a specification of the equation $\mathbf{y} = \mathbf{y}_1$ in (5). The role of $\mathbf{s}_y$ terms is explained below. So, the shadow prices that are associated with the former equation are the values of $\mu_i$.

The correspondence between (5) and (13) requires that **X** from (10) must span all inputs except those that form ITC and must not include none of the inputs that are attached to ITC. Theoretically, the composition of **X** allows a researcher to match the chosen definition of ITC. Yet, this is hardly possible in practice due to data limitations. Instead, the actual composition of **X** implicitly provides an *ad hoc* definition of ITC.

The term $\alpha_n$ allows for possibly positive $\mathbf{f}(\mathbf{x}) - \mathbf{y}$ in (5), in which case the specification (13) cannot be feasible. It captures possible technical inefficiencies that cannot be avoided in short-term period by means of internal transactions. The purpose of the constraint $\alpha_n \leq 1$ is to prohibit the situation when the actual outputs exceed optimal outputs. It is interpreted as presence of non-economic motivation to large-scale production (like governmental preferences for large-scale farming or disinclination to slaughtering dairy cattle). In absence of this constraint $\alpha_n$ can exceed one when, given a solution of (13), there exist some reference farms (i.e. the farm with $\beta_h > 0$, providing that $\boldsymbol{\beta}$ consists of $\beta_h$) that are loss-making. As there is a majority of loss-making farms in the studied sample, this constraint is often binding. Even if it is not, $\alpha_n$ almost always appears to be larger than $\alpha_{Tn}$, unless the $n$th farm is technically efficient.

As it is shown in Subsection 2.3, $\mu_i$ is not defined in $(\mathbf{x}_0, \mathbf{y}_0)$. Thus, it is necessary to provide[1] that $(\mathbf{x}_1, \mathbf{y}_1)$ differs from $(\mathbf{x}_0, \mathbf{y}_0)$. Moreover, due to allowance for technical inefficiency in (13), the estimator also remains indefinite in any $k(\mathbf{x}_0, k\mathbf{y}_0)$, $k \in (0;\infty)$. This situation is shown up by $\alpha_{An} = 1$. So, the model (13) must not be applied to the farms that match this condition. Speaking informally, the existing ITC are not effective on such farms, as they do not hamper avoiding allocative inefficiencies.

The indicator of validity of the requirement rank$(\mathbf{J}_f) = m$ (refer to Subsection 2.3) is absence of positive components in $\mathbf{s}_y$. To avoid low bias, the estimates for farms that do not match the condition $\mathbf{s}_y = \mathbf{0}$ are dropped. To lessen the share of dropped cases, the number of outputs should commonly be smaller than the number of inputs and much smaller than the number of farms in the sample.

### 3.4. Data

In this study we use the annual data of 1998 and 2005…2007 from the Moscow oblast Registry of large and medium corporate farms (compiled by Russian federal statistical agency). Year 1998 is of special interest as a base for tracking ITC changes (refer to the introductory section).

The sample consists of the farms that gain at least ⅓ of total revenue from sales of dairy milk, sell less than 14 tons of milk per dairy cow (to sort resellers off), have at least 0.2 hectares of farmland per dairy cow and have neither pigs nor poultry. The number of cases in the sample is 210 in 1998, 206 in 2005, 130 in 2006 and 167 in 2007.

In this study the components of **y** are as follows: dairy milk, animal output excluding milk and crop output. All outputs are measured in thousand roubles. The monetary values are inflated to 2007 by means of agricultural production price indices from Goskomstat (2003) and Rosstat (2008). Only sold production is reckoned as output, while intermediate products are not taken into consideration.

Concerning the composition of input matrix **X**, the set of inputs is such that it approaches the definition of ITC suggested in Subsection 2.1 to the best extent (subject to the available data). In particular, none of the components of management and organizational costs are included in **X**. Each vector $\mathbf{x}_n$ consists of arable land (hectares), hayland and grassland (hectares), number of dairy cows, number of agricultural workers, depreciation (thousand roubles) as a proxy for fixed production assets, short-term production and marketing costs (thousand roubles) as a proxy for floating assets. The monetary values are inflated to 2007 by means of industrial production price indices from Goskomstat (2003) and Rosstat (2008).

For the reference, by the end of 2007 one Euro amounts to 35.93 roubles.

