THE MEASUREMENT OF THE EFFECT OF PRODUCTION SUBSIDIES

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SUMMARY

A methodology of drafting subsidy impact studies is described. The procedure suitable for calculating three impact indices may be applied for the type of subsidies that can be interpreted as the increment of a specific expenditure. The recommended indices, providing numerical expressions for the spread (E_I), concentrated (E_{II}) and accumulated (E_{III}) impact of various subsidies, are based on the measurability of the difference between the impact of a given expenditure with and without subsidy. Their application is recommended in preparing sector-policy decisions.

1. FOREWORD

The term 'public policy' is used in the practice of Western economic governance for the preliminary work conducted in ministries in preparing for decision-making. The specifics of this activity vary from one area to the other, but there is a fundamentally uniform methodology and system of tools behind all such work. In the present paper the author will attempt to complete the latter and report on the methodological results achieved in the area of measuring the changes in the return from sales due to subsidies. The methods presented have been developed for the Pilot System database. This is the Hungarian sub-system of the European Union 'Farm Accountancy Data Network' providing information based on the detailed data supplied by some 1800 model farms that may be used for a variety of agricultural economical analyses. The detailed cost data supplied by the participating farms offer the opportunity to make a profound investigation of the relation between subsidies, costs and returns from sales.

The author's purpose is to describe the developed methods and to document their effectiveness.

2. THE CLASSIFICATION OF SUBSIDIES BASED ON THEIR IMPACT MECHANISM

Hereinafter the recent methodological results obtained in the field of measuring the return from sales and the changes of profit occurring as an outcome of subsidies will be described, relying on some methods belonging to the wider methodological framework also described in the present paper.

The methods described have been developed for the Farm Accountancy Data Network database. The data-supplying companies belonging to this system supplied very detailed cost data very suitable for the application of innovative analysis tools used for the profound investigation of the relation between subsidies, costs and returns from sales.

In doing so, the prime aim was to document the feasibility of the author's methods. The procedures used for verifying the impact of subsidies were developed on the basis of the mathematical description of their effects. Two categories were set up, which are clearly separable but also relatively homogenous in respect of the subsidy types belonging to each of them. One of these categories comprises *production subsidies,* whereas the definition of the category required the utilisation of these subsidies in production. The other category is that of *(direct) supplementary income subsidies,* where the chief criterion of application is exactly that they cannot be utilised at the same time when they are obtained.

Two fundamentally different routes of income generation can be observed. The subsidies given to producers either directly or indirectly, as a result of community decisions aimed at changing the income status of a sector, will be treated as production or sales subsidies, provided that they are involved in the generation of return from sales. If, on the other hand, these subsidies are not channelled through the production and sales process, and are added to the gross production value as additional income apart from the return from sales, they will be classified as supplementary income subsidies[1].

However, the present investigations are restricted to a narrower but more detailed analysis of revenue generation instead of encompassing the entire complex process of income generation. Therefore it is more appropriate to differentiate two types of subsidies disbursed in the same business year, namely:

- subsidies generating return from sales, or
- supplementary income subsidies.

In view of the fact that, production units being involved, some supplementary income subsidies may be utilised in production during the following business year, it is even more appropriate to make a distinction between

subsidies generating a synchronous return from sales and

subsidies generating a delayed return from sales.

It was stated on the basis of the investigations carried out that the present system of subsidisation used in Hungary comprises no elements not directly linked with production but remaining outside it. This circumstance enables the *direct subsidies* applied at present to be dealt with *in a single methodological framework, classing them among the so-called subsidies generating a delayed return from sales.*

However, with a view to the imminent entry of Hungary into the European Union, it is also reasonable to examine in the claims to subsidies applied in the EU from the point of view of return from sales by trying to class them among one of the two categories defined above. Namely, *a part of the supplementary income subsidies may be used in production in the following business year.*

Subsidies generating a synchronous return from sales will be investigated specifically using *production functions.*

Hereinafter the methodology applied for the investigation of subsidies generating a synchronous return from sales will be examined in detail.

[1] The Hungarian practice of giving production subsidies also as a kind supplementary income, or the impact of this practice, cannot be examined here in a methodological framework separated from the subsidies of the expenditure type. In judging which function is dominant in the effect of a subsidy in a specific case one can rely on the precursor of the indicator studied (improved efficiency corresponds to positive values, and supplementary income to negative ones).

