IMPACT OF THE USING COBB-DOUGLAS PRODUCTION FUNCTION TO DETERMINE THE STRUCTURE OF PRODUCTION FACTORS AND THE SUSTAINABILITY OF THE AGRICULTURAL SECTOR IN ROMANIA

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For a correct approach to sustainable development, knowing the contribution in time and space of production factors is a sine qua non condition for substantiating strategic decisions and using the available economic and social potential. Starting from the analytical and predictive capacity of the theoretical methodological tools of production functions, in the present research we used one of the most used forms, namely the Cobb-Douglas production function, formulated in 1928 by American economist Paul Douglas, together with mathematician Charles W. Cobb. We used this function in its homothetic form and in the non-embedded technical progress, pursuing analytical and predictive purposes regarding the contribution of capital and labor factors to the economic growth.

We are currently witnessing an accelerated growth in scientific and technical progress, which leads us to assert that the contribution of unprompted technical progress (institutional management and efficiency of the economy) can still be a factor with a very modest contribution to output growth, which what is a challenge for the smooth functioning of our market economy in the future due to factors influencing technological processes in agriculture and rural development, factors outside decision-making processes, especially under the current climate change conditions as well as multiple risks facing the current business environment.

Key words: sustainable development, production factors, finance and microeconomics in agriculture.

Introduction

Due to climate change and the different levels of development of geographic areas, efforts are needed to adapt them and countries to the new conditions. This involves knowing the potential of soil, labor, etc. trends in climate change, and identifying financial, material, informational and workforce sources to adapt activity to the risks that may arise from climate change.

The decision on the adaptation of agricultural sub-branches to climate change implies a correlation of all factors of influence and must take into account, first of all, the local economic and financial potential at the level of the economic agent, farm level, commune level, region level, etc. **Identification of attracted sources** for the change of activities requires additional financial, human, material effort and an appropriate mechanism of transformation of sources into resources. Attracted sources include European funds as well as other government sources that directly contribute to the sustainability of the activity of economic agents.

Efficiency business environment is a business sustainability indicator, and in agriculture the creation of eco products under specific pedoclimatic conditions represents the most efficient sector in relation to conventional agriculture.

In the future, emphasis will be put on efficiency, given the change in agricultural production structure by region according to the aforementioned, as well as due to a problem very often discussed by agricultural research specialists, namely the problem of soil quality and desertification.

Therefore, in our paper we analyze the quality of Romania's economic growth, in terms of the intensity of the use of capital and labor factors in agriculture, as determinants of the level and structure of production, with a direct impact on GDP.

Methodology

The existing statistical information in Romania raises a series of problems regarding the availability of data necessary for calculating the Cobb-Douglas production function, especially for the capital production factor, with its usable variants - total fixed assets, fixed assets, gross investments - chronologically convenient as a number of observations or in a territorial profile. The greatest theoretical-methodological and practical interest in using the Cobb-Douglas production function at macroeconomic level is, in our opinion, the possibility to analyze the quality of Romania's economic growth, in terms of the ***intensity of the use of capital and labor factors***, as determinants for level and structure of production and GDP.

In the analysis we started from the known form of the Cobb-Douglas production function:

$$Y = A*K^{\alpha} *L^{\beta},$$

with $\alpha, \beta > 0$

where:

Y- output;

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K - the capital production factor;
L - the labor factor;
A, α, β - constant.

Parameters α and β measure the proportion of total output that is generated by capital and labor. These two constants, in a certain sense, can also be assimilated to sui-generis elasticity coefficients.

If a + β = 1, the production function has a constant return to scale; for example, doubling the consumption of each factor, production will double.

Constanta is not just a simple proportionality factor of economic significance that is more difficult to establish but can provide information on the full **efficiency of the factors of production**.

If the sum of exponents equals the unit (α + β = 1), the Cobb-Douglas production function is linearly homogeneous, indicating constant returns to scale. If a + β> 1, the function expresses rising returns, and when a + β <1, the scale yields are decreasing.

The logarithmic transformation of the function Y = A * Kα * Lβ is frequently used in econometric analyzes, both for the estimation of the output function exponents and for the deepening of the analysis. Thus, by logging this function you get:

$lnY = ln\ A + \alpha ln\ K + (1 - \alpha)ln\ L$

Note that, with a one-percent increase in capital or labor, production Y increases with only α% or (1- α)%, i.e. by less than one percent, since α <1; Instead, the increase by one percent of the total productivity factor (parameter A) ensures the Y production also increases by 1%.

Economic decision makers should consider this specific growth potential when assessing the likely impact of different economic policy measures.

The available statistical data on the Romanian economy do not allow the establishment of appropriate chronological series to perform analyzes based on the *Cobb-Douglas production function*, which has led us to use the cross-section analysis method. In the absence of chronological data series we have an interesting substitute for them, adopting the working hypothesis that each company integrates into a group with a similar technological process. Moreover, using the balance sheets of all active companies in the real economy, the results are representative and can effectively serve decision-makers.

The Cobb-Douglas model, in its variant based on cross-sectional analysis, it is less or not applied in Romania. The cross-sectional analysis was completed with the introduction of analytical elements in two main directions:

1. Determining the Cobb-Douglas model parameters based on the cross-over method for several years and comparing the results obtained for different years;
2. Using chronological series (with a sufficient number of terms) for labor and capital production factors as well as for output.

Research results

Specifically, in order to estimate the parameters of the Cobb-Douglas production function for Romania's economy, the balance sheet data for the companies in some sub-branches of Romania's agriculture for the period 2008-2016 was used. In order to be conclusive, the sub- 2016 have at least 200 active companies (**see appendix no. 1**).

To estimate the Cobb-Douglas function parameters, the following were used:

1. the turnover achieved;
2. the value of fixed net assets;
3. labor costs (including contributions and tax).

The statistical analysis of the three data strings reveals a homogeneous distribution of the values of the statistical series terms, a conclusion validated by the values of the multiplication coefficients (**see annex no.2**).

Estimating the Cobb-Douglas production function parameters is typically done using the smallest square method.

For the 12 sub-ranges selected from the agriculture of Romania, the results can be found in appendix no.2.

Image of the evolution of the two parameters α and β from the Cobb Douglas production function and is illustrated in the following graphs.