## 4. Results

The estimates suggest that the burden of the ITC on the studied farms is very heavy. On average, the ITC exceed a half of revenue from sales of an output, sometimes approaching the

[1] Missing this condition in Svetlov (2009) adds extra noise in the estimations presented there.



whole amount of the revenue and even exceeding it. As for 2007, the percent of estimates of ITC that exceed one rouble per rouble of output is 22.0% for milk, 3.8% for other animal production and 16.7% for crop production (Table 1). In absence of congestion, as it is imposed by model (13), ITC per unit of output can exceed the price of the output only in cases when the amount of the output exceeds the optimum. In such cases the excess output can bind the resources that, subject to the available technology, could be used alternatively so to generate times larger revenues. In the studied sample this situation is widespread, as the majority of the studied farms are loss-makers, thus capable to gain from large drop of some outputs. Losses are born even by the majority of the farms that appear on the production frontier.

Table 1. Share of ITC estimates that do not exceed the threshold

| Threshold | Years | | | |
|---|---|---|---|---|
| | 1998 | 2005 | 2006 | 2007 |
| Milk | | | | |
| 1…5 | 100.0 | 98.1 | 98.8 | 95.1 |
| 0.5…1 | 96.6 | 92.6 | 88.2 | 78.0 |
| 0.25…0.5 | 75.3 | 84.0 | 64.7 | 63.4 |
| 0.1…0.25 | 18.4 | 65.4 | 29.4 | 38.2 |
| < 0.1 | 2.3 | 27.8 | 8.2 | 3.3 |
| Other animal production | | | | |
| 1…5 | 96.5 | 97.5 | 98.5 | 99.0 |
| 0.5…1 | 86.7 | 80.5 | 96.9 | 96.2 |
| 0.25…0.5 | 40.7 | 53.4 | 36.9 | 21.9 |
| 0.1…0.25 | 23.9 | 39.0 | 6.2 | 7.6 |
| < 0.1 | 0.0 | 5.9 | 1.5 | 2.9 |
| Crop production | | | | |
| 1…5 | 100.0 | 95.3 | 98.6 | 100.0 |
| 0.5…1 | 97.0 | 88.4 | 88.7 | 83.3 |
| 0.25…0.5 | 83.6 | 46.5 | 62.0 | 34.7 |
| 0.1…0.25 | 44.0 | 23.3 | 36.6 | 16.7 |
| < 0.1 | 6.7 | 1.2 | 14.1 | 8.3 |

Source: author's calculations.

Table 2 displays the increased efficiency of the studied farms in the recent years in comparison to 1998. The progress in the technical efficiency is larger than in AE, meanwhile ITC do not decrease in comparison to either 1998 or 2005. *The first hypothesis* of institutional progress since 1998 *is not rejected* by the estimations: although the allocative efficiency significantly improves, per-unit ITC either grow or demonstrate no significant change. As for the recent years, the data of Table 2 witness even a stronger statement: the internal institutional conditions on the studied farms became worse since 2005. Indeed, there is no progress in allocative efficiency despite significantly larger ITC of the both animal outputs and the insignificant change of the ITC of crop production. As a consequence, we also observe no progress in the short-term profit, even despite the continuous growth of the average technical efficiency. Due to the recent bugfixes, this study does not support the earlier conclusion of Svetlov (2010a) about evidence of some institutional progress regarding to animal production excluding milk.

Table 2. Characteristics of the sample farms that have allocative inefficiencies

| | Years | | | | 2007 to 2005 | 2007 to 1998 |
|---|---|---|---|---|---|---|
| | 1998 | 2005 | 2006 | 2007 | | |
| Percent of farms with AE < 1 | 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%** |
| 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 ITC (roubles per rouble of an output, arctangential average) | | | | | | |
| Milk | 0.36 | 0.26 | 0.43 | 0.50 | **+0.24** | +0.14 |
| Animal production excluding milk | 0.32 | 0.34 | 0.36 | 0.51 | **+0.17** | **+0.18** |
| Crop production | 0.22 | 0.27 | 0.35 | 0.30 | +0.03 | **+0.08** |

* Depreciation is excluded.
Monetary values are inflated to 2007.
Significant differences at $\alpha = 0.05$ are printed in **bold** and those at $\alpha = 0.1$ are printed in *italic* (Mann-Whitney test).
Source: author's calculations.

Table 3 suggests the significantly positive relation between per unit ITC of milk, which is the major product of the studied farms, and overall sales in all years. This result meets the expectations in respect of (Williamson, 1981). Hence, the corresponding *second hypothesis* of this study *is not rejected*. It is noticeable, however, that the farms with larger sales tend to achieve higher allocative efficiency (in 2005 and 2006) despite higher ITC. So, the theoretically predicted growth of ITC that is experienced by a growing farm is not necessarily harmful if some of allocative inefficiencies are removed in the course of growth.