3. THEORETICAL FOUNDATIONS OF THE METHODOLOGY

Based on a survey of professional literature, two approaches can be considered the methodological models in the quantification of the value of subsidies.

One of these approaches handles subsidies as *externalities* in the macroeconomic models. In these models the subsidy as a form of state intervention in the business process is treated as an independent explicative variable. This approach is promoted by B. Schmitt and S. Charlot; who are associated primarily with INRA, a French workshop involved in research in agricultural economics. In their studies subsidy is considered a state-financed infrastructural investment. The same approach is followed in his empirical studies by the Australian L. Song, who extends its scope to areas other than agriculture.

The other approach to the quantification of the impact of subsidies studies the latter within the system of the *welfare economy.* The impact of state transfers in economy may be followed by studying OECD research on the subject. In this area outstanding results have been achieved by J. Dewbre et al. with their matrix models (PEM), J. Kola with his completion of methodological problems, and J. Antón and C. Le Mouel with their study of subsidies in grain production.

The methodology developed by the author has to add to the above mentioned research works. *The logic of its methodological approach is based on an examination of the impact of expenditure with and without subsidies, whereas the difference between these two factors is considered the effect of the subsidy. In this interpretation, the subsidy is the increment of a kind of expenditure, which is one of the explanatory variables in a multi-variable production function.*

Here, such production functions are computable as are generated by the farm-level cross section of the sector. It is true that this will be an aggregate production function, and aggregation always raises new requirements and doubts in respect of interpretation. Even so, it will be possible to generate this function at the sectoral level, with the depth dimension of products, which is exactly what is needed for the cost-benefit analysis. The production function is also used for *determining the elasticity of production.* The elasticity of the production, the marginal efficiency, and the mean efficiency are composed in a tripartite relationship (see the Euler formula), based on which the *marginal efficiency* is calculated from the mean expenditure and the mean efficiency. This marginal efficiency relates to a specific point in the yield function, being at the same time the mean point of the production function. This is the point the values at which interest us.

Calculations were based on the 2001 FADN data. In that year, data for 1757 farms were available. The entire sample included a wide range of farm forms, of which three sub-samples were set up:

1. petty and family farms,
2. companies (organised as unlimited partnerships, limited liability companies, or shareholding companies), and
3. agricultural cooperatives.

The value increment elements included in the model have covered the entire range of production factors, complemented by the values established for own labour and own land as input. Therefore, the value judgement of the market is understood here as the only factor of any significant degree of uncertainty within the model, which makes the latter stochastic. This induced stochastic nature of the model justifies its treating as a regression model.

The dependent variables, explicative variables and other items modifying the value of the explicative values listed in Table 1 were included in the model.

Table 1.

The composition of variables in the model

Model elements	Indicators	Main components
Dependent variable	Net return from sales	
Explicative variables	Material costs of crop farming	Seeds, propagating material, fertilisers and pesticides
	Material costs of livestock farming	Animal purchases, feed, insemination and veterinary services
	Material-type expenditure	Combustibles, electricity, water, fuel and lubricants, machine spare parts, packaging materials, machine operation, transportation and maintenance
	Depreciation	
	Other costs	Lease of tangible assets
	Other expenditures	Taxes and duties payable to the state budget, state budget funds and local governments
	Labour expenditure	Wages and wage-type payments, social security and health care contribution, **value generated in own labour input**
	Land value	Land lease and **value generated through land use**
Modifying items	Subsidies	Development subsidies, supplementary income and market access support

4. THE STRUCTURE OF THE METHOD

M-1. The following exponential production function was specified for each type of subsidy under scrutiny:

$$BT = \prod_{i=1}^{4} RT_i^{\beta T_i}$$

where:

i = the index of expenditures (where i=1 is in all cases the so-called „key expenditure" element containing the subsidy examined). The following subsidy types were used (in an order that may be changed from one subsidy type to the other):

1. key expenditure (costs of plant growing or animal husbandry; cost of services; depreciation; other expenditure),

2. crop farming costs + livestock farming costs + costs of services + depreciation + other expenditure – key expenditure,
3. personnel-type expenditure,
4. land value;

BT = net return from sales for goods produced from expenditure containing elements of subsidy;

RT_i = expenditure element for goods produced from expenditure containing elements of subsidy;

βT_i = theoretical parameter of the expenditure element for goods produced from expenditure containing elements of subsidy;

PT_i = estimated parameter of the expenditure element for goods produced from expenditure containing elements of subsidy.

