MAKING AGRICULTURAL SUPPORT OBJECTIVE-ORIENTED: A LINEAR PROGRAMMING APPROACH FOR UKRAINE

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Abstract: The overall aim of the paper is to analyse the distribution of state agricultural support in Ukraine with the purpose of drawing up proposals on how to make it more objective-oriented. The investigation is based on the results of a case study conducted in Zdolbuniv district[3], in the Rivne region of Ukraine, where interviews with local agricultural experts were held. The research is founded on the Linear Programming (LP) methodological approach, which is applied to calculate an objective-oriented agricultural budget allocation. This approach also integrates judgements from district agricultural experts. The outcomes show that agricultural support should have been redistributed in a slightly different way from the district perspective. However, the calculated changes in most cases match with the overall development directions in the Ukrainian agricultural support policy. Furthermore, the developed model has proved to be a useful and, at the same time, quite simple tool in application support, and one which could have been used by the agricultural decision-makers in the process of the distribution of agricultural support.

Key words: *Agricultural support, Linear Programming, Ukraine*

1. Introduction

The usefulness, means and scale of state agricultural support have been already discussed many times by scholars from both developed and developing countries. A lot of scientific attention is paid to this field because of the unique particularities of agriculture and its important role in the food security of a state and the life of a society (Dibrova, 2009). In the European Union (EU) the "evolution" of the Common Agricultural Policy (CAP) has eventually led to a shift from production support to rural development support and the enhancement of agri-environmental measures (EC, 2010).

The state agrarian policy of the Ukraine considers the necessity of the country's integration into the EU (VRU, 2005a, article 1). As a result, the Ukraine has also proclaimed social and economic developments of rural settlements as one of its main priorities in agrarian policy . However, despite this fact, a large part of its agricultural budget is still spent on agricultural production support (VRU 2007, 2008 and 2010). Also, in the current conditions of restricted budgetary resources, it is especially important to rationalise agrarian policy, optimise the financial support of agriculture and enhance the efficiency of budget expanses expenses (Bojda, 2006).

As from 1991, the allocation of agricultural budget has been carried out by the Verkhovna Rada of Ukraine (VRU) and the Ministry of Agrarian Policy of Ukraine (MAPU). The overall objective pursued in the agrarian policy is to improve the social economic conditions of 3.5 million peasants engaged in agriculture and 14.7 million citizens living in rural areas (MAPU 2008a and 2008b). However, the experts of the district state administration (DSA) agricultural departments, who know all the social economic particularities of specific areas and work directly with the farmers and agricultural entrepreneurs, are not in any way integrated in the decision-making process concerning agricultural funds distribution. The question arises as to how possible suggestions and propositions could be made at the district level if the criteria on how these funds should be allocated either do not exist

[3]Administratively, Ukraine is divided into 25 regions which are further divided into several districts each. The number of districts differs from region to region and depends on the region's size in terms of of production, population, etc. (Administrative units, by region, available at http://www.ukrstat.gov.ua/).

or are not known to the public, including regional level state authorities. Which instruments, models and methods could have been employed to provide support for the agricultural decision-makers in charge on the district level?

The research is guided by two particular objectives: (1) to analyse the recent distributions of agricultural budgets in Ukraine, and (2) to develop a model for calculating an "optimal" agricultural budget allocation based on the judgements of district agricultural experts – judgements that are realistic, objective and independent from personal preferences.

The first objective is reached by making a thorough review of existing official documents related to agricultural support and analysing relevant scientific papers. The methodological approach that is used to reach the second objective comprises the development of a model based on the Linear Programming (LP) approach. The judgements of official agricultural representatives received during the interviews in the case study Zdolbuniv district are further integrated in the model.

2. Agricultural budgeting in Ukraine

The experience of 2010 has shown that Ukraine remains quite unpredictable in the sphere of budgetary planning. The country has gone through almost a third of the year without the main financial document which is the budget. This meant a sum total of zero Ukrainian Hryvnia (UAH) for agricultural support from January till April 2010. When the budget was finally adopted on the 27th of April 2010 (VRU, 2010) it was comparable to those of previous years.