What is of particular interest is the results obtained from the application of the model and the conclusions of economic policy that can be deduced from the analysis of the parameters of the production function. In this respect, the preliminary conclusions that can be highlighted from the application of the Cobb-Douglas production function with two factors - labor and capital - for the Romanian economy, refer mainly to:

1. the labor factor has a significantly higher contribution than the capital in obtaining the total results (turnover);
2. the significant contribution of the labor force to the economic growth in the current stage of development of Romania, supports the positive economic evolutions of the last years.
3. Natural population growth is negative in the last 20 years, and the migration process is significant for Romania, with integration into the EU structures. In this respect, in the future, there will be a significant problem for the firms in the analyzed sectors, in the direction of rising labor costs, as the rarity of this resource rises.

The alternative appears to be: investment in fixed assets that ensure a significant increase in labor productivity and technical provision of labor.

Relevance of the two parameters of the production function for Romania in agrozootechnical sector.

From the point of view of the strategy of sustainable development of the Romanian economy, the magnitude of these parameters offers elements of substantiation of the decision in support of the promotion of a high rate of gross fixed capital formation, under the conditions of their high efficiency. The experience of countries with strong economic start-up and lasting performance in the economic growth process (e.g. Japan, China, Norway) recorded a high rate of gross fixed capital formation over long periods, but this rate was accompanied during the respective coefficient periods sensitively raised micro and macroeconomic efficiency. Practically, it means the accumulation of new generations of technological breakthrough, strongly marked by cutting-edge technologies and the IT impact.

The agricultural sectors representative of our model (which recorded in the balance sheets of each economic agent turnover, total assets and wage costs) and reflected in the graphs and annexes below are: Cultivation of cereals (excluding rice), leguminous plants and plants oilseeds; Cultivation of vegetables and melons, roots and tubers; Growing grapes; Cultivation of fruit, berries, strawberries, nuts and other fruit trees; Breeding of dairy cattle; Pig farming; Bird breeding; Activities in mixed farms (plant culture combined with livestock breeding); Ancillary activities for crop production; Forestry and other forestry activities; Forestry and Marine Aquaculture and in Sweet Waters.

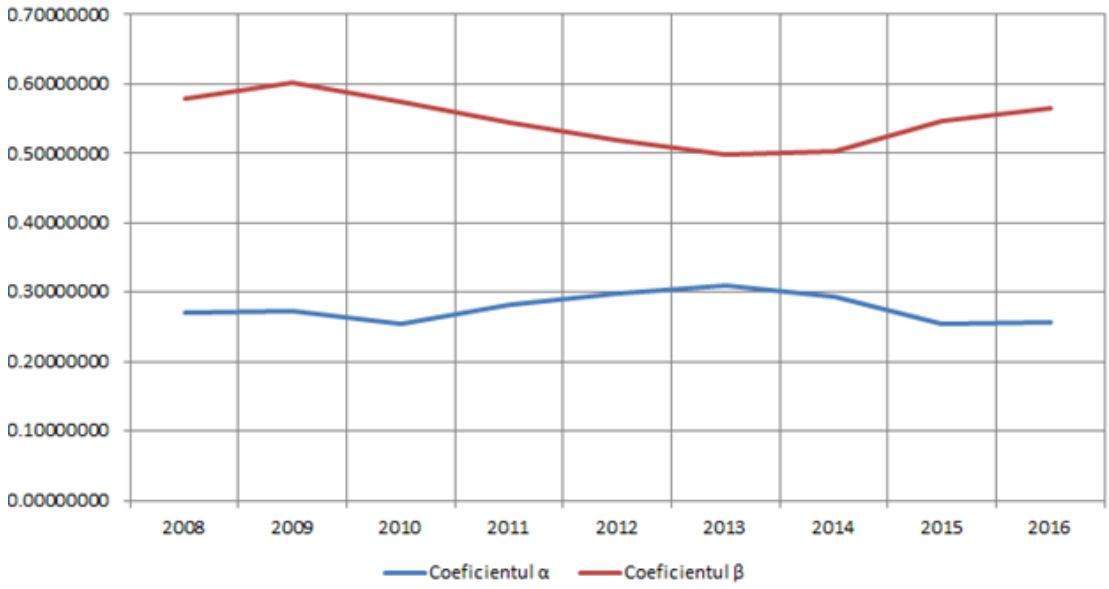

Chart 1. Cultivation of cereals (excluding rice), leguminous plants and oleaginous plants

