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Subsidies Allocation on Belarusian Corporate Farms

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1 Introduction

The state support of agriculture is of special importance in the countries that face low competitiveness of agricultural production and lack of capital that could be used for reconstruction of the sector. In the specific case of Belarus, both problems are heavily aggravated by the impact of Chernobyl catastrophe. For these reasons, the modernization of Belarusian agriculture is hardly possible unless reasonable state support is available. State financial support helps to soften these problems, but raises new problems instead. It influences the signal system of markets and reduces their capability to allocate resources optimally. It creates unequal conditions for participants in the agricultural markets. It leads to corruption and abuse of governmental power. Finally, it increases the burden of taxes. The essence of the subsidy distribution problem is to increase benefits from state support while bringing the related negative effects to a minimum.

This paper is aimed at developing a methodological framework that allows a researcher to explore and optimize subsidy policies subject to the specified political prerequirements. This framework is supposed to form a base for unified and transparent enforcement and monitoring routines. It must not result in competitive (dis)advantages depending on size, location, legal form, input and output allocation except for the advantages that are explicitly intended by the aim of the support. Finally, the amount of subsidies should be as small as possible, providing that the aim of the support is fulfilled.

The methodology we develop allows us to test the following hypotheses about the state support of Belarusian corporate farms:

i. The largest part of the funds should be expended so that they will increase current assets of the supported farms;
ii. The subsidies are more effective when received by the relatively efficient farms;
iii. The relatively inefficient farms can efficiently absorb larger amount of subsidies than the farms that achieve higher efficiency.

The first hypothesis relies on the Russian analogies (Yastrebova, Subbotin and Epstein, 2008; Svetlov and Hockmann, 2005). Currently, a typical Belarusian corporate farm has almost no access to external private sources of current assets, as was the case in Russia before 2002. Thus, it can be expected that increasing farm's own stock of current assets is the primary way use all other assets efficiently.

The background for the second hypothesis is that an efficient farm is likely to produce high profit per unit of assets. Thus, at least a marginal growth of the farm's stock is expected to turn into high incremental profits. Additional reason for this hypothesis is provided by (Csaki, Lerman and Sotnikov, 2000, p.33): 'The restrictions on transferability and convertibility may prove an impediment to reallocation of assets to more efficient users'. Thus, given the institutional failures that cause a lack of transferability, more efficient production units are expected to experience relative shortage of inputs. In this case budget subsidies may contribute in decreasing this shortage.

The reason for the third hypothesis is that, in common, inefficient farms need large structural changes in their assets to improve performance.

Following the aim, the contribution of this paper is mainly methodological. The empirical results that we present seem to be informative, as they correlate to those of previous studies (Zakhorozhko, 2009; Zhudro, 2009; Kazakevich, 2009). Nevertheless, they need further elaboration to increase their practical value (see Section 5 for more details).

2 Theoretical framework

2.1. Theoretical pre-conditions of state support in transitional economies

State interventions in underdeveloped markets have much more need to be carried out in comparison to the markets that are stable and properly functioning. Figure 1 aggregates the reasoning of such interventions by scientists from CIS and Europe (e.g. Brьmmer and Koester, 2004; Csaki, Lerman and Sotnikov, 2000; Buzdalov, 2009 etc.).

The difference between the economic and institutional reasons of the governmental interventions, as presented in the figure, is something informal. The root of both reasons is the current state of institutions. However, the latter case assumes that the government attempts to directly introduce or modify certain institutions, while in the former case it rather reacts to their current state.

It is widely accepted that state support distorts motivation to improve both the technical and allocative efficiency of a firm. So, state funds are not sufficient means to solve economic problems of such kind, no matter whether the economy is transitional or not. However, there is another type of economic problem that relates to the capability of the market to serve as a discovery engine in the spirit of (HAYEK, 1968). In transitional economies this problem is of special severity.

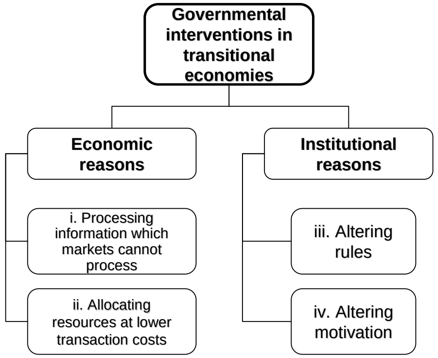

Figure 1. Reasons for governmental interventions in transitional economies.