The agricultural share in the whole budget slowly increased for some time over recent years, going from 3.5% in 2004 to 6.4% in 2008 (fig. 1). Based on this tendency, predictions had been made that agricultural issues were of growing concern to state political leaders and that more financial resources would be "invested" by the state into the agricultural sector[1]. However, the agricultural share then became twice as small (3.2%) in 2009 as in the previous year. In 2010 its share in the whole budget reduced even more, comprising only 2.2%.

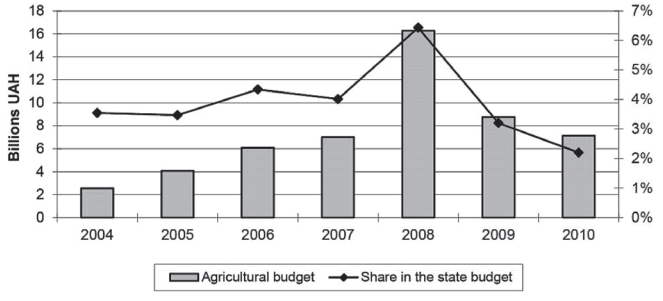

Figure 1. Share of agricultural budget in the state budget of Ukraine, 2004 to 2010. Source: Own compilation based on data from laws on state budgets

3. The agricultural sector in the research district

Zdolbuniv district is an administrative part of the Rivne region, situated in the north-western part of Ukraine. The contribution of the agricultural sector to the Zdolbuniv district's GDP had been changing between 2006 and 2008. It comprised the largest share, at 21%, in 2005 and the lowest of 12% in 2008 (Drozd, 2009). However, this share had always been larger during the mentioned period than the average one in Ukraine. Therefore, it might be concluded that the agricultural sector plays quite an important role in the economics of Zdolbuniv district.

The employment opportunities within the agricultural enterprises of Zdolbuniv district declined between 2006 and 2008 (Drozd, 2009). Furthermore, the average salary of the workers engaged in agricultural production was also less than that in other spheres of activities during the same period. While the job opportunities are decreasing and agricultural income is at its lowest, the size of agricultural budget in Zdolbuniv district in 2009 sharply diminished by almost four times when compared to the previous year (Drozd, 2009).

At the same time, the volume of agricultural production does not fluctuate so quickly. Therefore, it is very important for the agricultural producers and state agricultural representatives in Zdolbuniv district to be able to adjust to such changes. For these reasons it was proposed to investigate the possible scientific "inventions" which could offer support in finding the "optimum" allocation of agricultural funds in Zdolbuniv district under such conditions.

4. Linear programming approach

The application of a linear programming approach with the purpose of deciding which agricultural policy measures should be financed to meet the particular objectives in the best possible way was introduced by Jechlitschka, Kirschke and Schwarz (2007). They also describe how to implement this method in MS-Excel.

The objective function can be defined as follows (Kirschke et al., 2007, p.3):

$$Z_1 = \sum_{i=1}^{n} z_{1i} \cdot B_i$$

with:

Z_1	1st objective
B_1	budgetary expenses for a measure i
i = 1, …, n	index of the respective measure considered
z_{1i}	constant marginal and average coefficient of

the objective function describing the impact of the budgetary expanses for measure i on the 1st objective.

In fact, policies measures are often implemented to meet several objectives (VRU, 2005). If there are, for example,

[1]This statement is based on the opinions of the agricultural department's experts in Zdolbuniv district.

two objectives determined, an aggregated objective function can be defined by putting together both objectives' functions, giving weights:

$$Z = (1–\alpha)Z_1 + \alpha Z_2$$

with (1–α) and α being weighting factors.

The weighting factors (1–α) and α represent the contribution of the objectives Z_1 and Z_2 in the objective function Z. If more objectives have to be included in the decision-making process, it is recommended to consider them as restrictions in order to avoid possible difficulties (Kirschke et al., 2007).