Source: own processing

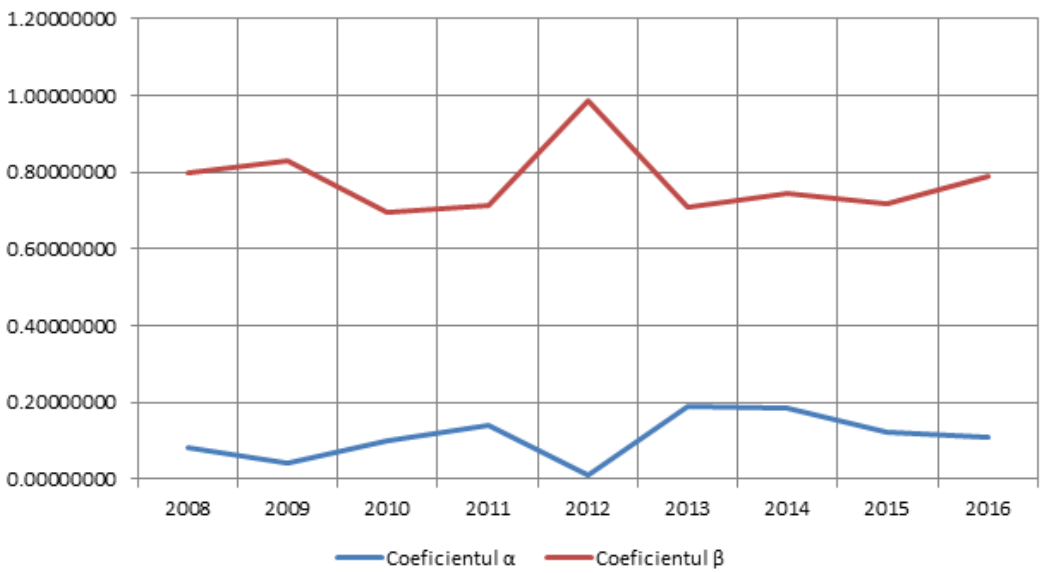

Chart 2: Cultivation of vegetables and melons, roots and tubers

Source: own processing

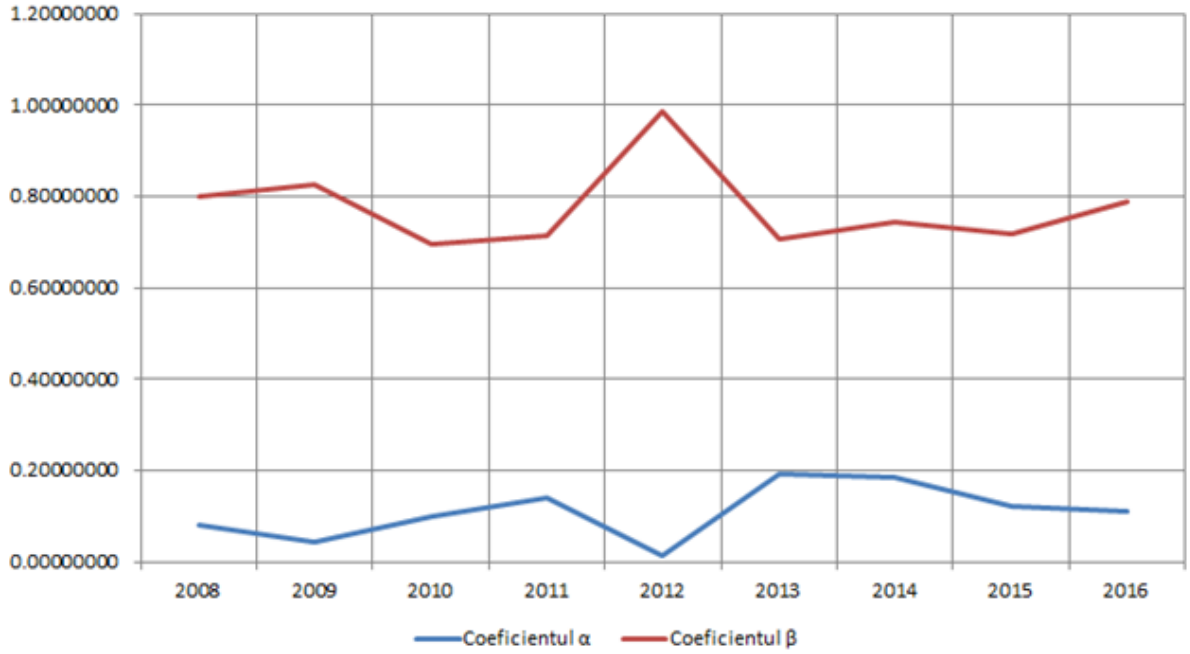

Chart 3. Growing grapes

Source: own processing