Two specific forms of this problem exist. They relate to boxes (i) and (ii) in Figure 1. The first form is a need for information flow that the market cannot facilitate by its nature. This happens when the institutions that are supposed to facilitate such flows (like business networks, producer and trade unions, social networks, extension services etc.) are either insufficient (e.g., inherited from the communist past) or have not yet emerged. In this case, governmental agencies can temporarily take this function on themselves. The second form, which is a characteristic feature of transitional markets, is large market transaction costs (SVETLOV, 2010), which may even exceed transaction costs of governmental guidance. Both of these discussed forms do not, as a rule, influence the efficiency of a firm, but relate to the resource and production allocation of the whole market.

Regarding to box (iii), the mainstream of the new institutional theory believes that (a) institutional impact of a government should be limited to establishing a transparent and fare environment for economic activities and (b) interaction between the government and the market should only be aimed at preventing market failures.

In the case of a transitional economy these limitations may appear too restrictive. For example, when transaction costs are high, market agents may try to decrease them by escaping from the market and from private property. The accumulated experience of production in a non-market system lightens this way out. This example illustrates numerous institutional traps (POLTEROVICH, 2001) along the path of transition. So, in order to meet the political willingness of nations to exercise benefits of a developed market, a government may have to enforce injection of the 'obviously missing' institutions instead of facilitating the 'naturally emerging' institutions.

A more disputable direction of governmental interventions in the economy is the impact on motivation (box iv). Although it is commonly thought of as a subject outside of economic theory, the new institutional school necessarily addresses it in a specifically economic manner. It takes into consideration that motivation underlies institutions; meanwhile, institutions can be compared by their revealed efficiency. So, in cases where the existing motivation serves as a ground for obsolete institutions, a government may pursue the goals of reformation by exerting influence upon the motivation. This can be achieved by temporary support of 'too weak' benefits that arise in the market with 'stronger' benefits that remain under state governance. In many cases the procedures suggested by (GITTINGER, 1984) can serve as tools of accessing the 'desired' motivation in distorted markets. These procedures rely on approximating opportunity costs of the commodities that are not freely tradable in international markets.

2.2. Theoretical model of governmental financial support

All these considerations form the logical framework of the microeconomic approach to the distribution of state subsidies. This framework should address the following expected effects of subsidies. First, improving the allocation of farm assets in cases where the factor markets are not transparent, which relates to boxes (i) and (ii) in Figure 1. Second, adjusting motivation in cases where the existing motivation leads to degrading assets and collapsing markets (regarding to box (iv) in Figure 1). Moreover, with respect to box (iii), the methodology should be able to access these effects in presence of policies aimed at altering the standards and rules of economic interaction. The effect that *should not* be expected from state financial support and thus does not need to be accessed within the developed framework is changes in farm performance. As stated above, in either case governmental support weakens the incentive to improve efficiency.

The theoretical model applied in this study relies on the production frontier $\mathbf{y} = \mathbf{f}(\mathbf{x}, \mathbf{h}) - \boldsymbol{\theta}$, where $\mathbf{y} = (y_k)$ is a vector of outputs, $\mathbf{x} = (x_l)$ is a non-negative vector of non-marketable freely disposable inputs, $\mathbf{h} = (h_m)$ is a non-negative vector of non-marketable non-disposable inputs, $\mathbf{f}(\cdot) = (f_k(\cdot))$ is a production frontier function, and $\boldsymbol{\theta}$ is a non-negative vector of inefficiency components.

The $\mathbf{f}(\cdot)$ is required to have the following properties:

i. to be $\mathbf{0}$ if at least one component of either $\mathbf{x}$ or $\mathbf{h}$ is zero;

ii. to be positive and continuous in all positive $\mathbf{x}$ and $\mathbf{h}$;

iii. to be linearly homogenous of degree one[1];

iv. $\frac{\partial f_k(\mathbf{x},\mathbf{h})}{\partial x_l} \geq 0;\ \frac{\partial^2 f_k(\mathbf{x},\mathbf{h})}{\partial x_l^2} \leq 0;\ \frac{\partial^2 f_k(\mathbf{x},h)}{\partial h_m^2} \leq 0\ \ \forall k,l,m$ excluding the points where these derivatives do not exist.

Suppose now that some of the non-marketable inputs can be enlarged at the expense of the government: $\mathbf{y} = \mathbf{f}(\mathbf{x}+\mathbf{s}, \mathbf{h}) - \boldsymbol{\theta}$, where $\mathbf{s}$ is a non-negative vector representing the subsidized part of the non-marketable inputs[2]. This form assumes that the inefficiencies remain unchanged in the presence of subsidies, as it was argued above. Subject to this production frontier, a firm is expected to choose the output allocation that maximizes $\mathbf{py} - \mathbf{vx}$, where $\mathbf{p} = (p_k)$ is a non-negative vector of output prices and $\mathbf{v} = (v_l)$ a non-negative vector of input prices. Considering market imperfections, the prices may depend on the chosen technology:

$$\mathbf{p} = \mathbf{p}(\mathbf{x},\mathbf{y}) \text{ and } \mathbf{v} = \mathbf{v}(\mathbf{x},\mathbf{y}). \tag{1}$$

The next step introduces the governmental impact on motivation $\mathbf{p} = (p_k)$ and $\mathbf{v} = (v_l)$. This impact either strengthens or weakens the existing market motivation, which is reflected by $\mathbf{p}$ and $\mathbf{v}$. It takes the form of a price subsidy when either $p_k > 0$ or $v_l < 0$. Otherwise, it acts as an excise duty.

