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## THE RELATIONSHIP BETWEEN NEWLY INTRODUCED FIXED ASSETS AND FINAL OUTPUT IN POLISH AGRICULTURE

*The study describes the regression relationship between net final output on gross value of newly introduced fixed assets and on net value of fixed assets already held in total in Polish agriculture in the years 2010, 2011 and 2012. The results demonstrate that the value of the final output intended for sale in relation to the combined effect of the growth in gross value of newly introduced fixed assets and the net value of fixed assets already held increased more than proportionally (1.204) at the constant level of other factors. This results from the assessment of marginal productivity and average productivity marginal of the abovementioned values of fixed assets that they were in the sphere of rational management, while the growth rate of fixed asset restoration (33.8%) ensured rational exploitation of fixed assets in Polish agriculture in the years under study.*

*Keywords:* net final output; fixed assets; marginal productivity; average productivity; rational exploitation.

*JEL classification:* C13; C51; E23; L16.

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## ВЗАЄМОЗВ'ЯЗОК МІЖ НОВИМИ ОСНОВНИМИ ЗАСОБАМИ ТА КІНЦЕВОЮ ПРОДУКЦІЄЮ: ЗА ДАНИМИ СІЛЬСЬКОГО ГОСПОДАРСТВА ПОЛЬЩІ

*У статті за допомогою регресії досліджено взаємозв'язок між чистою кінцевою продукцією від нових основних засобів та чистою кінцевою продукцією від основних засобів вже в використанні. Даний взаємозв'язок описано на прикладі польського сільського господарства у 2010, 2011 та 2012 роках. Результати аналізу демонструють, що вартість кінцевої продукції, призначеної на продаж, під спільним впливом вартості нових та вже використаних основних засобів зростала швидше, ніж пропорційно, за умови незмінності інших факторів. Результати оцінювання граничної та середньої продуктивності даних двох категорій основних засобів показали, що підвищене відновлення основних засобів гарантувало більш раціональне їх використання в сільському господарстві Польщі у досліджені роки.*

*Ключові слова:* чиста кінцева продукція; основні засоби; гранична продуктивність; середня продуктивність; раціональне використання.

*Табл. 5. Літ. 20.*

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## ВЗАИМОСВЯЗЬ МЕЖДУ НОВОВВЕДЁННЫМИ ОСНОВНЫМИ СРЕДСТВАМИ И КОНЕЧНОЙ ПРОДУКЦИЕЙ: ПО ДАННЫМ СЕЛЬСКОГО ХОЗЯЙСТВА ПОЛЬШИ

*В статье при помощи регрессии исследована взаимосвязь между чистой конечной продукцией от нововведённых основных средств и чистой конечной продукцией от основных средств уже в пользовании. Данную взаимосвязь описано на примере польского сельского хозяйства в период 2010, 2011 и 2012 годов. Результаты анализа демонстрируют, что стоимость конечной продукции, предназначенной на продажу, под совместным влиянием стоимости новых и уже использованных основных средств росла быстрее, чем пропорционально, при условии неизменности других факторов. Результаты оценивания граничной и средней продуктивности данных двух категорий основных средств показали, что*

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*повышенное восстановление основных средств гарантировало более рациональное их использование в сельском хозяйстве Польши в указанные выше годы.*

*Ключевые слова:* чистая конечная продукция; основные средства; граничная продуктивность; средняя продуктивность; рациональное использование.

**Introduction.** As early as in the 1980s Japanese government noted that external variable impulses are of particular importance for the adaptation of the economic system. They favoured the strengthening and consolidation of the achievement of the final goal of economic expansion, even at increasingly higher costs. This finds justification in the dynamic theory of comparative advantage (Shinohara, 1982). Therefore, changes led to the consolidation of various economic entities, and in consequence to structuring. Increasing complexity and accelerated dynamics of changes in the environment must exert impact on structural solutions applied at enterprises (Bleicher, 1991). This is especially important in the agricultural sector, which, due to its natural determinants, develops at a slower pace than other sectors of national economic systems (Drucker, 1989).

The principle of investing in productive fixed assets applied in highly developed countries marks the investment limit when production capacity of these assets in the long term is exploited at ca 80% (Lynch et al., 2004). In addition, at such a relative level the following should arise: concerns related to partial loss of market share, and securing the stocks of agricultural raw materials. The anticipated effects of the performed investments should be future market demand, short investment project implementation cycles, employment growth and high effectiveness (Zizlavsky, 2011).

The abovementioned determinants are the basis for further technological progress and growth in production per agricultural land area (Bojnec and Latruffe, 2009).

**The aim of this study** is to determine the regression relationship between the value of the net final output on growth in newly introduced fixed assets (their gross investment outlays) and the net value of fixed assets already held in Polish agriculture in the years 2010, 2011 and 2012. Furthermore, to determine the effectiveness of fixed asset restoration with the use of average and marginal productivity of the gross value of the growth in newly introduced and net value of the fixed assets, already held.