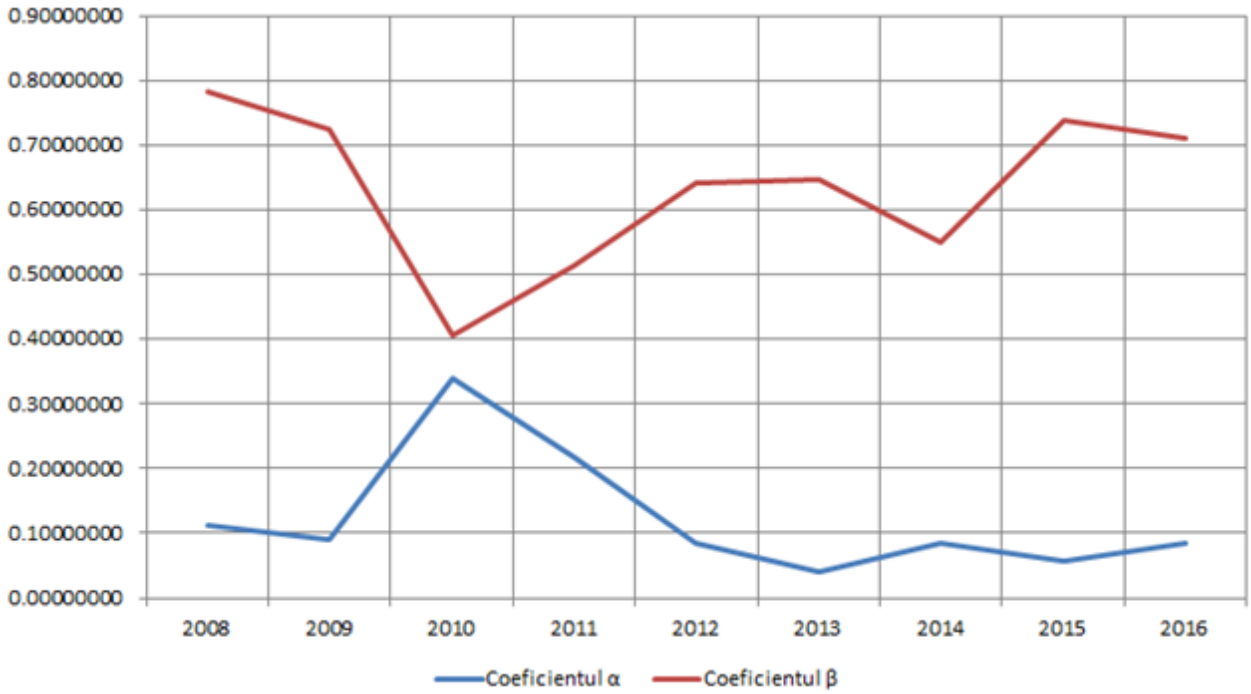

Chart 4. Growing of fruit, berries, strawberries, nuts and other fruit trees

Source: own processing

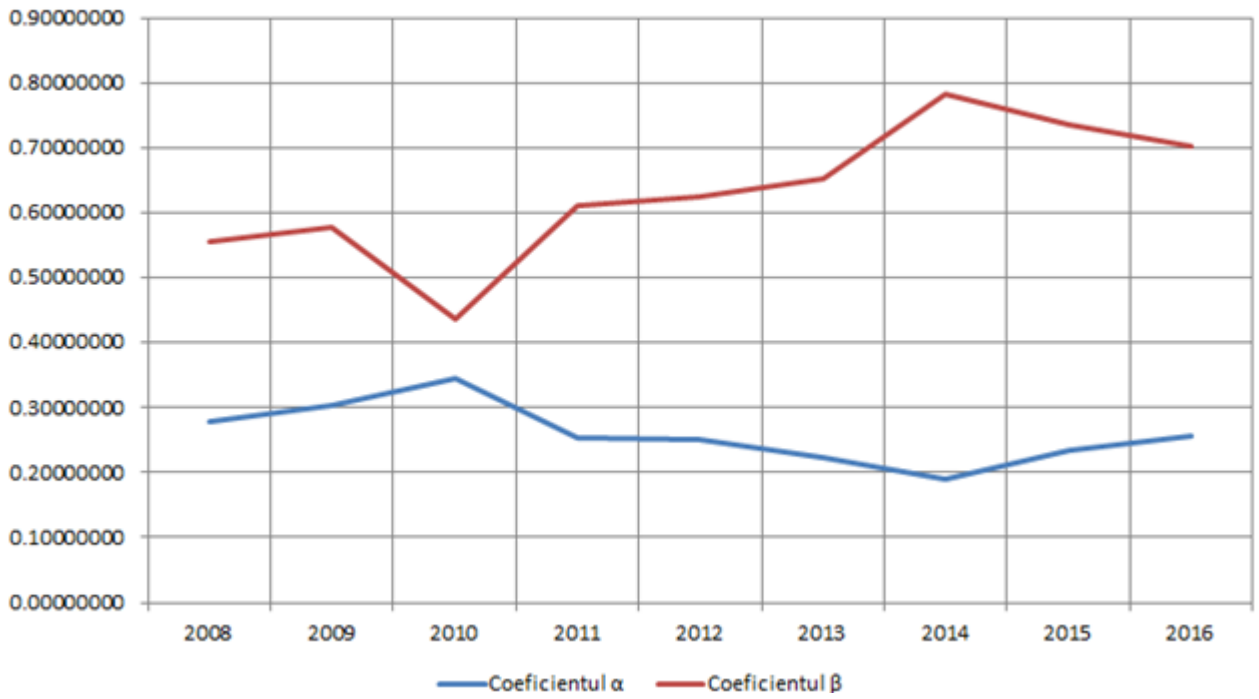

Chart 5. Breeding of dairy cattle

Source: own processing

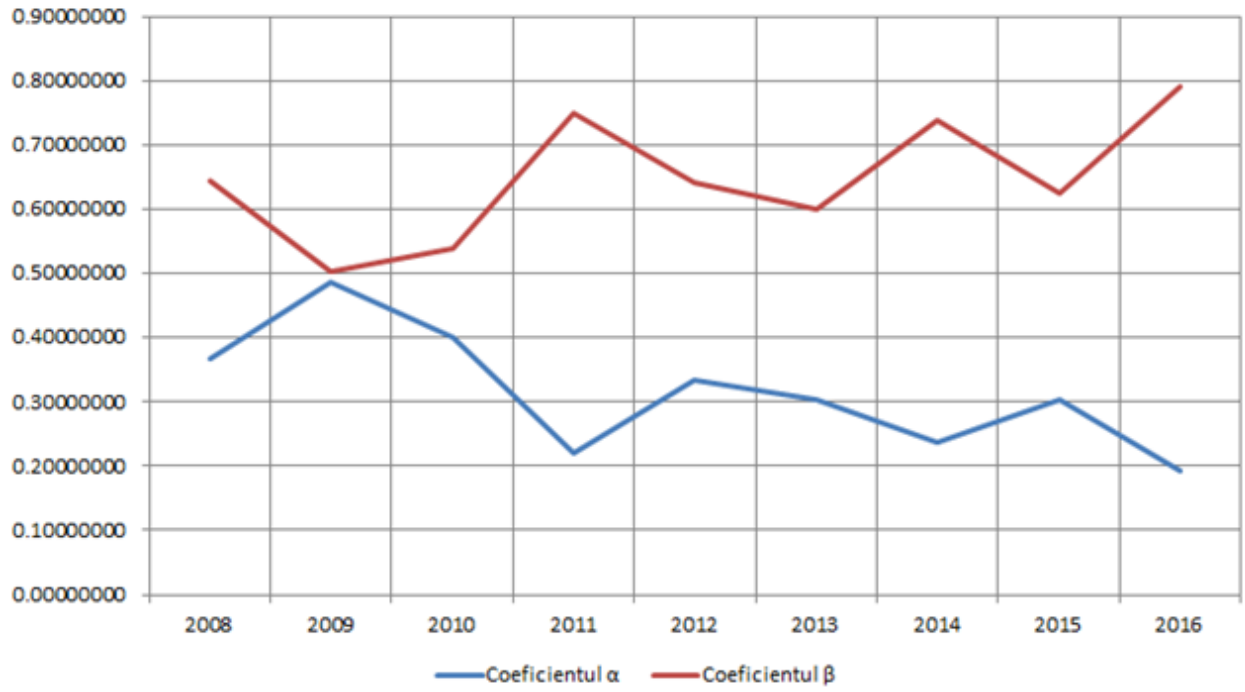

