

Dachin, Anca; Ursu, Ana

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SENSITIVITY OF GROSS MARGIN FOR FIELD CROPS

ANCA DACHIN¹, ANA URSU²

Abstract. A major issue of agriculture in Romania is to achieve the level of profitability of farms which ensures their economic viability. In this respect farms seek profitability of each product. The gross margin is a measure of profitability, which for the field crops is determined by the producer price, yield per hectare and variable costs. Since some of the crops are not profitable every year, subsidies also play an important role in economic calculation. The paper aims to estimate the sensitivity of the gross margin to changes of these factors in the case of cereals, sunflower, soybean, potato and beet. The sensitivity analysis relies on estimated data regarding the crop in 2015/2016 and has the purpose to explore the impact of assumptions of changes in determinants on the results measured by gross margin. The sensitivity of gross margin is the highest and also similar in relation to the producer price and the yield per hectare.

Key words: gross margin, sensitivity, field crops

JEL classification: Q02, C63, H25

INTRODUCTION

The main reason for carrying out the sensitivity analysis is the necessity to identify key sources of variability and uncertainty for the variation of an expected result in order to take the best decisions. The literature provides models and techniques for the analysis of the most important input factors which generate uncertainty in achieving the output. These models may use multidimensional uncertainty parameters (Saltelli et al., 2004). The sensitivity analysis is commonly used in the cost-benefit analysis for projects financed from European funds (Stoian și Gligor, 2012), including the projects with application in agriculture (Vârlănuță et al, 2010).

The gross margin of the farm is a measure of output, respectively of the farm profitability, which is a useful indicator in planning at enterprise level (Farm Gross Margin Guide, 2015). A key issue is the comparative analysis of the impact of various parameters on the agricultural output. Since the parameters and the output have different measurement units and therefore are not directly comparable, this problem can be overcome by calculating the “elasticity” or the percentage change in output to a percentage change in other parameters (Pannell, 1997). The paper aims to estimate the sensitivity of the gross margin achieved from the field crops in Romania.

MATERIAL AND METHODS

The sensitivity analysis is a technique used to determine the effect of different values of input parameters (independent variables) on a certain dependent variable in predetermined conditions. Such an analysis allows the evaluation of results when the input parameters progress through the confidence intervals and these changes are translated into a range of economic results, also within confidence intervals. The sensitivity analysis takes into account various possible input variables with impact on the result, while separating these variables and the corresponding range of outcomes. The method used in this paper is the *determinist sensitivity analysis*, which can be applied by means of a step by step calculation.

For a numerical input and a numerical output the usual option is for the “one input – one output” method in order to evaluate the effects on the output. This approach requires:

- the change of one factor at a time;

¹ PhD Anca Dachin, The Bucharest University of Economic Studies, ancadachin@yahoo.com

² PhD Ana Ursu, Institute for Agricultural Economy and Rural Development, ursu.ana@iceadr.ro

- the return to the reference values after each range of changes of the selected factor.

In this case, each change of the outcome is due to the variation of a single factor, while all others are fixed at the reference value. In the paper the outcome is the gross margin (dependent variable). The sensitivity analysis allows the identification of the “critical” variables of the model, respectively the parameters which have positive or negative variations with the highest impact on the gross margin.

The sensitivity analysis is possible also when two determinant factors change simultaneously step by step. Thus the organization of data in matrix form is suitable for the calculation of the gross margin as a result of successive values of the input factors.

The standard gross margin is calculated as:

$$\text{Standard gross margin} = \text{Gross income} - \text{variable costs}$$

Considering the importance of subsidies granted per hectare, in the present paper this component of income is included in the calculation. Thus the detailed formula of the gross margin is:

$$\text{Gross margin per hectare} = p \times q - vc + s$$

where:

p = price of the main crop (lei/ton)

q = average yield per hectare of the main crop (ton/ha)

vc = average variable costs per hectare (lei/ha)

s = subsidies per hectare (lei/ha)

According to this formula, the gross margin is influenced decisively by the sales price of the main product, yield, variable costs and subsidies (independent variables). The sensitivity is calculated to explore the impact of assumptions regarding the changes of these determinant factors on the gross margin, by using the principle “what if”.