The resulting formulation of the theoretical model of a firm is as follows:

$$\begin{aligned} &\max_{\mathbf{y}} (\mathbf{p}(\mathbf{x},\mathbf{y}) + \Delta\mathbf{p})\mathbf{y} - (\mathbf{v}(\mathbf{x},\mathbf{y}) + \Delta\mathbf{v})\mathbf{x} \\ &\quad \textit{subject to} \\ &\quad \mathbf{y} = \mathbf{f}(\mathbf{x}+\mathbf{s},\mathbf{h}) - \boldsymbol{\theta}. \end{aligned} \tag{2}$$

[1] This supposition allows for constant returns to scale, since in the course of the supporting policies the firms are allowed to change their sizes.

[2] The subsequent analysis can be extended with subsidizing inputs $\mathbf{h}$ without altering its implications.

The problem of the government is to distribute the available funds b between $\mathbf{s}$, $\mathbf{p}$ and $\mathbf{v}$ pursuing the goal $g(\mathbf{y}^*, \mathbf{p}^*, \mathbf{p}, \mathbf{v}, b)$, where $\mathbf{y}^*$ is defined by the problem (2) and $\mathbf{p}^* = \mathbf{p}(\mathbf{x},\mathbf{y}^*)$:

$$\begin{aligned} &\max_{\mathbf{s},\Delta\mathbf{p},\Delta\mathbf{v},b} g(\mathbf{y}^*, \mathbf{p}^*, \Delta\mathbf{p}, \Delta\mathbf{v}, b) \\ &\quad \textit{subject to} \\ &\quad \mathbf{is} + \Delta\mathbf{py}^* - \Delta\mathbf{vx} \leq b, \end{aligned} \tag{3}$$

where $\mathbf{i}$ is a vector of ones.

Assume the following:

- $g(\mathbf{y}^*, \mathbf{p}^*, \mathbf{p}, b) = (\mathbf{p}^*+\mathbf{p})\mathbf{y}^* - (\mathbf{v}^*+\mathbf{v})\mathbf{x} - rb$, where r is the exogenously given opportunity cost of capital and $\mathbf{v}^* = \mathbf{v}(\mathbf{x},\mathbf{y}^*)$;
- there exists a private investor who owns at least b units of funds but does not invest them in the firm (2);
- the assumption that $(\mathbf{p}+\mathbf{p})$ is a 'true' or 'desirable' motivation is correct.

Then $g(\cdot)$ does not conflict with the goal of the firm, as it assumes that the government is acting in the same direction as market forces would act under the 'true' motivation. Let $\mathbf{s}^*$ be the optimal subsidies with respect to (3). Then it meets the economic reasons of the governmental intervention (Figure 1). This can be seen from the fact that the private investor, unless it is unable to access the necessary information at a reasonably low cost, could benefit by investing the amounts $\mathbf{s}^*$. As it was said above, $\mathbf{p}$ and $\mathbf{v}$ correct motivation, matching box (iv) in Figure 1. Allowance for adjusting the rules, which relate to box (iii) at the bottom of Figure 1, can be made either by inserting the corresponding constraints into (3) or by changing $g(\cdot)$. So, the proposed theoretical framework allows a researcher to develop a policy of governmental financial support that relies on the doctrine summarized in Figure 1.

Finally, if the above assumptions hold and b is not exogenously given, the following problem can be formulated:

$$\begin{aligned} &\max_{\mathbf{y},\mathbf{s},\Delta\mathbf{p},\Delta\mathbf{v}} (\mathbf{p}(\mathbf{x},\mathbf{y}) + \Delta\mathbf{p})\mathbf{y} - (\mathbf{v}(\mathbf{x},\mathbf{y}) + \Delta\mathbf{v})\mathbf{x} - r(\mathbf{is} + \Delta\mathbf{py} - \Delta\mathbf{vx}) \\ &\quad \textit{subject to} \\ &\quad \mathbf{y} = \mathbf{f}(\mathbf{x}+\mathbf{s},\mathbf{h}) - \boldsymbol{\theta}, \end{aligned} \tag{4}$$

which solves both (2) and (3). Existence of the solution of this problem depends on the set of additional assumptions, which are not the subject of this study. In general, $\mathbf{p}(\mathbf{x},\mathbf{y})$, $\mathbf{v}(\mathbf{x},\mathbf{y})$ and r must be such that the objective function of (4) remains concave. The necessary assumptions can be provided at the stage of empirical specification.