Chart 6. Growing pigs

Source: own processing

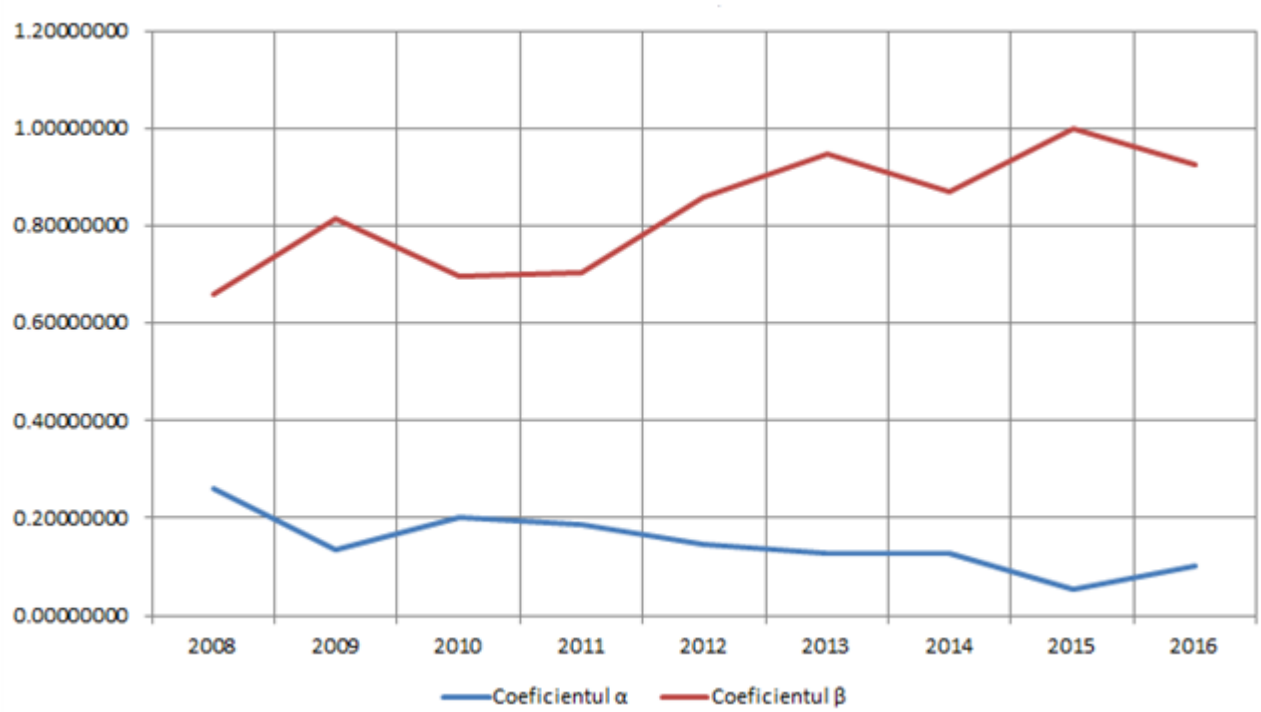

Chart 7. Bird breeding

Source: own processing

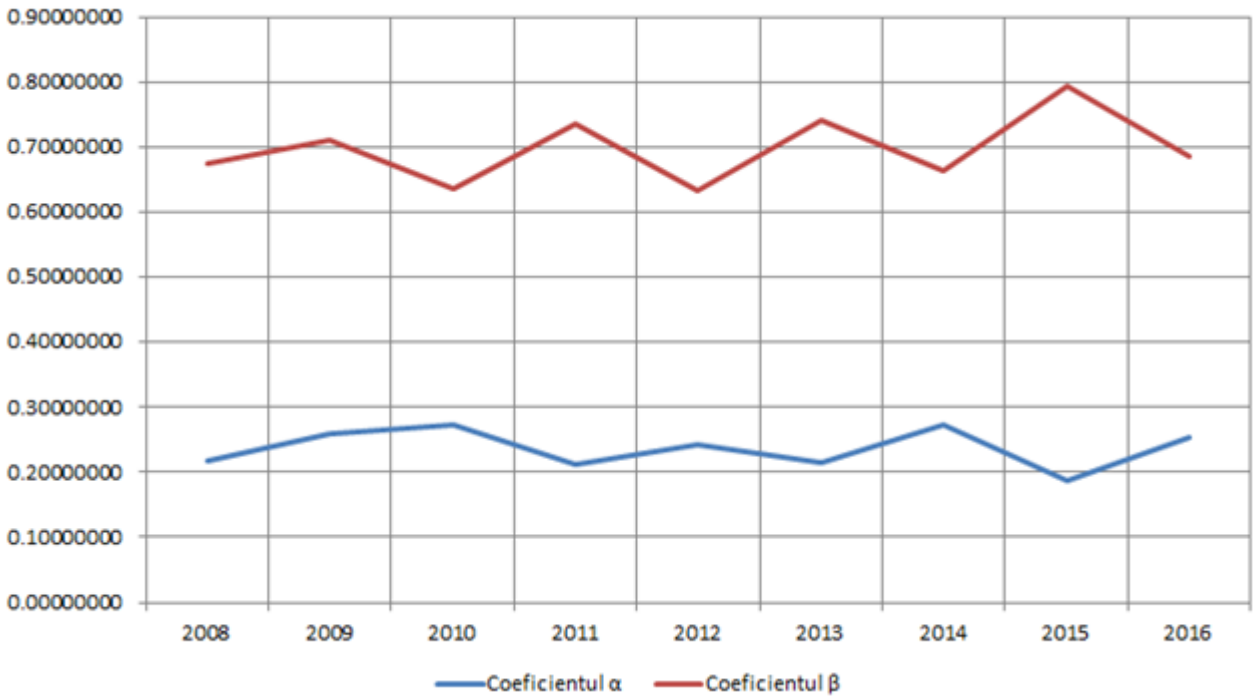

Chart 8. Activities in mixed farms (combined crops with livestock breeding)