The break-even-price and the break-even yield are calculated as follows:

$$\text{Break-even price} = \text{variable cost/yield}$$

$$\text{Break-even yield} = \text{variable cost/price}$$

The break even yield is needed to cover variable costs and it provides some indication of the exposure of the farm.

The calculations rely on data from the technological sheets of field crops (wheat, maize, barley, sunflower, soybean, potato and sugar beet) produced in a non-irrigated conventional system, data provided by the Institute for Agricultural Economy and Rural Development (IAERD).

In the first part of the paper the sensitivity is interpreted as the elasticity of gross margin to changes of the determinant factors by +/- 10% for each crop. The second part presents the estimated impact of the simultaneous change of price and yield on the absolute values of gross margin.

RESULTS AND DISCUSSIONS

1. Data estimations of the crop production in 2015/2016

The reference data for the sensitivity analysis is the estimation of the crop production in 2015/2016 (table 1). The main determinants as well as the gross margin are calculated per hectare. Since the influence of the secondary production on the gross income is low, this factor has not been taken into consideration.

Table 1: Calculation of the gross margin related to the crop production in Romania,2015/2016

	Wheat	Corn	Barley	Sun-flower	Soybean	Potato	Sugar beet
Independent variables							
Sales price (lei/t)	681	681	681	1600	1830	750	165
Average yield (t/ha)	4	5	4	2.5	3	30	40
Variable costs (lei/ha)	2846.7	3417.5	4404.1	3305.9	4791.9	16086	6100
Subsidies (lei/ha)	733,6	733,6	733,6	733,6	1944,072	733,6	4270,7
Dependent variable (results)							
Gross margin (lei/ha)	-122.7	-12.5	-1680.1	694.1	698.1	6414	500
Gross margin with subsidies (lei/ha)	610.9	721.1	-946.5	1427.7	2642.2	7147.6	4770.7

Note:

1. Subsidies for wheat, barley, maize, sunflower, potatoes = SAPS subsidies 161,0161 euro (SAPS 79,7392 lei/ha + 5 euro/ha redistributive payment first interval + 59,1277 euro/ha for greening + 19,1492 euro/ha TNA) = 733,6 lei/ha
2. Subsidies for soybean = SAPS subsidies + coupled support granted = 161,0161 euro/ha + 269 euro/ha = 432 euro/ha (1944,072 lei/ha)
3. Subsidies for sugar beet = SAPS subsidies + coupled support granted = 161,0161 euro/ha + 786 euro/ha = 949,0161 euro/ha (4270,572 lei/ha)