3 Empirical specification and data

The empirical model relies on the specification of the non-parametric production frontier (Färe et al., 1994). The current specification is not intended to span the whole capacity of the model (4). For that purpose we would have to conduct separate extensive studies of desirable motivation and rules. The proposed empirical model is therefore capable to access only the economic reasons of government financial interventions as shown in Figure 1.

We derive an optimal subsidy distribution from the following linear programme:

$$\begin{aligned}
&\max_{\substack{\mathbf{z}_n,\boldsymbol{\lambda}_n,\mathbf{s}_n,\\ \mathbf{r}_{0n},\mathbf{r}_{1n},\mathbf{r}_{2n}}} \boldsymbol{\delta}_1\mathbf{z}_n - \mathbf{c}\boldsymbol{\lambda}_n - \delta_2\mathbf{i}\mathbf{s}_n - \varepsilon\mathbf{i}(\mathbf{r}_{1n} \,|\, \mathbf{r}_{2n}) \\
&\textit{subject to} \\
&\mathbf{z}_n = \mathbf{Y}\boldsymbol{\lambda}_n \\
&\mathbf{x}_{1n} + \mathbf{s}_n = \mathbf{X}_1\boldsymbol{\lambda}_n + \mathbf{r}_{1n} \\
&\mathbf{x}_{2n} = \mathbf{X}_2\boldsymbol{\lambda}_n + \mathbf{r}_{2n} \\
&\mathbf{x}_{3n} = \mathbf{X}_3\boldsymbol{\lambda}_n \\
&(\mathbf{z}_n \,|\, \boldsymbol{\lambda}_n \,|\, \mathbf{s}_n \,|\, \mathbf{r}_{1n} \,|\, \mathbf{r}_{2n}) \ge \mathbf{0},
\end{aligned} \qquad (5)$$

where $\mathbf{z}_n$ is a vector of modeled outputs for the farm n (measured in a monetary form); $\boldsymbol{\lambda}_n$ a vector of linear combination factors for the farm n; $\mathbf{s}_n$ a vector of asset-specific subsidies for the farm n; $\mathbf{r}_{1n}$ and $\mathbf{r}_{2n}$ vectors of residuals in the farm n problem; $\mathbf{Y}$ a matrix of observed outputs; $\mathbf{X}_1$... $\mathbf{X}_3$ observed matrices of subsidized inputs, non-subsidized freely disposable inputs and non-disposable inputs, correspondingly; $\mathbf{x}_{1n}$...$\mathbf{x}_{3n}$ vectors of observed inputs on the farm n (the nth columns of $\mathbf{X}_1$...$\mathbf{X}_3$, respectively); $\boldsymbol{\delta}_1$ a vector of price-subsidy policy factors; δ_2 an opportunity cost of subsidies; $\mathbf{c}$ is a vector of observed production costs; $\mathbf{i}$ is a vector of ones; ε is a positive non-Archimedean element that is smaller than any real positive number; the vertical line is a concatenation operator. This problem extends the specification by (Cooper et al., 2000, p. 236), reverted to output orientation, with the variable vector $\mathbf{s}_n$.

Regarding to the theoretical model, the first term of the objective function $\boldsymbol{\delta}_1\mathbf{z}_n$ relates to the corresponding term of (4) $\mathbf{p}(\mathbf{x},\mathbf{y})+\Delta\mathbf{p})\mathbf{y}$, assuming constant farm-specific output prices and absence of impact on motivation. If neither subsidies nor excise duties are allowed to adjust the market motivation with respect to an output, the related component of $\boldsymbol{\delta}_1$ is the price. Alternatively, a component can be set to zero in order to fully ignore market signals from this output while allocating the asset-specific subsidies. This option can be used in order to allocate the subsidies regardless to the outputs that are 'self-sufficient', i.e. the profits from their sales tend to be re-invested in their production[3].

The term $\mathbf{c}\boldsymbol{\lambda}_n$ in the objective function of (5) relates to $(\mathbf{v}(\mathbf{x},\mathbf{y})+\Delta\mathbf{v})\mathbf{x}$ in (4). The background assumption is that inputs are not perfectly homogenous and input markets are fragmented. So, by attaching a non-zero value to λ_{qn}, which is the q-component of $\boldsymbol{\lambda}_n$, the farm n should access input factors $\lambda_{qn}(\mathbf{x}_{1q} \mid \mathbf{x}_{2q} \mid \mathbf{x}_{3q})$ at the same prices as the farm q. Otherwise the farm n may be unable to engage the q-technology. Another obvious assumption is that the input subsidies or excise duties are zero, regardless to their desired impact on motivation.