Source: own processing

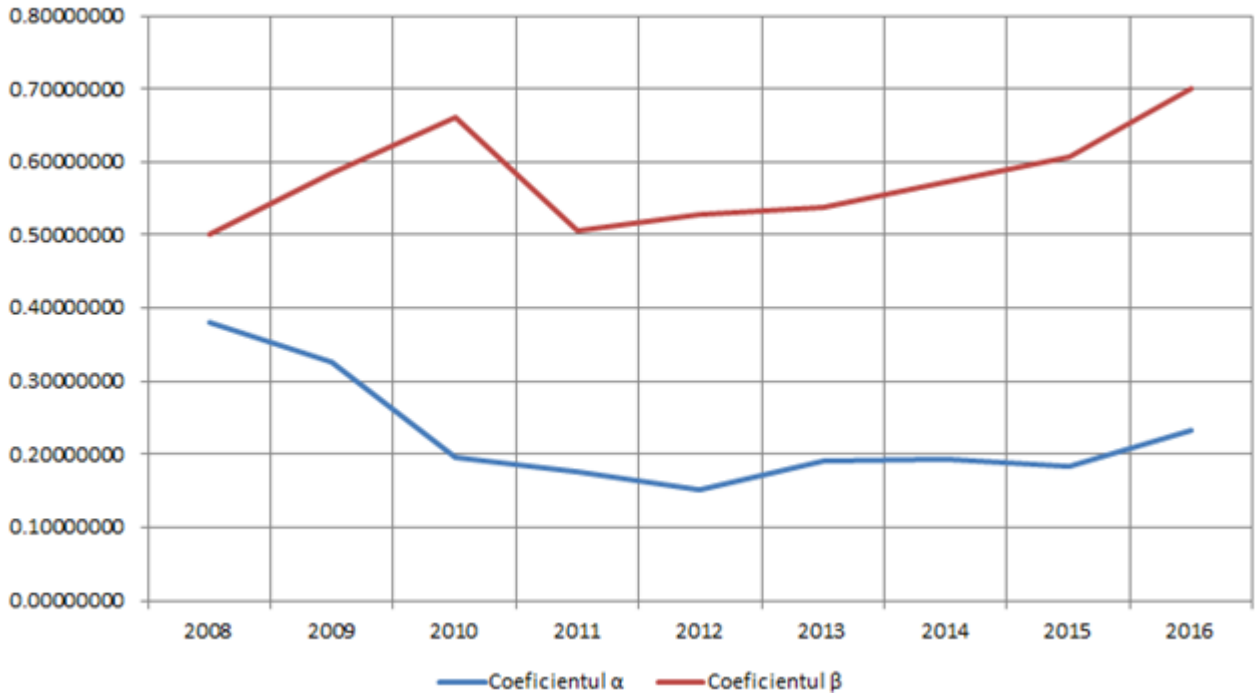

Chart 9. Auxiliary activities for crop production

Source: own processing

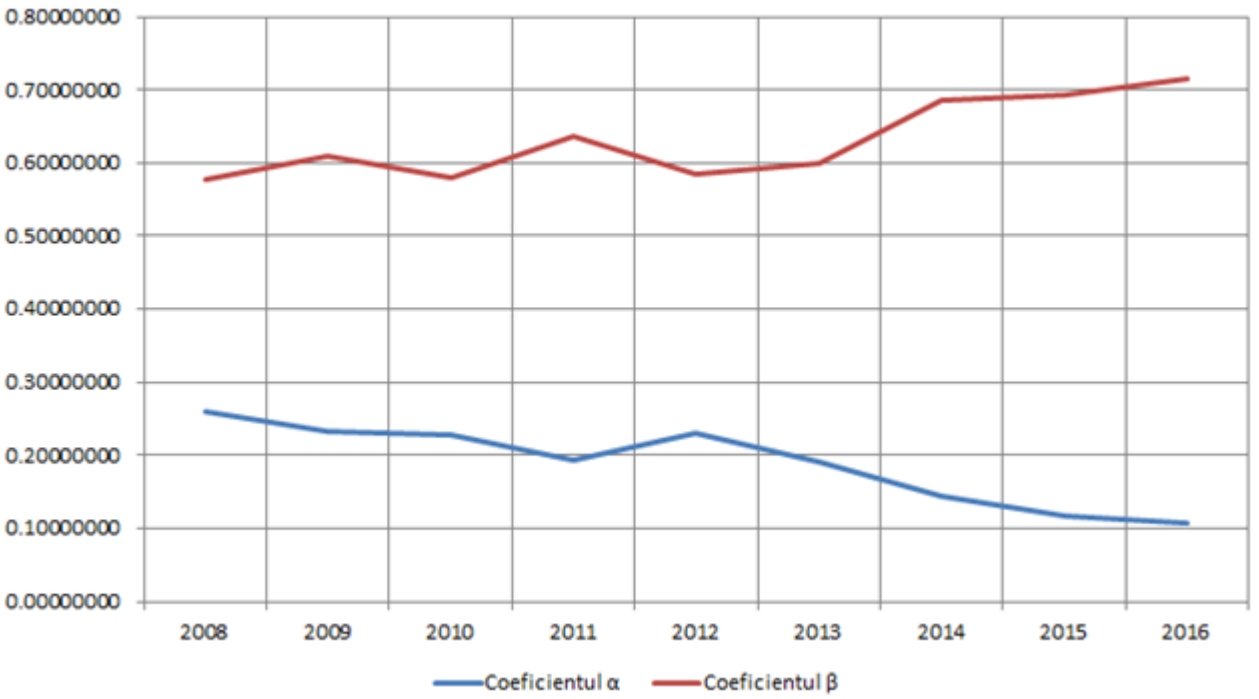

Chart 10. Forestry and other forestry activities

Source: own processing

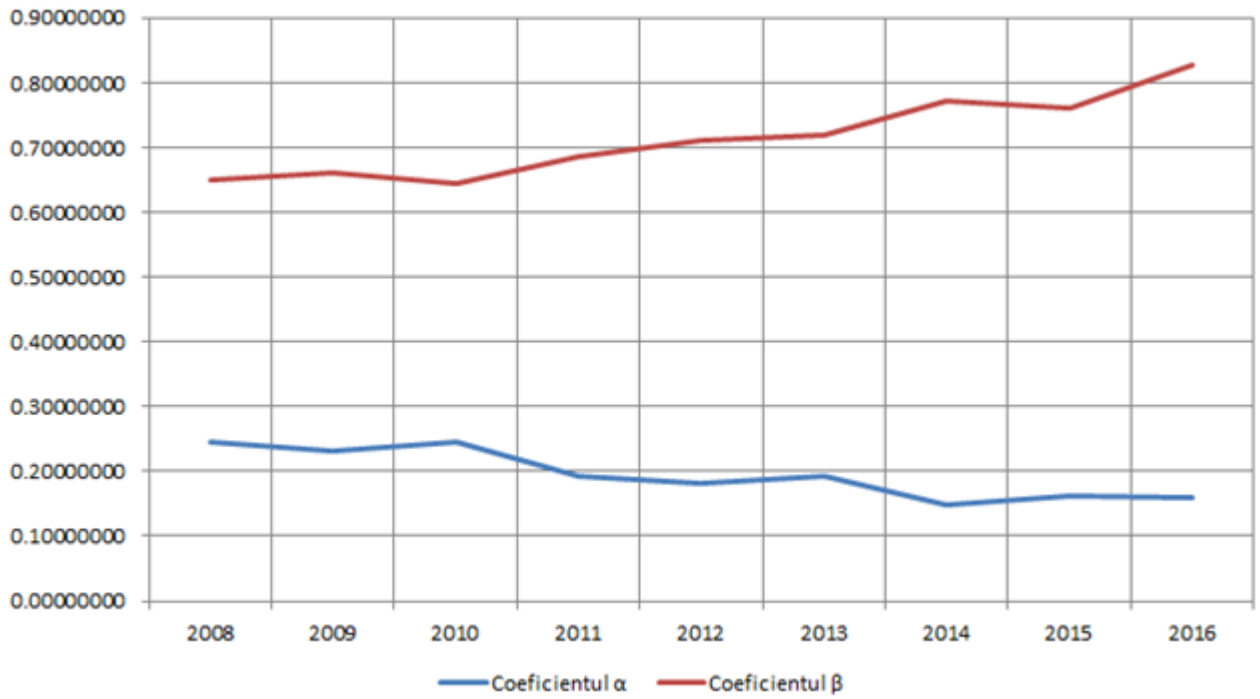

Chart 11. Forest exploitation

Source: own processing

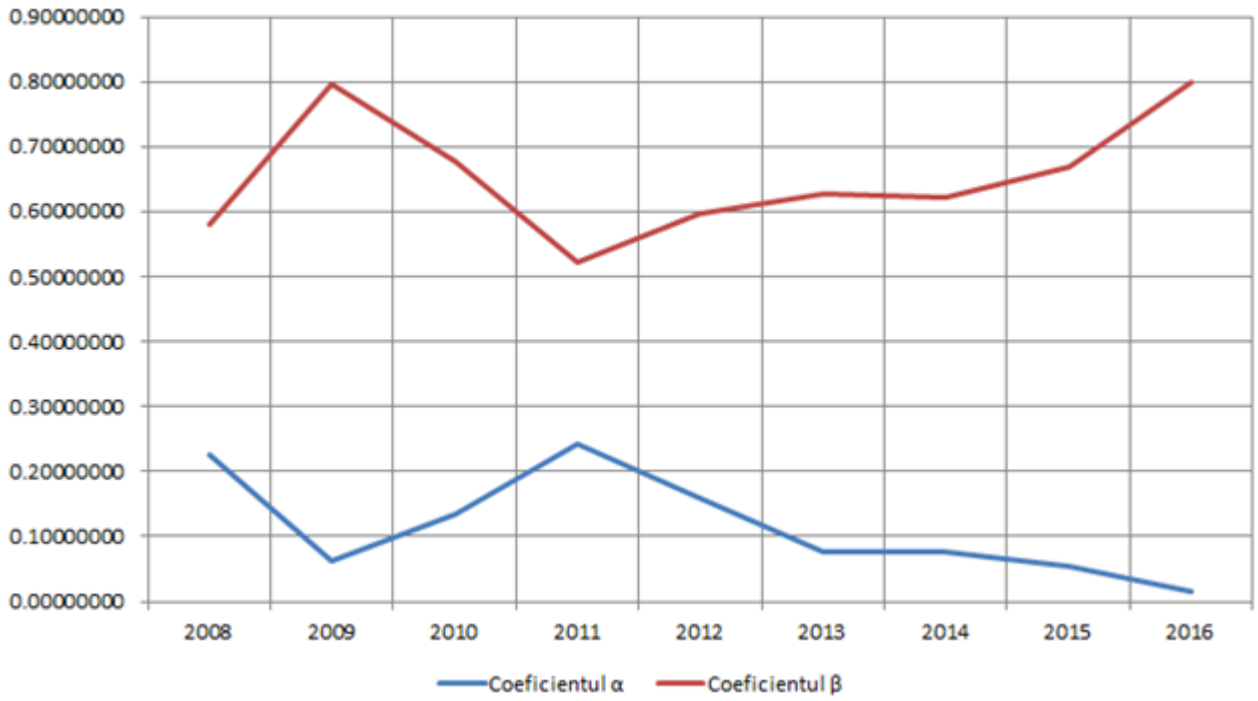

Chart 12. Marine aquaculture and freshwater

Source: own processing

Conclusion

As can be seen from the data of annex no.2, in most cases, $\alpha + \beta < 1$ which means the existence of decreasing yields. Moreover, with a one-percent increase in net fixed assets or labor costs, turnover increases by a%, respectively b%, i.e. by less than one percent. Instead, the increase by one percent of the total productivity factor (parameter A) ensures the increase of the turnover by more than 1%. Economic decision makers should consider this specific growth potential when assessing the likely impact of different economic policy measures.

• From what we know, for the first time in Romania, the calculation of the Cobb-Douglas model at the level of the significant sub-sectors of Romania's agriculture provides conclusive results that check all the usual statistical tests.

• the most dramatic conclusion resulting from the application of the model refers to the particular importance of capital (the technological level of machinery and equipment) that needs to be granted for economic growth, given that labor is becoming a rare resource for Romania.

• The contribution of unprompted technical progress (management and institutional efficiency of the economy) is still a factor with a very modest contribution to output growth, which is a challenge for the smooth functioning of our market economy in the future.

• Finally, but not least, the Cobb-Douglas production function could be a very useful tool for substantiating decision-making at different levels of economic aggregation, combining the static and dynamic analysis of the factors of influence considered, based on the hypothesis constant or variable substitution elasticity; of our research shows that the main part of this substitution is the cost of labor, supported by a higher technical endowment.