It was assumed that the subsidy investigated had been part of the corresponding (key) expenditure element in advance, and that it had an effect on the value generated in accordance with the production technology characteristics of the expenditure in which it was incorporated.

M-2. The parameters of expenditure elements were computed from individual sub-samples using regressive estimation ($\beta T_1 \rightarrow PT_1$, $\beta T_2 \rightarrow PT_2$, $\beta T_3 \rightarrow PT_3$, $\beta T_4 \rightarrow PT_4$), which elements include the key expenditure comprising the subsidy investigated, which was invariably indicated as PT_1 .

$$\hat{BT} = \prod_{i=1}^{4} RT_i^{PT_i}$$

M-3. The production function was modified in a way that it was presumed that the amount of the subsidy was not available to the farmer at the time when he needed it, and that he did not receive that amount subsequently either. I. e., the farmer could not rely on the subsidy, and therefore generated less output. In order to do the required computation, on the right-hand side of the equation the subsidy amount for each production unit was subtracted from the key expenditure, and the rest of the expenditure elements was adjusted in proportion to the extent of this decrease[1] (c), while on the left-hand side the net return from sales was divided by the effect of the expenditure element containing the subsidy, and multiplied by the effect of the net expenditure of the subsidy ($\hat{BT} \cdot c^{\sum_{i=1}^{4} PT_i}$)[2]:

$$c = \frac{RT_1 - T}{RT_1}, \quad R_i = c \cdot RT_i$$

$$B = BT - \hat{BT} + \hat{BT} \cdot c^{\sum_{i=1}^{4} PT_i} = BT + \hat{BT} \cdot (c^{\sum_{i=1}^{4} PT_i} - 1)$$

Further marks:

B = net return from sales for goods produced from expenditure containing no subsidy;

R_i = expenditure element for goods produced from expenditure containing no subsidy;

β_i = theoretical parameter of expenditure element for goods produced from expenditure containing no subsidy;

c = adjusting multiplier determining the value of the net key expenditure of subsidy, and used in the propor-

[1] When taking this step, the usual assumption concerning the curve of the partial yield curve, i. e., the already mentioned „ceteris paribus" situation was omitted. Instead, the assumption of a proportional factor change was used, which means that it was supposed that the proportion in which the key expenditure element increased by adding on the subsidy was identic with the proportion in which the rest of expenditures grew. This latter hypothesis suggests the use of a return-to-scale function, and is more in line with the technological context of agricultural production.

[2] The extent of other factors used was changed in proportion to the amount of subsidy: c = proportional adjustment coefficient.

tional reduction of other expenditure elements.

M-4. Parameters were estimated anew with the modified expenditure elements ($\beta_1 \rightarrow P_1$, $\beta_2 \rightarrow P_2$, $\beta_3 \rightarrow P_3$, $\beta_4 \rightarrow P_4$), including the key expenditure containing the investigated subsidy, which is invariably marked as P_1 :

$$\hat{B} = \prod_{i=1}^{4} (c \cdot R_i)^{P_i} \cdot$$

Further marks:

P_i = estimated parameter of expenditure for goods produced from expenditure containing no subsidy.

M-5. Marginal efficiencies were expressed as the variance of the quotients of the figures of the original and the modified return from sales, and the expenditure. Also, the change of these values was computed (E_I, E_{II} and E_{III}), which is used to quantify the effect of the subsidy on return from sales.

4.1. The modifying (spread) impact of subsidies on the efficiency of the key expenditure: E_I

$$E_I = RBT_1 - RB_1$$

Further marks:

RBT_1 = marginal efficiency for goods produced from expenditure containing subsidy elements.

RB_1 = marginal efficiency for goods produced from expenditure containing no subsidy element.

4.2. The full (concentrated) impact of the subsidy as a part of the key expenditure: E_{II}

$$E_{II} = \frac{PT_1 \cdot BT - P_1 \cdot B}{RT_1 - R_1}$$

4.3. The full (accumulated) impact of the subsidy exercised through the total expenditure: E_{III}

$$E_{III} = \frac{BT - B}{\sum_{j=1}^{4} RT_j - R_j}$$

5. INDEX DATA EXPRESSING THE EFFECTS OF THE SUBSIDY

Using 2001 data, each of the three indices (E_I, E_{II} and E_{III}) described above was calculated for all types of subsidies applied in the pilot system. The results are presented in Table 2.,3.,4.