The term $\delta_2\mathbf{i}\mathbf{s}_n$ in (5) corresponds to $r(\mathbf{i}\mathbf{s}+\Delta\mathbf{p}\mathbf{y}-\Delta\mathbf{v}\mathbf{x})$ in (4) in absence of political impact on motivation. Finally, the term $\varepsilon\mathbf{i}(\mathbf{r}_{1n} \,|\, \mathbf{r}_{2n})$ is specific for non-parametric production frontier specification (see e.g. Cooper et al., 2004). It conjoins the constraints of (5) in defining the production frontier $\mathbf{f}(\mathbf{x}+\mathbf{s},\mathbf{h})-\boldsymbol{\theta}$ in (4).

In addition to $\mathbf{s}_n$, the model calculates the vector $\mathbf{z}_n$ of optimal outputs and the optimal profit $\boldsymbol{\delta}_1\mathbf{z}_n - \boldsymbol{\lambda}_n\mathbf{c}$. In advance of using these data in the analysis of the impact of subsidies, we have to make allowance for the fixed inefficiency terms $\boldsymbol{\theta}$, as stated by the theoretical model. For this purpose, (5) should be solved subject to the additional constraint $\mathbf{s} = \mathbf{0}$. To determine the impact of subsidies on outputs, the optimal $\mathbf{z}_n$ must be compared against $\mathbf{z}_{0n}$ rather than against $\mathbf{y}_n$, where $\mathbf{z}_{0n}$ is a vector of the optimal outputs in absence of the subsidies and $\mathbf{y}_n$ is a vector of the actual outputs on the farm n. The same holds for the profit. In addition, the ratio $\mathbf{i}\mathbf{y}_n \ / \ \mathbf{i}\mathbf{z}_{0n}$ defines the overall efficiency measure that is used in testing the second and third hypotheses of this study (formulated in Section 1).

In this study $\mathbf{Y}$ contains the following five rows, all measured in millions of Belarusian roubles[4]: grain, other crop production, dairy milk, other animal production, and non-agricultural production (including food processing and various services). All inputs that could be enlarged by subsidies must be measured in a monetary form. So, $\mathbf{X}_1$ contains ten rows, all measured in million Belarusian roubles: human capital, build-

[3] Should the desired impact on motivation be known, the corresponding price subsidies (excise duties) are can be defined by the components of $\boldsymbol{\delta}_1$ that exceed prices. The components that are lower than prices represent excise duties. However, in this case the term $\delta_2\mathbf{i}\mathbf{s}_n$ in the objective function of (5) should be replaced with $\delta_2(\mathbf{i}\mathbf{s}_n+(\boldsymbol{\delta}_1 - \mathbf{p})\mathbf{z}_n)$.

ings, machinery, vehicles, basic herd, other fixed assets, raw materials, growing and fattened animals, incomplete production, and other current assets. $\mathbf{X}_2$ includes two rows that reflect land resources: arable land ('average quality' hectares) and hayland and pastures (hectares). The underdeveloped labour and herd markets in Belarus result in congestion effects on farms. To allow for them, $\mathbf{X}_3$ contains two variables both measured in kind: number of agricultural workers and number of cows.

We use the data set of the official statistical reports from the year 2008 by 1399 corporate farms located in all oblasts of Belarus. This data set either contains or allows calculating (by summing more detailed variables) of all the data of $\mathbf{c}$, $\mathbf{Y}$, $\mathbf{X}_1$, $\mathbf{X}_2$ and $\mathbf{X}_3$ excluding the human capital. Of these 1399 records, 315 are dropped due to either missing data or absence of any production. The human capital is currently approximated as 17,4 million Belarusian roubles per agricultural worker, which is to be changed in future for a better proxy.

We have obtained the solutions of (5) for four different ad hoc levels of δ_2: 100%, which relates to a scarce budget financing, 50%, 35% and 10%. Since $\mathbf{y}$ are expressed in monetary terms and the impact on motivation is not yet taken into consideration, all the components of $\boldsymbol{\delta}_1$ are ones in the *full specification* of the empirical model. Alternatively, we introduce a *restricted specification* with $\boldsymbol{\delta}_1 = (1,0,1,0,0)$, which assumes targeting of state support to grain and milk only. Correspondingly, in the case of full specification, vector $\mathbf{c}$ reflects total farm production costs; otherwise it includes production costs of grain and dairy milk only. In total, four levels of δ_2 and two specifications form eight scenarios of state support allocation that are analyzed in the next section of the paper.