As expected, technical efficiency is higher on larger farms. It drives the overall efficiency in the same direction. However, in 2007 this impact is unable to cause significant advantages of larger farms in the overall efficiency. Unless happened at random, this may signal saturation of the trend of enlarging high-performance farms in the Moscow oblast reported by Svetlov (2010).



Table 3. Rank correlations of revenue from sales of agricultural production

| With respect to: | Years | | | |
|---|---|---|---|---|
| | 1998 | 2005 | 2006 | 2007 |
| Overall efficiency score | **0.561** | **0.552** | **0.377** | 0.186 |
| Allocative efficiency score | 0.045 | **0.282** | **0.268** | -0.066 |
| Technical efficiency score | **0.579** | **0.476** | **0.327** | **0.268** |
| ITC of milk | **0.275** | **0.220** | **0.488** | **0.294** |
| ITC of other animal production | -0.012 | 0.076 | -0.091 | -0.023 |
| ITC of crop production | 0.166 | 0.019 | 0.173 | 0.064 |

Significant differences at $\alpha = 0.05$ are printed in **bold**.
Source: author's calculations.

The data of Table 4 addresses *the third hypothesis* about positive dependence of allocative inefficiency on ITC. Given the testing procedure that is described in Subsection 2.5, this hypothesis is *not rejected for 2005…2007 but is rejected for 1998* due to the presence of significantly positive rank correlation between the allocative efficiency score and ITC of animal production excluding milk.

It should be noted, though, that the rank correlation between the ITC of the major output and allocative efficiency scores is insignificant in 2005…2007. In respect of the motivation for the third hypothesis (Section 1) this suggests the balance between opposite effects of homogeneity and heterogeneity of internal farm institutions regarding to the milk production. So, the heterogeneity still remains but it is not that large to determine the relation between milk ITC and allocative efficiency.

Table 4. Rank correlations of allocative efficiency scores

| With respect to: | Years | | | |
|---|---|---|---|---|
| | 1998 | 2005 | 2006 | 2007 |
| Overall efficiency score | **0.400** | **0.621** | **0.855** | **0.782** |
| Technical efficiency score | **0.180** | **0.335** | **0.610** | **0.480** |
| ITC of milk | **-0.197** | -0.148 | 0.060 | -0.071 |
| ITC of other animal production | **0.228** | **-0.316** | **-0.271** | **-0.289** |
| ITC of crop production | -0.152 | **-0.341** | 0.030 | -0.228 |

Significant differences at $\alpha = 0.05$ are printed in **bold**.
Source: author's calculations.

Another noticeable observation is that if a farm demonstrates higher technical efficiency, it also allocates its outputs more efficiently. This conclusion is nowhere near intuitive, because, given a collection of fixed assets, a farm often needs to sacrifice technical efficiency in order to improve output allocation or vice versa. However, on the studied farms the common causes of both technical and allocative inefficiencies dominate, which may witness the institutional nature of these reasons.

*The fourth hypothesis* regarding the relation between ITC and technical efficiency *is rejected in neither year* (Table 5). In case of the major output all the corresponding rank correlations are significantly positive, as expected; in other cases none is significantly negative.

Although the importance of technical efficiency slightly decreases during the studied period, it remains being the major determinant of overall efficiency: the corresponding rank correlations are higher than whose between overall and allocative efficiency scores presented in Table 4 above. This fact is a probable explanation of minor institutional progress. Since the reforms opened the internal market for imported technologies, the farms choose to achieve technical perfection at the cost of delaying institutional improvements.

Table 5. Rank correlations of technical efficiency scores

| With respect to: | Years | | | |
|---|---|---|---|---|
| | 1998 | 2005 | 2006 | 2007 |
| Overall efficiency score | **0.963** | **0.910** | **0.883** | **0.887** |
| ITC of milk | **0.439** | **0.514** | **0.468** | **0.574** |
| ITC of other animal production | 0.022 | **0.463** | -0.203 | 0.101 |
| ITC of crop production | **0.253** | **0.335** | **0.331** | 0.218 |

Significant differences at $\alpha = 0.05$ are printed in **bold**.
Source: author's calculations.

