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A Microeconomic Model for Subsidies Allocation: the Case of Belarus

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Abstract: The paper develops a microeconomic methodological framework that allows approaching subsidy allocation across the types of assets and impact of subsidies on agricultural outputs and profits. The methodology is based on a non-parametric production frontier estimation. The empirical application is made to 1084 Belarusian corporate farms. The results suggest targeting governmental support at grain and milk production. In this case, 4.14 trillion Belarusian roubles of subsidies increase the overall profit of the sample farms by 1.46 trillion. In the case of targeting, the farms with higher overall 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.

Microeconomic model, data envelopment, subsidies, Belarus. JEL codes: K18, C61.

1 INTRODUCTION

State support of private agricultural business is a widely spread world practice. The position of many politicians and scientists is that the market can cause harm to agriculture and food supply when a government relies on its forces only. The reasons are the high specific risks of agricultural production, the long production period, and the large demand for assets in turnover. Difficult access to loans in areas where the land is not marketable due to either regulations (Belarus) or low value (Russia) is another reason, which is specific for CIS countries.

The agriculture that misses state support may over-use natural resources, thus causing harm to the environment, making it unable to meet quality standards, and leaving many people at the edge of hunger.

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 both on businesses and citizens.

The essence of the subsidy distribution problem is to increase benefits from state support while bringing the related negative effects to a minimum. Regarding the agricultural economy, this problem is especially urgent in the countries that face two simultaneous difficulties:

- low competitiveness of agricultural production;
- scarce accumulated capital that could be used for reconstruction of the sector.

Because of these two difficulties the modernization of the agricultural sector in Belarus is hardly possible unless reasonable state support is available.

This paper is aimed at developing a methodological framework that allows a researcher to explore and optimize subsidy policies subject to the specified political pre-requirements.

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:

- accumulation of the current assets is a primary direction of state support;
- the subsidies are more effective when received by the relatively efficient farms;
- 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 no private sources of current assets, as was the case in Russia before 2002. Thus, it can be expected that the accumulation of current assets is the primary way to improve the utilization of all other assets.

The grounds for the second hypothesis is the fact that the efficient farms produce, on average, higher profit per unit of assets. This should remain the same at least with marginal, incremental changes of their assets. Additional reasons for this hypothesis are provided by (CSAKI, LERMAN and SOTNIKOV, 2000).

The reason for the third hypothesis is that the inefficient farms need large structural changes in their assets to achieve the desired level of efficiency by introducing the technologies and managerial practices of the best-practice farms.

Following the aim, the contribution of this paper is mainly methodological. The empirical study is still in progress. Some parameters of the model are rough guesses, and the data we use may still comprise some noise. Nevertheless, the preliminary empirical results that we present seem to be informative, as they correlate to those of previous studies (ZAKHOROZHKO, 2009; ZHUDRO, 2009; KAZAKEVICH, 2009). We address the quality of results in more details in the concluding section of the paper.

2 THEORETICAL FRAMEWORK

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. BRÜMMER and KOESTER, 2004; CSAKI, LERMAN and SOTNIKOV, 2000; BUZDALOV, 2009 etc.).

It should be noted from the beginning that the difference between the economic and institutional reasons of the governmental interventions, as presented in the figure, is something informal. In any case, the root of both reasons is the current state of the institutions. However, in the latter case the government attempts to directly introduce 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.

Two specific forms of this problem exist. They relate to the two bottom-left boxes 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 cooperative networks, producer and trade unions, social networks, extension services and so on) are either insufficient (e.g., inherited from the communist past) or have not yet emerged. In this case, governmental agencies can temporarily facilitate some such information flows. Second, the characteristic feature of transitional markets is large transaction costs (SVETLOV, 2009) which may exceed the 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.