A special note should be made that in both cases the components of vector $\mathbf{c}$ include depreciation, which biases our estimations. Unfortunately, the data that could exclude the depreciation are currently unavailable (that may change in the future). The impact of this imperfection on this study is discussed in Section 5.

4 Results

The summary of the optimal subsidies allocation is presented in Table 1. In general, the data of this table support the first research hypothesis in the case where subsidies are assumed to influence overall production of the studied farms (the full

[4] As to 2008, one Euro is about 3200 roubles of Belarus.

specification) and at least does not reject the hypothesis in the case of restricted specification.

In the full specification, the majority (more than s) of state funds reserved for the sample farms should be invested in current assets. The exclusion is the case where the funds flow to the farms until the return from them falls to 10%. However, this case is absolutely unrealistic because of the required amount of money, of which almost a half would be used in construction, actually turning the farms into the plants.

In the case of restricted specification, 50% and 35% levels of subsidy efficiency also need more than s of the subsidies to be invested in the current assets (mainly to avoid shortages of raw materials). In two remaining cases the share of current assets is slightly above S. The most urgent governmental funding (with 100% return) should be directed to animal stock, while the consequent portions of money should enlarge the inventory.

Table 1: Amount and distribution of subsidies depending on the rate of their efficiency

	Full specification				Restricted specification			
Rate of efficiency:	**100%**	**50%**	**35%**	**10%**	**100%**	**50%**	**35%**	**10%**
Human capital, %	1.8	8.3	7.3	6.4	3.8	3.2	2.9	6.8
Buildings, %	0.2	0.1	0.1	**46.2**	0.0	0.5	0.8	4.8
Machinery, %	0.9	2.0	4.2	20.1	0.3	0.5	1.3	18.2
Vehicles, %	10.1	4.3	1.4	3.1	8.9	4.8	4.7	3.2
Basic herd, %	4.1	1.1	0.3	1.1	19.3	6.9	5.7	4.6
Other fixed assets, %	6.7	1.8	0.6	0.6	14.2	7.7	7.1	2.6
Raw materials, %	**30.7**	**35.9**	**36.5**	8.8	8.6	**39.4**	**41.7**	**28.6**
Growing and fattening animals, %	12.3	13.2	15.7	5.2	**25.0**	23.6	21.6	17.0
Incomplete production, %	3.5	3.0	3.8	1.3	6.9	3.9	3.4	3.2
Other current assets, %	29.6	30.3	30.0	7.1	13.0	9.5	10.9	11.0
Total amount, in trillions of Belarusian roubles	0.60	4.47	15.89	113.87	0.14	0.79	1.40	4.14

Notes: Full specification assumes that all outputs are affected by the subsidies; restricted specification assumes that the subsidies are targeted to grain and dairy milk outputs only.
As of 2008, one Euro is about 3200 roubles of Belarus.
The dominating shares are printed in bold.
Source: Authors' calculations.

State investments in machinery become important only at the 10% level of the expected return. As a result of the existing state support programs for investments in machinery, shortages of machinery are not widespread in Belarus.

The human capital accumulation is not an important target of state support. This result may change if the qualitative differences in the working force would be taken into consideration while determining the values of the human capital proxy.

Table 2 displays the shifts of output allocation due to the subsidizing policies presented in Table 1. The straightforward suggestion from Table 2 is that, unless enlarging dairy milk production is not listed among the major goals of agricultural policy, the subsidies should be strongly targeted to certain branches of agricultural production, e.g. to grain and dairy milk branches. In the absence of such targeting, the best results are achieved at a 50% level of subsidy efficiency. Only in this case all the outputs grow. Yet, the milk production grows to the smallest extent. The major beneficiaries of this policy are non-agricultural activities and non-milk animal production (most likely pork and poultry), both growing by more than 3 times. The available data show, though, that in many farms these branches are profitable and capable of self-financing.

Table 2:Impact of optimal subsidies on production

per cent of year 2008 optimal production in the absence of subsidies

Rate of subsidies efficiency:	100%	50%	35%	10%
Full specification				
Grain	97.9	121.4	97.2	95.3
Other crop production	85.8	127.1	145.6	73.2
Milk	97.1	104.1	36.9	77.5
Other animal production	**167.4**	337.3	923.5	**1898.3**
Food processing and other non-agricultural production	148.7	**349.1**	**1154.5**	1298.3
Restricted specification				
Grain	**109.6**	127.8	139.1	161.5
Milk	109.1	**130.8**	**142.5**	**170.2**

Notes:Full specification assumes that all outputs are affected by the subsidies; restricted specification assumes that the subsidies are targeted to grain and dairy milk outputs only.
The largest growth rates are printed in bold.
Source: Authors' calculations.