Source: IAERD calculations

2. Effects of changing one factor at a time on the gross margin

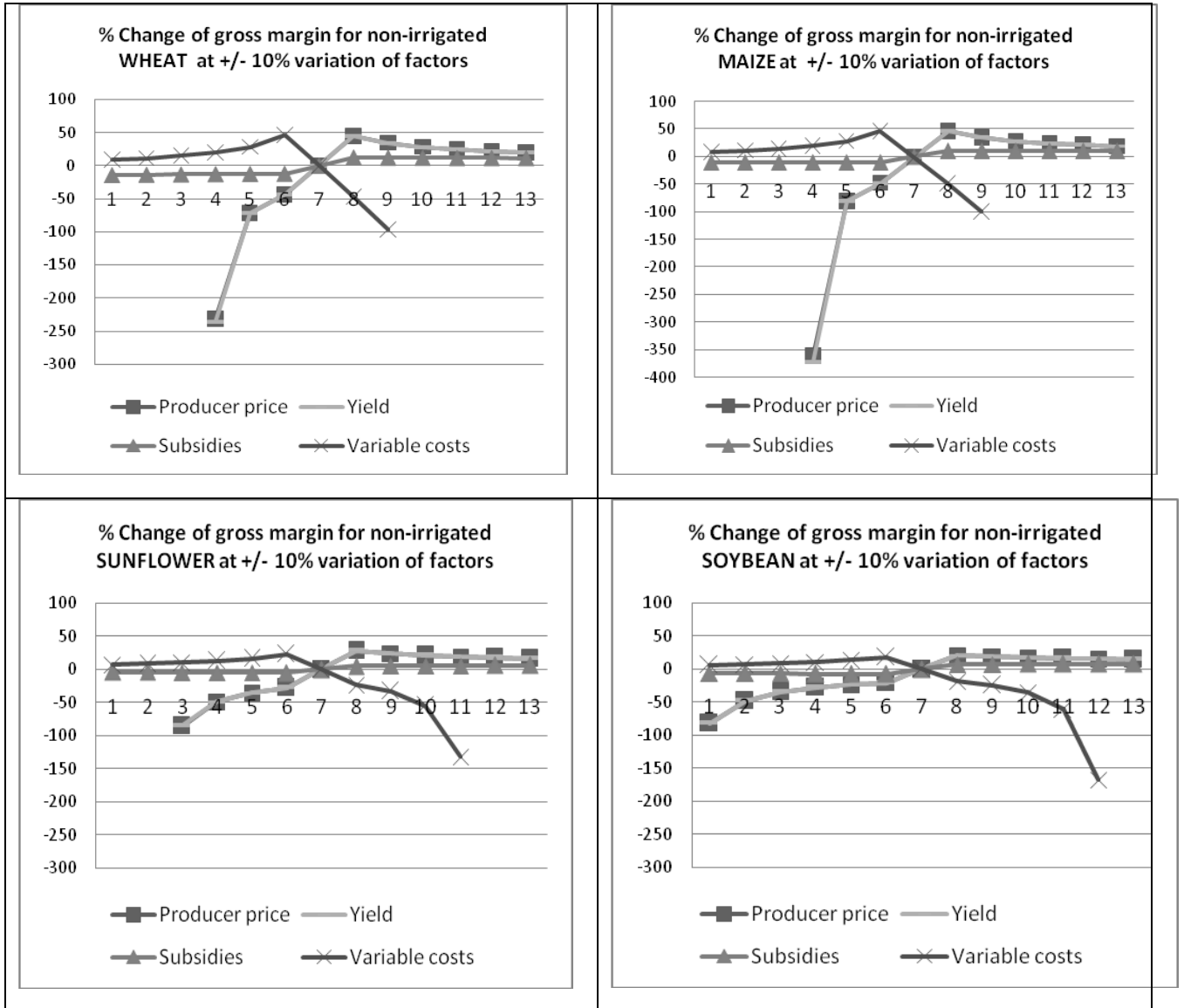
The sales price is one of the independent variables in this research which is assumed to increase/decrease step by step by 10%, while other factors remain constant. The generated variation in the price of wheat, maize and barley, according to the “what if” principle, is 362 – 1207 lei/t (80.5 – 268.2 euro/t) which is falling in the range of real prices recorded in the period 2007-2016 in the EU statistics and is therefore a confidence interval.