As mentioned above in Section 2, the presented method of studying the impact of subsidies can only be used to quantify the impact of subsidies interpreted as expenditure increments. This requirement is fully met when the subsidies have the effect of reducing the production costs. However, when studying the effects of market access subsidies, the application of the method must be carefully considered. It can be used only when the subsidy is understood as a supplementary financing of additional expenses advanced by the producer, but cannot be used to calculate the impact of supplementary income subsidies because these may be expended freely.

An analysis of the E index equations reveals their substantive differences. The E_I index indicates the *spread* impact of the subsidy, i.e., each unit of expenditure shows the same change in efficiency. The E_{II} index expresses the effect of the subsidy as a whole in a way *concentrated* on its unit. The E_{III} index expresses the *accumulated* effect of the subsidy as an increment of a specific expenditure, including mandatory extra costs incurred for other expenditures. For the decision-maker the three indices provide specific extra information. In other words, *each of the three indices should be used simultaneously* in order obtain a comprehensive understanding of any type of subsidy.

Table 2.

Change in the net return from sales (in HUF) per HUF 100 of the of key expenditure completed by subsidies in 2001, E_1

I. Subsidies reducing the production costs		National average	Petty and family farmers	Companies	Cooperatives
Group	**Title**				
Land based plant growing subsidies	Wheat and spelt wheat	8,5	9,3	8,1	46,4
	Rye	3,3	3,9	--	--
	Barley	3,3	3,4	3,3	--
	Oat	10,4	13,7	--	--
	Triticale	3,6	3,7	-13,8	--
	Maize	5,9	5,9	19,1	13,6
	Spring and winter rape	2,7	2,3	--	--
	Potato	1,2	1,7	--	--
	Sugar beet	0,9	1,3	--	--
	Field vegetables	0,7	1,2	--	--
	Related to crop farming	18,9	19,8	22,5	23,9
Livestock subsidies	Cattle	18,3	21,6	1,7	10,7
	Sheep	3,9	9,4	--	--
	Livestock farming	15,9	20,6	4,1	5,1
Subsidies for the reduction of costs	Wage and social security costs	-14,1	--	-2,5	1,5
	Fuels and lubricants	17,8	11,8	24,6	30,8
	Other direct costs of livestock farming	4,7	--	-0,8	0,7
	Insurance fee	1,8	1,4	2,7	3,3
	Interests paid	0*	-0,1	0	0
	Subsidies for the reduction of costs	-0,3	-0,5	0	0
Other subsidies	Other subsidies	-0,1	-0,2	0	0
	For natural disasters	-0,2	-0,4	--	--
II. Market access subsidies		**National average**	**Petty and family farmers**	**Companies**	**Cooperatives**
Group	**Title**				
Direct market access subsidies	**For plant purchase**	0	-0,1	0	--
	For pig purchase	0	--	--	--
	For livestock purchase	0	0	0	0
	Sales of animal products	0	--	0	0
	Other, related to sales of animal products	0	--	-0,1	0
III. Investment subsidies		**National average**	**Petty and family farmers**	**Companies**	**Cooperatives**
	Title				
	Investment in buildings and machinery	13,4	4,3	37,4	-12,8
	Total subsidies	-0,3	-0,4	0	0

* "0": <= 0,01 HUF.

Table 3.

Change in the net return from sales (in HUF) produced by the completion of the key expenditure by subsidies (in HUF 100 of the latter) in 2001: E_{II}