Profit changes due to the subsidies are addressed in more details in Table 3. Actually, in 2008 the studied farms suffered 439 billion Belarusian roubles of losses. Particularly, the losses from grain and milk production amounted to 568 billion, of which only 56 billion can be attributed to both technical and allocative inefficiencies. Due to the subsidies, the improved structure of assets allows profitable sales over the whole sample (providing that the existing overall inefficiencies remain). The exclusion is the case of the 'targeted' support at a 100% level of efficiency. The amount of supporting funds in this case (139 billion Belarusian roubles) is too small to avoid the losses in the majority of farms.

Table 3: Impact of subsidies on profits

in trillion of Belarusian roubles

Rate of subsidies efficiency	Full specification	Restricted specification
100%	0.99	0.25
50%	3.44	0.68
35%	8.05	0.94
10%	21.33	1.46
Profit loss due to various inefficiencies	4.56	0.06

Notes:Full specification assumes that all outputs are affected by the subsidies; restricted specification assumes that the subsidies are targeted to grain and dairy milk outputs only.
As to 2008, one Euro is about 3200 roubles of Belarus.
Source: Authors' calculations.

The low level of inefficiencies in case of the restricted specification does not imply that the corresponding scheme of allocation of the state funds improves performance of the studied farms. The true background of this value is that the majority of opportunities to improve the performance are associated with other outputs than grain or milk. So, these opportunities are not taken into consideration by the restricted specification.

Table 4 addresses the second hypothesis of our study about the correspondence between the impact of the state support and the overall farm inefficiency. In the case of full specification, the situation is opposite to the hypothesis: larger farm inefficiency relates to a larger positive impact of subsidies. It should be noted, however, that the primary objects of state support in this case are the most profitable branches, including non-agricultural activities. Clearly, many farms that already have fully developed non-agricultural, pork and poultry branches appear on the production frontier, so they cannot gain much from subsidizing the corresponding assets. This peculiarity explains the result that contrasts to our a priori expectations. In the case of the restricted specification, the direction of the correlation matches the expectation, but it is not always statistically significant. In general, the second hypothesis is not rejected for this specification, remaining questionable in 50% and 35% cases.

Table 5 allows us to conclude about the third research hypothesis. In contrast to the previous hypothesis, the expectations are matched in the case of the full specification and vice versa. In full specification, the development of new profitable branches of agricultural and non-agricultural production in those farms that currently do not have them requires a large commitment of funds. In restricted specification (cases of 100% and 10% return to the subsidies) the major part of the subsidies are absorbed by the farms demonstrating relatively high overall efficiency. In the remaining cases the rank correlation is statistically insignificant.

Table 4: Spearman rank correlation between overall inefficiency and relative impact of subsidies

Rate of subsidies efficiency:	100%	50%	35%	10%
Full specification	**0.154**	**0.317**	**0.295**	**0.299**
p-value	**0.000**	**0.000**	**0.000**	**0.000**
Restricted specification	**-0.110**	-0.009	-0.015	**-0.133**
p-value	**-0.000**	-0.774	-0.615	**-0.000**

Notes: Full specification assumes that all outputs are affected by the subsidies; restricted specification assumes that the subsidies are targeted to grain and dairy milk outputs only. Correlations that are significant at α=0.05 are printed in bold.
Source: Authors' calculations.

Table 5: Spearman rank correlation between overall inefficiency and optimal amount of subsidies

Rate of subsidies efficiency:	100%	50%	35%	10%
Full specification	**0.154**	**0.232**	**0.121**	**0.096**
p-value	**0.000**	**0.000**	**0.000**	**0.002**
Restricted specification	**-0.064**	0.048	0.014	**-0.250**
p-value	**-0.035**	0.111	0.645	**-0.000**

Notes: Full specification assumes that all outputs are affected by the subsidies; restricted specification assumes that the subsidies are targeted to grain and dairy milk outputs only. Correlations that are significant at α=0.05 are printed in bold.
Source: Authors' calculations.

5 Open questions

The depreciation that is accounted as a part of the costs (vector **c**) diminishes the economic value of this study. The estimations based on rough guesses about depreciation suggest that the conclusions about the stated research hypotheses are unlikely to alter. However, the total amount of the subsidies may be affected significantly. So, availability of data on depreciation would largely improve the practical relevance of this study. The same holds for the human capital, which needs a better proxy. Taking into account differences in quality of labour, the present conclusion about minor consumption of subsidies for the purpose of developing the human capital can change.

The assumption of non-disposability with regard to labour may appear to be too restrictive for some suburban farms. City labour markets can absorb excess workers that are discharged from the farms. More precise results can be obtained by the as-

sumption of either disposable or non-disposable labour depending on the location of a farm. As for the herd, it would be more correct to explicitly account for the opportunity costs of culling a cow.