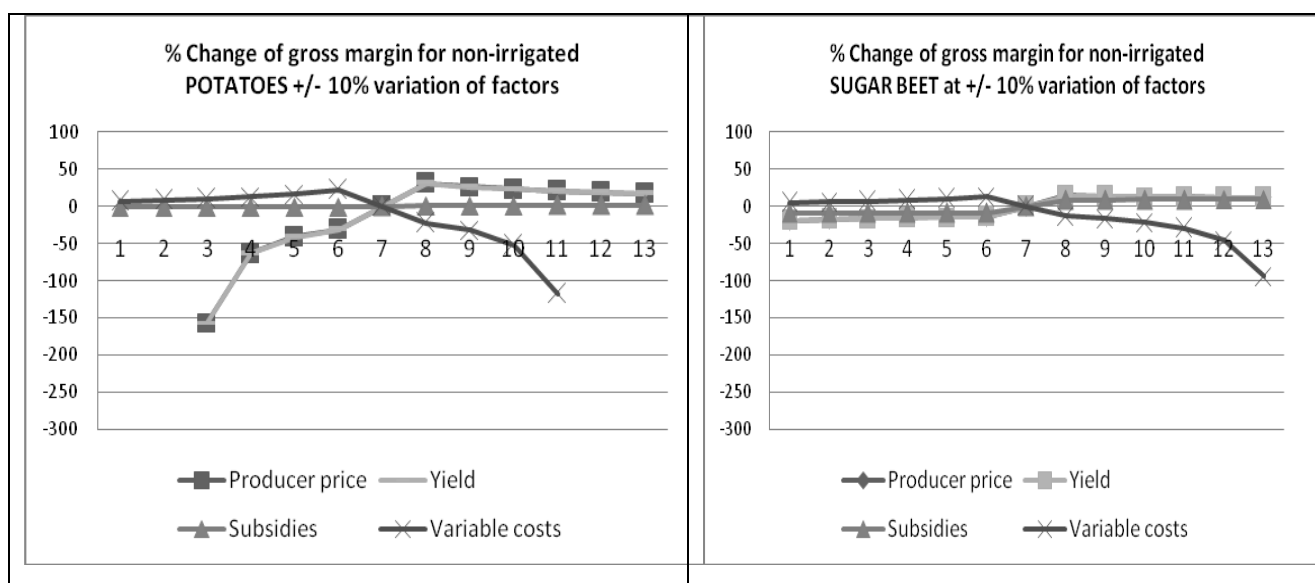
Data calculated and represented in fig.1 regarding the sensitivity of gross margin obtained from the cereal production show the following:

- The sensitivity of gross margin to changes in the determinant factors is very similar for wheat and maize;
- The gross margin is sensitive when changing the sales price. Taking wheat for example, an increase by 10% of the price results in an increase of more than 10% of the gross margin for the entire range of generated values. The sensitivity enters the inelastic area only when the price exceeds 4500 lei/t, which is outside the confidence interval. The same situation is observed regarding maize and barley, with slight differences in the size of coefficients. On the other hand, the decrease of the wheat price by 10% results in a major decrease of the gross margin, especially when the price reaches levels below 500 lei/t.
- The sensitivity of gross margin related to the yield changes is identical compared to price changes for all crops;
- When the wheat yield decreases and reaches levels below 3.2 t/ha, the sensitivity of gross margin becomes very high;
- Barley had a special situation in 2015/2016, taking into consideration the highly negative values of the gross margin, due mainly to high average costs per hectare;
- The variation of costs has an important impact on the economic results in the case of all cereals. An increase by 10% in the first step of the variable costs means already a decrease by 46% of the gross margin.

- Sensitivity of the gross margin is much lower related to the subsidies. A change by 10% of subsidies results in a change of gross margin by about the same size or lower.

Fig.1: Sensitivity of gross margin to changes in determinant factors, by field crop





Source: own calculations

A similar analysis for sunflower and soybean represented in fig.1 shows that the gross margin obtained from these crops is less sensitive compared to cereals. One of the reasons is that in these cases even the gross margin without subsidies has high positive values.

When analysing the cases of potato and sugar beet, most obvious is that the sensitivity of gross margin to subsidy changes is low. Sugar beet has all together the lowest sensitivity of gross margin resulting from changes of all input items.

It is worth mentioning that the comparability between cereals, oilseed crops, potatoes and sugar beet is limited, since there are differences in the types of fertilizers, weed control and other elements of the technology which vary for different locations and situations of farms.