Finally, the described optimisation approach may be formulated as follows (Kirschke et al. 2007, p.4):

$$Z = (1-\alpha)\cdot\sum_{i=1}^{n} z_{1i}B_i + \alpha\cdot\sum_{i=1}^{n} z_{2i}B_i$$

subject to: $\sum_{i=1}^{n}\alpha_{ri}B\begin{Bmatrix}\leq\\=\\\geq\end{Bmatrix}b_r$ for r = 1, …, m and $B_i \geq 0$ for i = 1, …, n

where:

r = 1, …, m is the index of restrictions (equations or inequations)
a_{ri} is the coefficient of restriction r for measure i
b_r is the right hand side of restriction r.

5. Generation of input parameters

5.1. Measures considered

The input parameters were generated as the result of overview of agricultural normative documents in Ukraine and the discussion with the district agricultural experts (just experts in the following) about the actual situation in Zdolbuniv district. This list, which is presented in table 1, consists of eleven measures.

Table 1. Measures considered in the model

M1	Breeding in animal and poultry production on the enterprises of agricultural sector.
M2	Budgetary state subsidies for the support of animal and plant production.
M3	Breeding in plant production.
M4	Financial support of agricultural enterprises through the mechanism of subsidising through credits from commercial banks.
M5	Creating reserve stocks of hybrid high-quality seeds.
M6	Planting and looking after young orchards.
M7	Reimbursement of the cost of domestically produced agricultural equipment.
M8	Financial support of farm enterprises.
M9	Farm enterprises crediting.
M10	State support of hop growing development.
M11	Partial recovery of insurance costs.

5.2 Selection of objectives

The criteria defined for the evaluation of state agrarian policy efficiency in the Law of Ukraine "On the Main Principles of State Agrarian Policy for the Period until 2015" (VRU 2005) were proposed to be used as objectives for the impact assessment of the above-mentioned measures.

During the discussion of these objectives with experts, all of them appraise the objectives of (1) *Creating job opportunities* and (2) *Increasing income* as being relevant for the evaluation of the effectiveness of agrarian policy. The choice of these objectives is also validated by the decrease of employment opportunities in the Zdolbuniv agricultural sector and the low income level in the agricultural sphere (Drozd, 2009). Furthermore, these two objectives are also included in the district agricultural development program as priority targets and the experts had no difficulties with the assessment of the measures' contribution to the achievement of these objectives.

5.3 Impact assessment

After agreeing on measures and objectives it is necessary to evaluate the impact of these measures with regard to the defined objectives. The six experts from the agricultural department of Zdolbuniv DSA were asked during individual interviews to make judgements based on one-dimensional 1-9 scale. Such a simple scale is argued by Jechlitschka et al. (2007, p. 201) to be an appropriate for the generation of coefficients of the objective function. Coefficients 1, 2 and 3 would indicate a small contribution of a measure to an objective, while coefficients 4, 5 and 6 signify a medium contribution, and coefficients 7, 8 and 9 a high one.

Figure 6 depicts the geometric means of the measure-specific impact parameters with regard to objectives one and two. Two tendencies can be summarised from figure 2. First, the impact parameters of each particular measure with regard to both objectives do not differ significantly. Second, in most cases the experts assigned higher contribution estimates for objective one (creating job opportunities). Such judgements might be partly explained by the opinions expressed by the experts during the interviews that "both objectives are interrelated" and "it is more likely that new jobs will be created than income will increase".