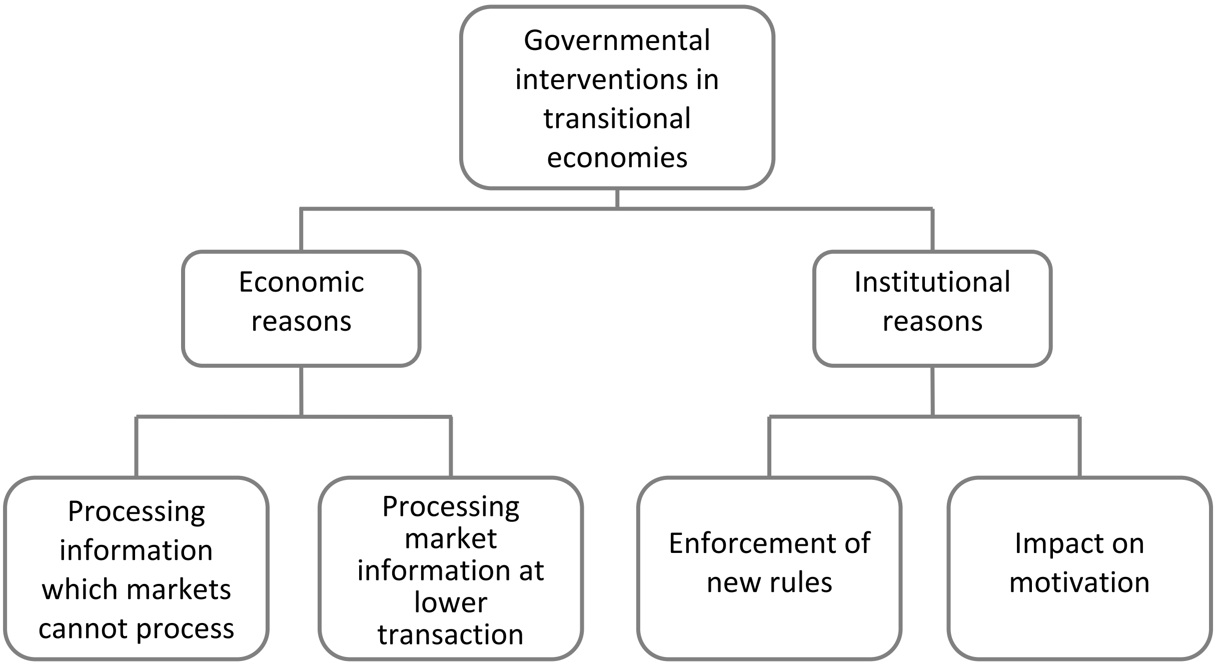

Figure 1. The reasons for governmental interventions in a transitional economy.

A more disputable direction of governmental interventions in the economy is the impact on institutional transformation. The mainstream of the new institutional theory believes that the interaction between the state and the market should be limited to preventing market failures. The perfection of economic institutions that is exhibited in the cutting of transaction costs, they say, should be driven by the common economic goals of any business.

Unfortunately, the experience of CIS countries shows that this is not always the case. 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 makes this way out even more advantageous. This is just an extreme example of 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.

The dominating motivation of economic agents is another institutional obstacle to market transition in countries with more than 70 years experience with central planning. Although motivation 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.

All these considerations form the logical framework of the microeconomic approach to the distribution of state subsidies. To resume, the following expected effects of subsidies should be accessed:

- improving the allocation of *farm assets* in cases where the related markets are not transparent at the farm level (which relates to the two bottom-left boxes in Figure 1);

- improving motivation in cases where the existing (revealed) motivation leads to degrading assets and collapsing markets (which relates to the bottom-right box in Figure 1).

The methodology should access these effects in the presence of the policies aimed at improving the rules that bring agricultural markets into order (which relates to the remaining box in Figure 1).

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 overall farm efficiency. As stated above, in either case governmental support weakens the incentive to improve efficiency. Particularly, improving the allocation of marketable inputs and outputs that could be discovered while modeling subsidies must not be attributed to the impact of the subsidies.

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 inputs that do not cause the congestion effect, $\mathbf{h} = (h_m)$ is a non-negative vector of non-marketable inputs that cause the congestion effect, $\mathbf{f}(\cdot) = (f_k(\cdot))$ is a production frontier function, and $\boldsymbol{\theta}$ is a non-negative vector of inefficiency components. A maximum possible number of the inefficiency components, subject to the functional form of $\mathbf{f}(\cdot)$, should be equal to zero.