The data of Table 6 provides a deeper insight into the first hypothesis. The additional argument in its favour is that none of the studied size proxies correlate significantly negatively with the ITC of the major output. However, significantly positive correlations are only observed in cases of monetary proxies and agricultural workers quantity. Of them, only in case of costs (in addition to gross revenue, as it is shown above in Table 3) the correlation is significant in all the studied years. As for the revenue from milk sales and the number of workers, the correlation is so weak that appears insignificant in some years. Both number of cows and farmland area display significant correlations to the milk ITC in neither year.

Table 6. Rank correlations of milk ITC

| With respect to: | Years | | | |
|---|---|---|---|---|
| | 1998 | 2005 | 2006 | 2007 |
| Revenue from sales of dairy milk | **0.301** | 0.210 | **0.523** | 0.226 |
| Production and marketing costs, thousand roubles* | **0.200** | **0.182** | **0.478** | **0.258** |
| Number of cows | 0.103 | 0.044 | -0.011 | 0.027 |
| Number of agricultural workers | **0.170** | 0.073 | **0.380** | 0.147 |
| Farmland area | -0.093 | -0.085 | 0.075 | 0.099 |
| Dairy milk price | **0.264** | 0.138 | *0.233* | **0.317** |

* Depreciation is excluded.
Significant differences at $\alpha = 0.05$ are printed in **bold** and those at $\alpha = 0.1$ are printed in *italic*.
Source: author's calculations.

Moreover, from Table 6 it follows that higher dairy milk prices are usually (but not always) associated with higher ITC. The most probable explanation is that (i) larger farms experience large ITC and (ii) larger farms are able to sell outputs at higher prices (Svetlov, 2010).



# 5. Conclusions and discussion

### 5.1. Conclusions

This study relies on the methodological ideas of Svetlov (2009). It improves both theoretical and empirical models so to make the estimations more accurate. In contrast to the aim of that paper (revealing microeconomic factors and consequences of ITC), this study is focused on ITC dynamics with special reference to farm size, technical and allocative inefficiencies.

Summarizing, since the reforms opened Russian agricultural markets, hard competition forced the dairy farms located in the Moscow oblast to improve the technical level of agricultural production. With the exception for hasty reforms that were enforced by the government, the institutional adjustment was postponed. As for now, the persistent underdevelopment of internal farm institutions keeps the ITC high. This makes it too costly for a farm to improve its output allocation and to be more sensitive to price signals. Consequently, the existing agricultural markets can help allocate resources efficiently only to a limited extent.

The four research hypotheses that are formulated in Section 1 are not rejected, with the exception of the third hypothesis in case of the year 1998. Acceptance of the first hypothesis makes it possible to conclude that the available data and performed estimations enlighten no evidence of significant progress of internal institutions on the studied farms. Moreover, in the short period 2005-2007 there is an evidence of either degrading or disadapted internal farm institutions.

The second hypothesis confirms the theoretical prediction that larger farms bear higher ITC. In addition, this study shows that the higher ITC can help large farms to achieve higher allocative efficiency.

Acceptance of the third hypothesis means that, on average, lowering ITC can help the farms achieve higher allocative efficiency. From the managerial point of view, this means the opportunity to accumulate additional competitive advantages. From the economic positions, this means that the reaction of the farms to price signals can improve. This would enlarge the advantages of the market economy, which, as for now, are not always experienced by the farms and the rural population in the Moscow oblast. Another implication of the third hypothesis is that the level of institutional development is not uniform throughout the studied sample. Hence, the transitional process is still incomplete, and the revealed absence of progress in this field since 1998 is not sufficient to witness the opposite.

Finally, the supported fourth hypothesis ensures that technical improvements are likely to be performed subject to increased ITC. However, technical and allocative efficiency are not contradictory in the studied farms. So, *ceteris paribus*, in case of improving the technology a farm can increase ITC without making harm to allocative efficiency.

The observed correspondence between ITC, size and efficiency matches theoretical expectations, thus contributing into the credibility of the developed methodology. The chosen theoretical model demonstrated its relevance and the assumptions of the empirical specification are proved to be reasonable. So, the developed methodology is usable for tracking institutional changes inside farms.

The expected practical impact of this study is drawing attention of dairy farm managers in the Moscow oblast to the opportunities of obtaining competitive advantages by means of cutting unnecessary ITC. These opportunities are of special importance to the farms that either completed technical renovation or aware of risks related to it. Studying institutional structure of advanced farms both in Russia and abroad, training personnel and hiring highly educated managers can help using this advice.