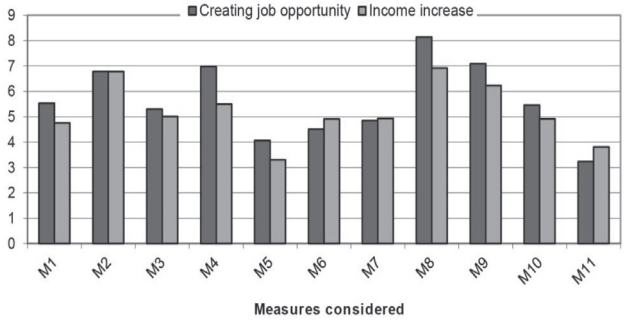

Figure 2. Impact parameters (geometric means) for objectives one and two. Source: Own compilation. (I would write job opportunities as the title for the blue bars)

5.4 Constraints incorporated

Based on the discussion with the experts, it was concluded that the model is only restricted by upper and lower bounds and the amount of budget available. According to Ukrainian legislation, there are no comprehended interrelations between the amounts of measures financed. Everything is financed only from the national budget through regional and district administrations to the final "consumers".

Therefore, it was agreed to stay with "realistic"[1] 20% of upper bounds (UB), while lower bounds (LB) change for each measure considered. For the three measures which were not actually financed during 2008 but are incorporated into the model, it was decided to set the UB at the level of the regional average for the specific measure and the LB at zero. Also, the second constraint is that the district agricultural budget has to be spent completely, but the whole amount of money defined for the district in the particular year cannot be changed.

6 Model definition and exploration of its potential for optimisation

The agricultural budget of the Zdolbuniv district constituted 6.05 million UAH in 2008. This money was distributed between eight measures, all of which belong to the "Support of agricultural enterprises" group according to the national legislation (VRU, 2007).

Figure 7 depicts the differences between the optimal and reference allocation of Zdolbuniv agricultural budget. The three measures M3, M5 and M11, which were financed on the regional level but not on the district one, do not appear in the optimal allocation either. In this case, the experts' evaluation matches with the actual distribution. However, the remaining eight measures should have been supported differently from the experts' perspective. The financing of two of them (M2 and M8) should be increased, while the financing of the other six should be diminished.

The production subsidy measure (M2), which comprised the largest part (74%) of Zdolbuniv's agricultural budget by far in 2008, is still enhanced by 6% in the computed optimum. This is despite the fact that this measure belongs to the "yellow box" group. At the same time, the second measure (M8), which has also a positive difference comparing to the reference situation, is focused on investment support of farm enterprises and is a "green" measure. However, it constituted only 2% of the reference budget. Further, it should be noticed that the amounts of the second and third largest financed measures (9% and 6% of the budget respectively) on supporting hop growing development and the reimbursement of the costs of domestically produced agricultural equipment (M10 and M7) should be decreased according to the district perspective. Also, the second chart of figure 7 shows that the upper and lower bounds are binding for all measures except one (M2).

As a result of the programming application, the overall value of the aggregated objective function increases from 38663.3 to 39130.9. Such an increase of 1.1% shows that the optimisation potential is not large. The hypothesis was made that the model optimisation potential is mainly restricted by the 20% upper and lower bounds which were used. It was therefore decided to test the optimisation potential under less restricted upper and lower bounds borders. After increasing the UB from 20% to 100%, setting the LB at zero and testing the model, the aggregated objective function increases by 5.2% compared to the reference situation. Hence, in order to obtain a larger value of the objective function, greater "fluctuations" within the agricultural budget should be allowed by the regional state agricultural department.

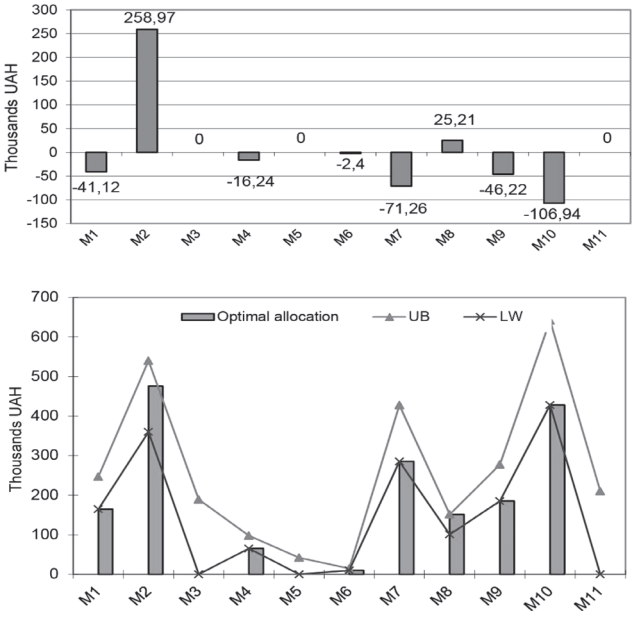

Figure 3. Allocation changes with respect to the reference situation*. Source: Own compilation and calculations.