From the point of view of the sustainability of agricultural production in Romania, in the medium and long term, there is the problem of rising labor shortages and deficit coverage by measures to increase the capital contribution to the turnover. Or, this entails building an appropriate strategy to provide sub-sectors of long-term interest (agricultural sub-sectors with eco-production, for example), responsibilities for making important investments in agriculture (private investment, state aid, co- financial mechanisms to provide support to trigger an appropriate investment process. Further, the strategy should be implemented consistently, irrespective of electoral cycles, in the economic policy mix, given the strategic importance of agriculture.

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Annex 1

Number of firms in agriculture in 2008 - 2016
which meet the conditions for determining the Cobb-Douglas function

No. crt.	Subsectors of agriculture	Period								
		2008	2009	2010	2011	2012	2013	2014	2015	2016
1	Cultivation of cereals (excluding rice), leguminous plants and oleaginous plants	3638	3603	3808	4071	4305	4556	4761	5222	5507
2	Cultivation of vegetables and melons, roots and tubers	274	280	304	350	381	378	367	391	435
3	Growing grapes	106	106	122	138	150	147	156	190	194
4	Growing fruit of berries, strawberries, nuts and other fruit trees	88	89	101	113	117	129	142	176	217
5	Breeding of dairy cattle	362	361	358	379	363	364	361	356	372
6	Pig breeding	158	203	236	274	296	272	291	293	294
7	Bird breeding	275	289	313	336	354	379	380	389	386
8	Activities in mixed farms (plant culture combined with livestock breeding)	536	552	557	591	619	627	649	681	716
9	Auxiliary activities for crop production	742	740	922	1197	1271	1265	1252	1230	1076
10	Forestry and other forestry activities	1232	1075	1022	1006	908	868	809	779	741
11	Forest exploitation	1228	1354	1447	1596	1689	1775	1828	1984	2041
12	Marine aquaculture and freshwater (321 + 322)	211	236	253	262	276	303	311	311	333
13	Total 1-12	8850	8888	9443	10313	10729	11063	11307	12002	12312
14	Total companies in agriculture	9835	9763	10297	11178	11594	11953	12242	13003	13399

Source: own processing

Annex 2

Evolution of the parameters of the Cobb-Douglas function for some sub-sectors of Romanian agriculture in the period 2008-2016