3. Effects of simultaneous changes of two factors on the gross margin

Knowing that the elasticity of gross margin to changes in price and yield is actually the same, it is of real interest to estimate the impact of simultaneous changes of these two factors on the absolute changes of the standard gross margin.

The variation of gross margin for cereal crops is available in tables 2-4. The values result from the increase/decrease of sales price and yield per hectare according to the "what if" principle and show the favourable possible combinations of the two independent variables needed to reach positive values of the standard gross margin. For example, when the price of wheat is higher than the break-even price of 711.6 lei/t and the yield per hectare is higher than the break-even yield of 4.18 t/ha, the gross margin is always positive. Regarding the calculations for barley, both price and yield in 2015/2016 were below the break-even values. At the given high average costs, the break-even price is 1101 lei/t and break-even yield de 6.47 t/ha. The break-even values for maize are close to the reference values.

Tables 5-8 refer to oilseed production, potatoes and sugar beet, which were profitable crops in 2015/2016, according to the levels of standard gross margin. The calculations provide useful information about the effect of possible changes of factors, especially of those with high volatility such as the sales price.

Table 2: Effects of changes in sales price and average yield per hectare of wheat on the gross margin

WHEAT – 2015-2016					
Average yield (t/ha)	4.0				
Price at the farm gate (lei/t)	681		Break-even yield (t/ha)	4.18	
A. Income from the main crop (lei/ha)	2724		Gross margin (A-B) (lei/ha)	-123	
B. Variable costs - total (lei/ha)	2846.8				
Average yield t/ha	Price at the farm gate (lei/t)				
	550	600	681	750	850
2.50	-1472	-1347	-1144	-972	-722
3.00	-1197	-1047	-804	-597	-297
3.50	-922	-747	-463	-222	128
4.00	-647	-447	-123	153	553
4.50	-372	-147	218	528	978
5.00	-97	153	558	903	1403
5.50	178	453	899	1278	1828

Source: IAERD calculations

Table 3: Effects of changes in sales price and average yield per hectare of barley on the gross margin

BARLEY – 2015-2016					
Average yield (t/ha)	4.0				
Price at the farm gate (lei/t)	681		Break-even yield (t/ha)	6.47	
A. Income from the main crop (lei/ha)	2724		Gross margin (A-B) (lei/ha)	-1680	
B. Variable costs - total (lei/ha)	4404.1				
Average yield t/ha	Price at the farm gate (lei/t)				
	500	600	681	850	900
3.20	-2804	-2484	-2225	-1684	-1524
3.50	-2654	-2304	-2021	-1429	-1254
3.80	-2504	-2124	-1816	-1174	-984
4.00	-2404	-2004	-1680	-1004	-804
4.20	-2304	-1884	-1544	-834	-624
4.60	-2104	-1644	-1272	-494	-264
4.80	-2004	-1524	-1135	-324	-84

Source: IAERD calculations

Table 4: Effect of changes in sales price and average yield per hectare of maize on the gross margin

MAIZE – 2015-2016					
Average yield (t/ha)	5.0				
Price at the farm gate (lei/t)	681		Break-even yield (t/ha)	5.02	
A. Income from the main crop (lei/ha)	3405		Gross margin (A-B) (lei/ha)	-13	
B. Variable costs - total (lei/ha)	3417.5				
Average yield t/ha	Price at the farm gate (lei/t)				
	550	600	681	750	850
4.00	-1218	-1018	-694	-418	-18
4.40	-998	-778	-421	-118	323
4.80	-778	-538	-149	183	663
5.00	-668	-418	-13	333	833
5.40	-448	-178	260	633	1173
5.80	-228	63	532	933	1513
6.00	-118	183	669	1083	1683

Source: IAERD calculations

Table 5: Effect of changes in sales price and average yield per hectare of sunflower on the gross margin