* The real amount of measure 2 is divided by 10 in the second chart of figure 3.

Since the agricultural budget amounts have been seriously fluctuating during recent years (fig. 1), it was decided to test the model optimisation potential also in the conditions of low agricultural support. In 2009, Zdolbuniv's agricultural budget comprised only 1.6 million UAH, which was almost four times less then in the previous year. Based on the same experts' judgements, the aggregated objective function increased from 19833.8 to 21892.6 (a growth of 10.4%), comparing the optimal to the reference situation, after the application of programming to the 2009 case. Therefore, under conditions of scarce budgetary resources, the optimisation potential of the model is even enhanced.

[1] *De jure* the upper bound for the district by each financed measure is limited by two amounts: the size of all regional money planned for this measure in the following year and the overall size of district agricultural budget. However, *de facto* the experts' experience shows that it is realistic to change the received distribution in the frame of about 20%.

7. Conclusions and Outlook

There are various measures and programs with the help of which the state is able to support agriculture. However, not all of them suit the specific agricultural features of each country. Therefore, the relevant ones need to be thoroughly chosen for implementation in each specific case in order to fulfil the set agricultural objectives and receive the maximum benefit from the use of state monetary resources. Furthermore, before deciding on relevant measures, it is important that the relevant objectives of the agricultural policy have been formulated. The undertaken agrarian policy has to correspond both to the domestic needs and international obligations of the country.

With respect to the first objective concerning agricultural budgeting in Ukraine, the following statements can be summarised. First of all, the agricultural budget is very "unpredictable" in that the amounts of both the whole budget and specific measures financed might change every year. The mechanism of deciding on the measures that are going to be financed in the next year is not transparent. A number of support programmes might also change every year and the agricultural producers are not informed about such alternations in advance. Local state agricultural officials are not engaged in the process of agricultural budget formation and neither are they familiar with the principles and purposes by which the distribution of agricultural support is decided.

According to the second objective of this paper, a model for calculating an "optimal" agricultural budget allocation was developed. The proposed modelling approach enables us to integrate the opinions of local agricultural experts in the decision-making process concerning agricultural funds distribution. This model is recommended for use with the purpose of supporting the agricultural decision-makers in their initiatives to make agricultural budget distribution more objective-oriented, at least on the district level. Although the results from the modelling approach which was used depend heavily on the experts' individual attitudes towards the necessary changes in the development of agricultural support, the modelling outcomes do show how the agricultural budget should be redistributed to achieve the optimum. It also proves that the set agricultural objectives are highly interrelated. Furthermore, the proposed approach demonstrates larger potential for optimisation in the conditions of scarce financial resources which is the actual situation in the sphere of agricultural support in Ukraine.

The results of the present research work raise a range of questions which remain to be thoroughly examined in the future. First, the agricultural policy framework need to be further analysed in order to develop proposals on specific objectives for the separate measures or group of related measures. These objectives need to be relevant, accurate and valid. Second, the LP approach could be used in order to model the distribution of agricultural funds on a regional level. At the regional agricultural department level, many decisions are made concerning the distribution of agricultural monetary resources. Therefore, the modelling of regional agricultural budget allocation might facilitate the officials in finding out its "optimum" distribution.

Thus, the results of this paper contribute to the scientific field focused on analysing the possibilities of making agricultural support more objective-oriented and highlight the related issues which need to be further investigated in the future.

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