The current version of the empirical model does not allow for the specific weather conditions of 2008. A fully credible model would have to rely on the data for average annual inputs and outputs over several years. Nevertheless, the model correctly reproduces the actual side-effects of subsidies. In particular, such effects actually exist with the subsidization of milk output that indirectly supports secondary branches which demonstrate competitive advantages. As a result, the intended reconstruction of milk production and improving its competitiveness slows down. The modelled allocation of the subsidies over assets conforms to the theoretical considerations of (Yastrebova, Subbotin and Epstein, 2008; Svetlov and Hockmann, 2005; Kazakevich, 2009).

The general outlook of the further studies considers a more detailed specification of agricultural policies and using data of several years to ensure robustness of estimates. Practical relevance of the study largely depends on the availability of methodology that would track the subsidies in order to secure their proper targeting. One of the opportunities is that government bodies would contract intermediate private agencies to deliver subsidies. These agencies would purchase assets for a farm at the expense of its subsidy quota providing that the farm proves use of the purchased assets for a target output. Alternatively, the targeting may appear unnecessary in presence of governmental impact on motivation. This hypothesis should be tested in future studies.

The whole amount of support should not necessarily be received from the state budget. From the economic point of view, the nature of the source of the support (whether it is the state, public or private funds) does not matter. However, the actual situation is that non-governmental investors demonstrate a limited activity in Belarusian agriculture (Zhudro, 2009), even despite the circa 4.6 trillion Belarusian roubles of state support that were received by 1399 corporate farms in 2008. It is still questionable whether the improved allocation of state support can drive private funds to Belarusian corporate farms. Concluding, the pessimistic approach suggests that it is risky to presume that a part of funds suggested by Table 1 would be covered from private sources.

6 CONCLUSIONS

This study develops a methodology of allocating state financial support over types of assets and tests hypotheses about the allocation of support across the set of farms. The core of the methodology is a DEA-like microeconomic model. It determines the optimal subsidy allocation subject to the non-parametric production frontier as defined by the available farm-level data. Subject to availability of the studies that suggest fare market prices for Belarusian farm outputs and new rules to be enforced, the empirical model developed in this study can serve as a ‘test bench’ for tuning a wide range of institutional changes by means of corresponding governmental impacts.

The first hypothesis of this study supposes that the current assets should be the dominating destination for state funding. It is strongly supported in the majority of the modeled cases defined by targeting the subsidies and their planned efficiency. In the case of full specification and 10% return to subsidies the findings opposes this hypothesis. However, this case does not have practical relevance due to a very large amount of subsidies needed. *The second hypothesis* about the higher efficiency of state financing on relatively efficient farms is supported only in a limited number of cases. Specifically, it holds when the financing is targeted to the milk and grain production and the supposed level of return to subsidies is either 100% or 10%. In absence of targeting to specific outputs, our findings are exactly opposite to this hypothesis, in contrast to the opinion of many scientists, e.g. (BUZDALOV, 2009). *The third hypothesis* is the positive correlation between the inefficiency and the amount of state financial support that can be efficiently absorbed. Just as in the case of the second hypothesis, its verification depends on the targeting of financial support. Our study strongly supports this hypothesis in the case of un-targeted support only.

With respect to the allocation of the subsidies, two basic results of our study should be considered by the policy makers: first, the arguments in favour of targeting subsidies at the grain and milk production support, and second, financing current assets prior to the fixed assets. The former conforms to the existing practice, while the second suggests correctives to the current policies.

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Abstract: Subsidy allocation across the types of assets and impact of subsidies on agricultural outputs and profits are studied. The methodology is based on estimating a non-parametric production frontier and applied to 1084 Belarusian corporate farms. The results suggest targeting governmental support at grain and milk production. In this case, the farms with higher efficiency are more sensitive to the support and are able to absorb larger amount of subsidies. The opposite is true in the absence of targeting.

Keywords: Microeconomic model, non-parametric econometrics, production frontier, subsidies, Belarus.

Аннотация: Исследуется распределение субсидий по видам активов и их влияние на производство сельскохозяйственной продукции и на прибыли товаропроизводителей. Методика, основанная на моделировании непараметрической границы производственных возможностей, применена к 1084 сельскохозяйственным организациям Беларуси. Результаты указывают на целесообразность субсидирования производства зерна и молока. В этом случае наиболее эффективные сельхозорганизации демонстрируют лучшую отдачу от субсидий и способны использовать больший их объём. При субсидировании всех видов продукции верно противоположное утверждение.

Ключевые слова: микроэкономическая модель, непараметрическая эконометрика, граница производственных возможностей, субсидии, Беларусь.