SUNFLOWER – 2015-2016					
Average yield (t/ha)	2.5				
Price at the farm gate (lei/t)	1600		Break-even yield (t/ha)	2.07	
A. Income from the main crop (lei/ha)	4000		Gross margin (A-B) (lei/ha)	694	
B. Variable costs - total (lei/ha)	3305.9				
Average yield t/ha	Price at the farm gate (lei/t)				
	1000	1400	1600	1650	1700
2.00	-1306	-506	-106	-6	94
2.20	-1106	-226	214	324	434
2.40	-906	54	534	654	774
2.50	-806	194	694	819	944
2.65	-656	404	934	1067	1199
2.85	-456	684	1254	1397	1539
3.00	-306	894	1494	1644	1794

Source: IAERD calculations

Table 6: Effect of changes in sales price and average yield per hectare of soybean on the gross margin

SOYBEAN – 2015-2016					
Average yield (t/ha)	3.0				
Price at the farm gate (lei/t)	1830		Break-even yield (t/ha)	2.62	
A. Income from the main crop (lei/ha)	5490		Gross margin (A-B) (lei/ha)	689	
B. Variable costs - total (lei/ha)	4791.9				
Average yield t/ha	Price at the farm gate (lei/t)				
	1200	1400	1830	1870	1900
2.40	-1912	-1432	-400	-304	-232
2.60	-1672	-1152	-34	70	148
2.80	-1432	-872	332	444	528
3.00	-1192	-592	698	818	908
3.20	-952	-312	1064	1192	1288
3.40	-712	-32	1430	1566	1668
3.60	-472	248	1796	1940	2048

Source: IAERD calculations

Table 7: Effect of changes in sales price and average yield per hectare of potatoes on the gross margin

POTATOES – 2015-2016					
Average yield (t/ha)	30.0				
Price at the farm gate (lei/t)	750		Break-even yield (t/ha)	21.45	
A. Income from the main crop (lei/ha)	22500		Gross margin (A-B) (lei/ha)	6414	
B. Variable costs - total (lei/ha)	16086.4				
Average yield t/ha	Price at the farm gate (lei/t)				
	650	700	750	800	850
24.00	-486	714	1914	3114	4314
26.00	814	2114	3414	4714	6014
28.00	2114	3514	4914	6314	7714
30.00	3414	4914	6414	7914	9414
32.00	4714	6314	7914	9514	11114
34.00	6014	7714	9414	11114	12814
36.00	7314	9114	10914	12714	14514

Source: IAERD calculations

Table 8: Effect of changes in sales price and average yield per hectare of sugar beet on the gross margin

SUGAR BEET – 2015-2016					
Average yield (t/ha)	40.0				
Price at the farm gate (lei/t)	165		Break-even yield (t/ha)	36.97	
A. Income from the main crop (lei/ha)	6600		Gross margin (A-B) (lei/ha)	500	
B. Variable costs - total (lei/ha)	6100				
Average yield t/ha	Price at the farm gate (lei/t)				
	120	135	165	200	250
32.00	-2260	-1780	-820	300	1900
35.00	-1900	-1375	-325	900	2650
38.00	-1540	-970	170	1500	3400
40.00	-1300	-700	500	1900	3900
43.00	-940	-295	995	2500	4650
46.00	-580	110	1490	3100	5400
48.00	-340	380	1820	3500	5900

Source: IAERD calculations

CONCLUSIONS

The gross margin is a measure for economic results dependent mainly on the sales price of the main crop, yield and variable costs. The gross margin is sensitive to price changes and to changes in yield per hectare in the same proportion, which means that an increase in productivity has the same effect as an increase in price. If yield per hectare would raise and reach a stable level, then the main source of uncertainty would be the price, which generally has a high volatility. The sensitivity of the gross margin is higher in relation to the average costs per hectare. Since fixed (overhead) costs are ignored when calculating the gross margin and there is no information about the specialization and size of the farms, the comparability between crops is limited. The sensitivity of the gross margin to changes in subsidies is low, especially when the crop production is profitable.

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