No.crt.	Subsectors of agriculture	variable	Period								
			2008	2009	2010	2011	2012	2013	2014	2015	2016
1	Cultivation of cereals (excluding rice), leguminous plants and oleaginous plants	A	3.503355	3.142805	3.910642	4.074577	4.123317	4.233467	4.351747	4.295940	4.070652
		α	0.269352	0.272219	0.254042	0.282997	0.298516	0.309074	0.293882	0.253938	0.255526
		β	0.578863	0.602622	0.573380	0.544053	0.519323	0.497604	0.503639	0.546969	0.565031
		α + β	<1	<1	<1	<1	<1	<1	<1	<1	<1
		R	0.766547	0.779036	0.760644	0.767691	0.771068	0.781150	0.778675	0.790400	0.799040
2	Cultivation of vegetables and melons, roots and tubers	A	2.436544	1.883064	2.450426	2.471397	2.750117	3.169149	2.430731	2.158436	3.320117
		α	0.219743	0.256507	0.266858	0.285863	0.172113	0.186825	0.170336	0.154885	0.161084
		β	0.679135	0.685827	0.625878	0.600952	0.705980	0.656617	0.739084	0.785656	0.671591
		α + β	<1	<1	<1	<1	<1	<1	<1	<1	<1
		R	0.700926	0.726046	0.656892	0.726003	0.695711	0.716214	0.720009	0.752571	0.742566
3	Growing grapes	A	2.392759	2.582836	3.502915	2.588047	1.190263	2.032747	1.562855	2.872166	2.151918
		α	0.081389	0.044069	0.100635	0.140219	0.011801	0.191150	0.183983	0.122553	0.108900
		β	0.798604	0.827594	0.696108	0.714892	0.985731	0.707561	0.742807	0.717629	0.788263
		α + β	<1	<1	<1	<1	<1	<1	<1	<1	<1
		R	0.736705	0.741183	0.760141	0.691066	0.702276	0.754673	0.799688	0.776608	0.819126
4	Growing fruit of berries, strawberries, nuts and other fruit trees	A	2.374139	2.978044	3.530354	3.865454	4.130157	4.649408	4.962325	3.289892	3.207984
		α	0.113226	0.090040	0.339975	0.219003	0.083878	0.039245	0.084432	0.058040	0.083374
		β	0.782938	0.724150	0.404934	0.513990	0.642437	0.647724	0.550886	0.739158	0.709978
		α + β	<1	<1	<1	<1	<1	<1	<1	<1	<1
		R	0.650478	0.666831	0.693044	0.705171	0.651256	0.595805	0.601513	0.609416	0.633171
5	Breeding of dairy cattle	A	3.331285	2.601502	3.669957	3.053176	2.888068	2.979584	2.026778	1.896132	1.851829
		α	0.278963	0.304162	0.345343	0.254872	0.251597	0.222484	0.190816	0.233280	0.255339
		β	0.556815	0.578152	0.437362	0.611180	0.624408	0.653482	0.781474	0.734544	0.702822
		α + β	<1	<1	<1	<1	<1	<1	<1	<1	<1
		R	0.766330	0.786609	0.751651	0.788743	0.790780	0.787557	0.822965	0.834312	0.804027
6	Pig breeding	A	1.519984	1.677368	2.407314	2.699576	2.398304	3.501806	2.680236	3.023193	2.528730
		α	0.367902	0.486112	0.400810	0.219192	0.335196	0.303675	0.237418	0.302782	0.193244
		β	0.644210	0.503439	0.539659	0.750424	0.640379	0.599265	0.737615	0.625802	0.789763
		α + β	>1	<1	<1	<1	<1	<1	<1	<1	<1
		R	0.827592	0.807704	0.797661	0.787018	0.759258	0.763128	0.773065	0.759161	0.804566
7	Bird breeding	A	3.047636	3.003382	3.364928	3.523115	2.279362	1.341092	2.405400	1.772141	1.931592
		α	0.260984	0.135266	0.201215	0.186883	0.147702	0.126296	0.126173	0.052565	0.102308
		β	0.658638	0.813702	0.694707	0.705156	0.858114	0.948334	0.869768	0.999281	0.924289
		α + β	<1	<1	<1	<1	>1	>1	<1	>1	>1
		R	0.855934	0.826673	0.828454	0.781087	0.821482	0.806556	0.831777	0.852176	0.869961
Nr.crt.	Subsectors of agriculture	Variable	Period								
			2008	2009	2010	2011	2012	2013	2014	2015	2016
8	Activities in mixed farms (plant culture combined with livestock breeding)	A	2.764225	1.728132	2.487053	2.285855	3.058836	2.187890	2.335240	1.882091	2.188075
		α	0.218919	0.258754	0.272044	0.213373	0.242791	0.214695	0.271824	0.186147	0.253572
		β	0.674360	0.711472	0.636812	0.735580	0.633587	0.742126	0.662557	0.794955	0.686388
		α + β	<1	<1	<1	<1	<1	<1	<1	<1	<1
		R	0.749751	0.799107	0.760161	0.745319	0.733464	0.750872	0.786138	0.783564	0.792130
9	Auxiliary activities for crop production	A	2.616150	2.363838	3.030756	4.803998	4.895449	4.284594	3.896002	3.475820	1.960113
		α	0.380473	0.325464	0.197000	0.177316	0.150695	0.190080	0.192824	0.184818	0.233449
		β	0.501114	0.584058	0.660610	0.506703	0.528193	0.537568	0.571769	0.607348	0.700365
		α + β	<1	<1	<1	<1	<1	<1	<1	<1	<1
		R	0.701209	0.720815	0.646643	0.522841	0.547120	0.550565	0.582812	0.581394	0.647573
10	Forestry and other forestry activities	A	3.645020	3.462687	3.895880	3.706681	3.833022	4.183467	3.744406	3.940362	3.755674
		α	0.260118	0.232481	0.228278	0.193797	0.230976	0.191238	0.143722	0.117104	0.108523
		β	0.577677	0.610245	0.579115	0.636290	0.585539	0.600445	0.686290	0.692726	0.714351
		α + β	<1	<1	<1	<1	<1	<1	<1	<1	<1
		R	0.776865	0.784756	0.752763	0.781790	0.773606	0.775863	0.806315	0.788355	0.829097
11	Forest exploitation	A	3.117888	3.044019	3.252671	3.463774	3.248451	3.102388	3.021757	2.980746	2.187519
		α	0.246246	0.232286	0.244850	0.191510	0.182757	0.191501	0.149097	0.162104	0.158310
		β	0.650494	0.660365	0.644690	0.684926	0.710921	0.719811	0.771990	0.760624	0.825641
		α + β	<1	<1	<1	<1	<1	<1	<1	<1	<1
		R	0.823749	0.785400	0.796665	0.805819	0.785454	0.789368	0.808820	0.804317	0.819590
12	Marine aquaculture and freshwater	A	3.216120	2.547377	3.028152	3.401658	3.648661	4.111378	4.161632	4.171734	3.129802
		α	0.225283	0.061814	0.134544	0.242304	0.160370	0.077330	0.077797	0.055169	0.016612
		β	0.580602	0.796138	0.678487	0.521950	0.596114	0.627863	0.622543	0.669984	0.800460
		α + β	<1	<1	<1	<1	<1	<1	<1	<1	<1
		R	0.723352	0.645095	0.702384	0.610778	0.656898	0.592372	0.532784	0.598716	0.692872

Source: own processing

A - proportionality factor;
α - the elasticity of the turnover figure relative to net fixed assets;
β - the elasticity of the number of factions in relation to the workforce;
R - multiple correlation coefficient,