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

- to be $\mathbf{0}$ if at least one component of either $\mathbf{x}$ or $\mathbf{y}$ is zero;
- to be positive and continuous in all positive $\mathbf{x}$ and $\mathbf{h}$;
- to be linearly homogenous of degree one;
- $\frac{\partial f_k(\mathbf{x},\mathbf{h})}{\partial x_l} \geq 0; \ \frac{\partial^2 f_k(\mathbf{x},\mathbf{h})}{\partial x_l^2} \leq 0; \ \frac{\partial^2 f_k(\mathbf{x},h)}{\partial h_m^2} \leq 0 \ \ \forall k,l,m$ excluding the points where these derivatives do not exist.

The supposition of the linear homogeneity allows for a constant return to scale. This assumption is very important for this study. The special reservation was made in the previous section that financial interventions of government should relate to the resource and production allocation *of the whole market*. So, in the course of the supporting policies the firms are allowed to conjoin, split and change their sizes in any other way in order to use the scale effects to the favour of their owners. The assumption of constant return to scale is required in order to properly represent the consequences of state support in the presence of such processes.

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[1]. 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 $\mathbf{py}$, where $\mathbf{p} = (p_k)$ is a non-negative vector of output prices.

The next step introduces the governmental impact $\Delta\mathbf{p} = (\Delta p_k)$ on motivation through either strengthening or weakening the existing market motivation, which is reflected by $\mathbf{p}$. This impact takes a form of price subsidies when $\Delta p_k > 0$ or excise taxes when $\Delta p_k < 0$.

[1] The theory can be easily extended with subsidizing the input $\mathbf{h}$ also, but this opportunity is outside the current framework of this study.

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

$$\max_{\mathbf{y}} (\mathbf{p}+\Delta\mathbf{p})\mathbf{y}$$
$$\textit{subject to} \qquad (1)$$
$$\mathbf{y}=\mathbf{f}(\mathbf{x}+\mathbf{s},\mathbf{h})-\boldsymbol{\theta}.$$

The problem of the government is to distribute the available funds b between $\mathbf{s}$ and $\Delta\mathbf{p}$ pursuing the goal $g(\mathbf{y}^*, \mathbf{p}, \Delta\mathbf{p}, b)$, where $\mathbf{y}^*$ is defined by the problem (1):

$$\max_{\mathbf{s},\Delta\mathbf{p},b} g(\mathbf{y}^*,\mathbf{p},\Delta\mathbf{p},b)$$
$$\textit{subject to} \qquad (2)$$
$$\mathbf{is}+\Delta\mathbf{p}(\mathbf{y}^*)\le b,$$

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

Suppose the following:

- b is fixed;
- $g(\mathbf{y}^*, \mathbf{p}, \Delta\mathbf{p}, b) = (\mathbf{p}+\Delta\mathbf{p})\mathbf{y}^* - rb$, where r is the opportunity cost of capital;
- there exists a private investor who owns at least b units of funds but invests nothing in the firm (1);
- the assumption that $(\mathbf{p}+\Delta\mathbf{p})$ is a 'true' or 'desirable' motivation is correct.

Then $g(\cdot)$ does not conflict with the goal of the firm, as it is acting in the same direction as market forces would act under the 'true' motivation. In this case the injection of the optimal, with respect to (2), subsidies $\mathbf{s}^*$ (if they are non-zero) 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, $\Delta\mathbf{p}$ corrects motivation (low-right box on Figure 1). Allowance for enforcement of the new rules, which relate to the remaining box at the bottom of Figure 1, can be made either by inserting the corresponding constraints into (2) 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.

3 EMPIRICAL SPECIFICATION AND DATA

The empirical model relies on the specification of the non-parametrical production frontier, which is commonly used in the data envelopment analysis (DEA) (CHARNES, 1994).