The important message to policy makers in the Moscow oblast is that the market transition of the dairy sector did not finish with privatization and allowing prices to freely vary. This study provides the evidence that the transition is still incomplete and the policy that favours dissemination of the most advanced internal farm institutions is still needed.

### 5.2. Discussion

Although shown itself as working, the methodology still leaves some open questions. First and the foremost, the theoretical model we use has an important disadvantage. Speaking informally, it ignores both unpredictable weather (and other indispensable uncertainties) and good luck of a manager. Unpredictability implies that the efficient output mix can be known at neither cost, as the procedure of *precise* determining optimal output allocation does not exist. So, the best practice farm is commonly not that which made the minimal errors when making its decision but which made a lucky error. This obstacle hampers the accuracy of the performed estimations and leaves the opportunities for perfectioning the methodology.

Another problem relates to the empirical specification. It concerns the data limitations that influence the composition of the input matrix. As a result, some ITC are not spanned by the estimator, while some non-institutional costs are. For instance, due to the existing difference between market value (which is unknown) and book value of obsolete fixed assets, the estimates of ITC can include a part of costs of technical renovation. Certainly, in such cases the efficient output allocation is not achieved due to the degraded technology rather than due to high ITC. The substantial part of this imperfection is absorbed by the inefficiency term in the empirical specification, but some bias still remains.

As for now, the methodology is limited to the case of fixed inputs. This restricts the relevance of the results and constraints the area of application. Particularly, many possible applications in the industrial studies require variable inputs. Variable inputs meet no insuperable difficulties, although surely add some complexity to the methodology.

The results of this study regarding to farm sizes suggest that the competitive advantages of large dairy farms in the Moscow oblast in presence of high ETC (Svetlov, 2010) are despite larger and still growing ITC.

Finally, further studies are expected to explain why the expected positive ITC to size correspondence is not observed when using the dairy herd size as a farm size proxy.



### 5.3. Acknowledges

The author acknowledges valuable advice by Prof. Dr. Heinrich Hockmann (IAMO, Halle, Germany) and Dr. Irina V. Bezlepkina (LEI, the Hague, the Nederlands). A part of the study was supported by IAMO (Halle, Germany).

## References

Afuah A. (2003) Redefining firm boundaries in the face of the internet: are firms really shrinking? *The Academy of Management Review*, **28**(1), 34-53.

Banker R., Chames A. and Cooper W.W. (1984) Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, **30**, 1078-1092.

Bedi A., Tunali I. (1999) Testing for market imperfections: participation in land and labor contracts in Turkish agriculture. Institute of Social Studies, The Hague, mimeo.

Benjamin C., Phimister E. (1997) Transaction costs, farm finance and investment. *European Review of Agricultural Economics*, **24**, 453-466.

Buduru B., Brem M. (2007) Transaction costs, strategic interaction, and farm restructuring. *Agricultural Economics*, **37**, 67-80.

Charnes A. (1994) Data envelopment analysis: theory, methodology and application. Boston, Kluwer Academic Publishers.

Chavas J.-P., Despins P.M., Fortenbery T.R. (2000) Inventory dynamics under transaction costs. *Amer. J. Agr. Econ*., **82**, 260–273.

Chavas J.-P., Thomas A. (1999) A dynamic analysis of land prices. *Amer. J. Agr. Econ*., **81**, 772-784.

Ciaian P., Swinnen J.F.M. (2006) Land market imperfections and agricultural policy impacts in the new EU member states. *Am. J. Agric. Econ*, **88**, 799-815.

Coase R. (1937) The nature of the firm. *Economica*, **4**(16), 386-405.

Cooper W.W., Seiford L.M. and Zhu J. (2004) Data envelopment analysis: history, models and interpretations. In: Cooper W.W., Seiford L.M. and Zhu J., eds. Handbook on data envelopment analysis. Boston: Kluwer Acad. Publ.

Debreu G. (1959) Theory of Value: An Axiomatic Analysis of Economic Equilibrium. Wiley.

Falconer K., Dupraz P., Whitby M. (2001) An investigation of policy administrative costs using panel data for the English environmentally sensitive areas. *J. Agr. Econ.*, **52**(1), 83-103.

Färe R., Grosskopf S., Lovell C. (1994) Production Frontiers. Cambridge, Cambridge University Press.

Farrell M.J. (1957) The Measurement of Productive Efficiency. *J. of the Royal Statistical Society*, **120**(3), 253-290.