I. Subsidies reducing the production costs		National average	Petty and family farmers	Companies	Cooperatives
Group	**Title**				
Land based plant growing subsidies	Wheat and spelt wheat	247,0	230,1	347,4	2109,8
	Rye	217,9	238,5	--	--
	Barley	218,3	208,5	246,5	--
	Oat	383,4	406,7	--	--
	Triticale	213,7	172,6	-39,1	--
	Maize	230,4	204,9	779,7	1033,6
	Spring and winter rape	194,8	212,8	--	--
	Potato	240,7	254,0	--	--
	Sugar beet	224,3	234,4	--	--
	Field vegetables	197,3	249,3	--	--
	Related to crop farming	248,6	222,1	393,9	667,1
Livestock subsidies	Cattle	314,6	258,7	124,1	245,8
	Sheep	93,6	162,0s	--	--
	Livestock farming	255,3	246,5	169,9	-196,3
Subsidies for the reduction of costs	Wage and social security costs	-2109,7	--	-556,9	267,6
	Fuels and lubricants	278,4	189,0	368,0	562,4
	Other direct costs of livestock farming	365,5	--	68,2	146,1
	Insurance fee	209,5	210,1	159,9	403,5
	Interests paid	105,2	105,7	111,4	99,1
	Subsidies for the reduction of costs	106,2	104,6	108,7	102,3
Other subsidies	Other subsidies	81,5	89,6	102,0	114,2
	For natural disasters	57,1	36,8	--	--
II. Market access subsidies		**National average**	**Petty and family farmers**	**Companies**	**Cooperatives**
Group	**Title**				
Direct market access subsidies	**For plant purchase**	99,4	93,7	101,6	--
	For pig purchase	92,5	--	--	--
	For livestock purchase	91	94,2	86,6	92,6
	Sales of animal products	90,1	--	88,3	86,8
	Other, related to sales of animal products	82,6	--	74,4	125,3
III. Investment subsidies		**National average**	**Petty and family farmers**	**Companies**	**Cooperatives**
	Title				
	Investment in buildings and machinery	470,5	217,9	974,9	-792,4
	Total subsidies	91,0	86,2	106,9	103,0

* "0": <= 0,01 HUF.

Table 4.

Full net change in the return from sales (in HUF) per HUF 100 of the subsidy and the related mandatory expenditure in 2001: E_{III}

I. Subsidies reducing the production costs		National average	Petty and family farmers	Companies	Cooperatives
Group	**Title**				
Land based plant growing subsidies	Wheat and spelt wheat	108,6	105,0	151,9	151,1
	Rye	98,3	95,2	--	--
	Barley	103,8	103,0	112,3	--
	Oat	105,4	105,3	--	--
	Triticale	105,5	103,6	211,7	--
	Maize	106,7	105,9	135,0	148,3
	Spring and winter rape	128,2	101,0	--	--
	Potato	106,8	107,3	--	--
	Sugar beet	120,0	122,0	--	--
	Field vegetables	110,2	107,6	--	--
	Related to crop farming	106,3	104,2	132,5	120,6
Livestock subsidies	Cow	106,4	110,3	108,8	99,7
	Ewe	79,0	79,8	--	--
	Livestock farming	102,6	101,8	114,0	107,7
Subsidies for the reduction of costs	Wage and social security costs	116,5	--	105,4	138,4
	Fuels and lubricants	113,4	105,5	139,0	136,0
	Other direct costs of livestock farming	112,8	--	82,3	116,5
	Insurance fee	119,8	108,3	126,7	130,0
	Interests paid	105,8	107,5	111,3	99,8
	Subsidies for the reduction of costs	105,4	103,8	108,9	102,8
Other subsidies	Other subsidies	96	86,4	102,8	101,7
	For natural disasters	70,6	47,5	--	--
II. Market access subsidies		**National average**	**Petty and family farmers**	**Companies**	**Cooperatives**
Group	**Title**				
Direct market access subsidies	**For plant purchase**	102,4	96,3	104,1	--
	For pig purchase	93,2	--	--	--
	For livestock purchase	92,0	95,4	87,8	93,6
	Sales of animal products	91,5	--	89,7	88,9
	Other, related to sales of animal products	86,8	--	78,0	94,7
III. Investment subsidies		**National average**	**Petty and family farmers**	**Companies**	**Cooperatives**
	Title				
	Investment in buildings and machinery	112,5	100,1	130,5	121,1
	Total subsidies	93,2	89,0	107,5	103,2

* "0": <= 0,01 HUF.

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A TERMELÉSI TÁMOGATÁSOK HATÁSÁNAK MÉRHETŐSÉGE

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A cikk egy a támogatások hatásvizsgálata során alkalmazható módszert mutat be. Az eljárás, amelynek alapján három hatásvizsgálati mutató számítható, olyan támogatásfajták esetében alkalmazható, amelyek egy adott ráfordítás növekményeként értelmezhetők. A javasolt mutatók – amelyek a különböző támogatások terített (E_I), koncentrált (E_{II}) és összegezett (E_{III}) hatását számszerűsítik – egy adott ráfordításnak támogatással és támogatás nélkül kifejtett hatása közti különbség mérhetőségén alapulnak. Alkalmazásuk az ágazatpolitikai döntés-előkészítés számára javasolható.