As justified in Section 2, the objective function of the government is assumed to match the objective function of a farm in the space of analyzed outputs. This assumption allows combining (1) and (2) in a single empirical model. We derive an optimal subsidy distribution from the following DEA-like linear programme:

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

$\mathbf{z}_n$ is a vector of modeled outputs for the farm n (measured in a monetary form);
$\boldsymbol{\lambda}_n$ is a vector of linear combination factors for the farm n;
$\mathbf{s}_n$ is a vector of subsidies for the farm n;
$\mathbf{r}_{1n}$ and $\mathbf{r}_{2n}$ are vectors of residuals in the farm n problem;
$\mathbf{Y}$ is a matrix of observed outputs;
$\mathbf{X}_1$ is a matrix of observed inputs that could be enlarged by subsidies. These inputs should be measured in a monetary form;
$\mathbf{X}_2$ is a matrix of observed inputs that do not cause congestion effects;
$\mathbf{X}_3$ is a matrix of observed inputs that may cause congestion effects;
$\mathbf{x}_{1n}\ldots\mathbf{x}_{3n}$ are the vectors of observed inputs on the farm n (the nth columns of $\mathbf{X}_1\ldots\mathbf{X}_3$, respectively);
$\boldsymbol{\delta}_1$ is a vector of price-subsidy policy factors;
$\boldsymbol{\delta}_2$ is a vector of asset-subsidy policy factors;
$\mathbf{c}$ is a vector of observed production costs;
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, SEIFORD and TONE, 2000, p. 236), reverted to output orientation, with the variable vector $\mathbf{s}_n$. A component of $\mathbf{s}_n$ displays the amount of state support that is invested in a specific type of asset. Vector $\boldsymbol{\delta}_2$ defines the marginal impact of the support on profit (roubles of incremental profit per rouble of subsidy).

Price subsidies are defined by $\boldsymbol{\delta}_1$. In the absence of price subsidies all the components of $\boldsymbol{\delta}_1$ are ones. To allocate price subsidies, the corresponding components of $\boldsymbol{\delta}_1$ should be set to values above one[2]. In this case, the amount of price subsidy per product i is $z_{ni}(\delta_{1i} - 1)$ and the total amount of price subsidies on farm n is $\mathbf{z}_n\boldsymbol{\delta}_1 - \mathbf{z}_n\mathbf{i}$, where $\mathbf{i}$ is a vector of ones.

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 access the fixed inefficiency terms, as stated by the theoretical model. For this purpose, (3) 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 the 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.

2 The empirical estimations of the price subsidies are to be performed.

In addition, the ratio $\mathbf{iy}_n$ / $\mathbf{iz}_{0n}$ 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 **Y** contains the following five rows, all measured in millions of Belarusian roubles[3]: grain, other crop production, dairy milk, other animal production, and non-agricultural production (including food processing and various services).

$\mathbf{X}_1$ contains ten rows, all measured in millions of Belarusian roubles: human capital, buildings, machinery, vehicles, basic herd, other fixed assets, raw materials, growing and fattened animals, incomplete production, and other current assets.

In this study $\mathbf{X}_2$ has just 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 basic herd population.

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 **c**, **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.

As for the human capital, currently we use a very rough proxy which is proportional to the number of agricultural workers. It is assumed that the opportunity cost of one high-quality worker (employed by farms located on the production frontier) is 17,4 million Belarusian roubles. This figure includes educational expenses and forgone output that this worker could produce outside agriculture. The source of this figure is not sufficiently representative, so this value should be verified in the future. In order to fully use its capacity, the empirical model needs to incorporate the results of studies of agricultural human capital based on special surveys.

In this study it is assumed that the rate of efficiency of state support should be equal for all farms and all directions. We test four ad hoc levels of efficiency: 100%, which relates to a relatively scarce budget financing, 50%, 35% and 10%. The complete study is expected to approach the Pareto optima set in the space of amount and efficiency of subsidies so as to let the politicians make the choice.