Goskomstat (2003). Российский статистический ежегодник [Russian statistical yearbook] (in Russian). Moscow: Goskomstat.

Henning C., Henningsen A. (2007) Modeling farm households' price responses in the presence of transaction costs and heterogeneity in labor markets. *Amer. J. Agr. Econ*., **89**(3), 665–681.

Hobbs J.E. (1997) Measuring the importance of transaction costs in cattle marketing. *Amer. J. Agr. Econ*. **79**, 1083-1095.

Kancs d'A., Ciaian P. (2010) Factor content of bilateral trade: the role of firm heterogeneity and transaction costs. *Agricultural Economics*, **41**, 305–317.

Lence S.H., Miller D.J. (1999) Transaction costs and the present value model of farmland: Iowa, 1900-1994. *Amer. J. Agr. Econ.*, **81**, 257-272.

Lerman, Z. (2001) Agriculture in transition economies: from common heritage to divergence. *Agricultural economics*, **26**, 95-114.

Liefert W., Osborne S., Liefert O., Trueblood M. (2003) Can Russia be competitive in agriculture? *EuroChoices*, **2**(3), 18-23.

Makhura M.T. (2001) Overcoming transaction costs barriers to market participation of smallholder farmers in the Northern province of South Africa. University of Pretoria, Pretoria, South African Republic.

McCann L., Colby B., Easter K.W., Kasterine A., Kuperan K.V. (2005) Transaction cost measurement for evaluating environmental policies. *Ecol. Econ.*, **52**, 527-542.

McCann L., Easter K.W. (1999) Transaction costs of policies to reduce agricultural phosphorous pollution in the Minnesota river. *Land Economics*, **75**(3), 402-414.

McCann L., Easter K.W. (2004) A framework for estimating the transaction costs of alternative mechanisms for water exchange and allocation. *Water Resour. Res.*, **40**, W09S09.

Meyer J. (2004) Measuring market integration in the presence of transaction costs - a threshold vector error correction approach. *Agricultural Economics*, **31**, 327-334.

Park A., Jin H., Rozelle S., Huang J. Market emergence and transition: arbitrage, transaction costs, and autarky in China's grain markets. *Amer. J. Agr. Econ*., **84**(1), 67–82.

Peerlings J., Polman N. (2004) Wildlife and landscape services production in Dutch dairy farming; jointness and transaction costs. *European Review of Agricultural Economics*, **31**(4), 427-449.

Rørstad P.K., Vatn A., Kvakkestad V. (2007) Why do transaction costs of agricultural policies vary? *Agricultural Economics*, **36**, 1–11.

Rosstat (2008). Российский статистический ежегодник [Russian statistical yearbook] (in Russian). Moscow: Rosstat.

Shagaida N. (2007) Институционально-экономические ограничения оборота земель в сельском хозяйстве России [Institutional and economic barriers to land turnover in Russian agriculture] (in Russian). Doctor of economic sciences thesis. Moscow, All-Russian institute of agrarian problems and informatics.

Svetlov N. (2009) Estimating internal transaction costs: the case of corporate dairy farms in Russia's Moscow oblast. *Agrarwirtschaft*, **58**(8), 346-353.



Svetlov N. (2010) External transaction costs and large-scale farming in Moscow oblast. *EuroChoices*, **9**(3) (forthcoming).

Svetlov N. (2010a) Экономико-статистическая оценка институциональных изменений в молочных хозяйствах Московской области [Econometric evaluation of institutional changes in dairy farms in the Moscow oblast] (in Russian). In: Труды XIV Международной научно-практической конференции Независимого научного аграрно-экономического общества России (23-24 апреля 2010 г.) [Proceedings of XIV international scientific and applied conference of Independent scientific association of Russian agricultural economists]. Kazan. Vol. 2, p. 44-51.

Uzun V. (2005) Large and small business in Russian agriculture: adaptation to market. *Comparative Economic Studies*, **47**(1), 85-100.

Vakis R., Sadoulet E., de Janvry A. (2003) Measuring Transactions costs form Observed Behavior: Market Choices in Peru. CUDARE Working Paper 962, Department of Agricultural and Resource Economics, University of California, Berkeley.

Williamson O.E. (1981). The economics of organization: the transaction cost approach. *The American Journal of Sociology*, **87**(3), 548-577.

Winter-Nelson A., Temu A. (2005) Impacts of prices and transactions costs on input usage in a liberalizing economy: evidence from Tanzanian coffee growers. *Agricultural Economics*, **33**, 243–253.