All four rates are tested for two possible targets of state support: either the corporate farms as a whole (*full specification*) or just grain and dairy milk production (*restricted specification*). The presented branch of the study does not span price subsidies, so $\boldsymbol{\delta}_1 = (1,1,1,1,1)$ in case of the full specification and (1,0,1,0,0) in case of the restricted specification. Correspondingly, in the former case, vector **c** reflects total farm production costs, while in the latter case it includes production costs of grain and dairy milk only.

A special note should be made that in both cases the values of vector **c** include depreciation, which biases our estimations. Unfortunately, the data that could exclude the depreciation are

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

currently unavailable (that may change in the future). The impact of this imperfection on this study is discussed in the concluding section of the paper.

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

In the full specification, the majority (more than ¾) 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.

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.

In the case of restricted specification, 50% and 35% levels of subsidy efficiency also need more than ¾ of the subsidies to be invested in the current assets (mainly to avoid shortages of raw materials). In the two remaining cases the share of current assets is slightly above ½. The most urgent governmental funding (with 100% return) should be directed to animal husbandry, while the consequent portions of money should enlarge the inventory.

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, modern shortages of machinery are not widespread in Belarus.

The model suggests that 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 do 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.

The targeted subsidies, as modelled by the restricted specification, result in smooth growth of both grain and milk production in the course of increasing state support. Even in the most demanding case the total amount of financing is quite similar to the actually existing state farming (year 2008) that amounts to 4.6 trillion Belarusian roubles, including so-called state 'budget loans'.

Noticeably, the 'non-targeted' support at 50% efficiency costs nearly the same as the 'targeted' support at 10% efficiency. The disadvantage of the former is that its impact on the politically important branches of agricultural production is limited, while the advantage is the relatively large positive influence on the farms' profits.

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.

Table 4 addresses the second hypothesis of our study about the correspondence between the efficiency 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, on average, 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 the theoretical 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 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.

Finally, 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 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 Conclusions and discussion

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 data concerning actual inputs and outputs.

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. However, in one case the findings opposes this hypothesis and in two cases the result is uncertain. In either case, the initial portion of financial support (100% return level) should be directed to the current assets. The destination of the consequent financial inflows depends on the targeting.

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%. Except for the cases that presume targeting, 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.

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 specific forms of state support (like partial subsidizing of interest rates) that succeed in Russia can drive private funds to Belarusian corporate farms. Concluding, the pessimistic approach to the estimation of state agricultural subsidies suggests that it is risky to presume that a part of funds suggested by Table 1 would be covered from private sources.

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.

A more detailed allocation may not need governmental enforcement. However, in the presence of non-transparency and other failures of the developing agricultural markets, the monitoring of the actual subsidy allocation among the different types of assets is desirable. A large difference between the actual allocation and the estimations may indicate shadow activities of the recipients of state support.

The depreciation that is accounted as a part of the costs (vector **c**) diminishes the economic value of the estimations that are presented in the paper. We do not expect significant changes in optimal subsidy distribution after cleaning the costs from depreciation, but the total amount of the subsidies may be affected largely.

The share of subsidies aimed at developing the farms' human capital is not fully reliable, as the human capital cost per worker needs to be estimated more precisely and may differ across farms. Excluding human capital subsidies and amounting the remaining subsidies to 100%, the shares of other subsidies are not likely to vary much due to changes in the uncertain parameter of 'human capital cost'.

The assumption of labour congestion effects 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 selecting either congestion or non-congestion empirical specifications with regard to the location of a farm. As for the herd, it would be more correct to explicitly account for the opportunity costs of discharging a cow from the herd. Unfortunately, it is not clear for the moment whether the necessary data is accessible.

Due to its experimental nature, 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 application of the proposed methodology is not limited to Belarus. Subject to the necessary changes in empirical specification and data availability, it can be applied to other transitional countries of Europe and to EU countries. In countries where family-run farms dominate, $\mathbf{X}_1$ should probably include only two rows for human capital and total assets. It is advisable to apply the model to the corporate and family farms separately. In developed and some transitional countries where the labour and herd markets operate properly, $\mathbf{X}_2$ may not be necessary. Further applications may gain from using a monetary measure of land availability, which is not available in Belarus.

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