**Methodological notes.** The accounting principle assumes a change in the balance of products, which has the character of a line item and allows determining of the cause-and-effect matching of costs and revenues. Change in the balance of products indicates the adjustment of income on sales and determination of the incurred costs by type, which include all costs incurred by an agricultural enterprise in a given period. These costs were incurred in order to produce the net final output which subsequently was or will be sold.

The accounting principle and resulting cause-and-effect matching of costs and revenues indicates that the net final output intended for sale has been adopted as the variable dependent on the growth in newly introduced fixed assets (their gross investment outlays) and the net value of fixed assets already held in Polish agriculture in the years 2010, 2011 and 2012.

The following were adopted as the features of the studied variables: arithmetic mean, coefficient of variation, and range. The parametric characteristics of the variable features are presented in Table 1.

**Table 1. Parameters of variable features in Polish agriculture in 2010, 2011 and 2012 (prices as of 2010)**

No.	Specification	Unit of measurement	Symbol	Arithmetic mean	Range, min–max	Coefficient of variation, %
1.	Value of the net final output intended for sale	mln PLN	Y1	3963.6	1211.1–11272.1	68.6
2.	Growth in the gross value of newly introduced fixed assets (their gross investment outlays)*	mln PLN	X1	33.3	1.0–188.5	126.7
3.	Net value of the fixed assets already held in total**	mln PLN	X2	1753.0	600.2–4034.6	51.5

Source: Agricultural statistical yearbook 2011, 2012 and 2013, Central Statistical Office, Warsaw, Poland.

\* The share of the hunting sector investment outlays in the gross value of both agriculture and hunting investment outlays amounted to 0.09% in 2010, 0.15% in 2011 and 0.09% in 2012. Source: Attachment to the letter of the Board of the Polish Hunting Association in Warsaw, Poland, 29.03.2013. The aforementioned share of the hunting sector in agriculture and hunting investment outlays did not affect the computation results in our study.

\*\* The share of the fixed assets of the hunting sector in the gross value of fixed assets of both agriculture and hunting amounted to 0.01% in 2010, 2011 and 2012. Source: Attachment to the letter of the Board of the Polish Hunting Association in Warsaw, Poland, 29.03.2013. The aforementioned share of the hunting sector in the gross value of both agriculture and hunting fixed assets did not affect the computation results.

It results from the data presented in Table 1 that internal variability of growth in the gross value of newly introduced fixed assets (their gross investment outlays) was nearly two times higher than the value of the net final output intended for sale. The aforementioned internal variability suggests its impact on the increase of net final output intended for sale in Polish agriculture in the years 2010, 2011 and 2012 (Pianta, 2001). Although the variability of the net value of fixed assets already held in total was over 2.5 times lower, their impact – as the basis – on the growth in the value of net final output intended for sale by Polish agriculture was of material significance, just like in any sector of the economy. This value was decreased by the value of fixed assets liquidated in the years 2010, 2011 and 2012. For the purpose of ensuring the comparability of the net value of the possessed fixed assets in those years, the values were expressed in process from 2010. The impact on growth in the net final output in Polish agriculture was also exerted by the relation of fixed asset restoration in agriculture.

The test of the random component distribution was performed by graphical analysis and the number series test, at the significance level of 0.05. Graphical analysis and number series test confirmed the hypothesis verification assuming the accuracy of the choice of the analytical form of these models (Table 2). Random component normality was checked with the Kolmogorow-Liliefors test. The achieved values, compared with the critical values at the 0.05 significance level, did not substantiate the hypothesis rejection that the random component distribution was normal. Autocorrelation, checked with the Durbin-Watson test, proved the absence of random component correlation at the 0.05 significance level. The hypothesis of random component homoscedasticity was verified with the Goldfeld-Quandt test. Assuming

that the significance level was 0.05, the obtained critical values of Snedecor's F distribution were higher than the calculated ones; therefore, there was no reason to reject the hypothesis about random components homoscedasticity (Aczel and Sounderpandian, 2002).

**Results and discussion.** Tabular presentation in Table 2 shows the regression relationship between the net final output intended for sale (Y1) on the growth in the gross value of newly introduced fixed assets (their outlays) and the net value of fixed assets already held in Polish agriculture in 2010, 2011 and 2012. The aforementioned independent variables have the nature of inactive production factors (Moosa, 1997). The coefficient of determination ( $R^2$ ) in Table 2 shows that the growth in the gross value of newly introduced fixed assets and the net value of fixed assets already held in total have explained the variability of the value of the net final output intended for sale by 87%. Therefore, the obtained explanation of the variability of the net final output intended for sale was very high. The remaining unexplained share of variability was caused by other factors not considered in the regression model. The power of the relationship expressed by the correlation coefficient ( $\sqrt{R^2} = R$ ) between the net final output value and the growth in the gross value of newly introduced fixed assets and the net value of fixed assets already held was 93% (Sheskin, 2004). Standard errors of regression parameters (regression coefficients) were lower than 50% of their absolute values. The t-test values were several times higher than the values of the regression coefficients (parameters), and errors (significance level) of regression coefficients remained in the range of 0.00–0.04. The aforementioned statistical evaluation of regression coefficients (parameters) indicates the possibility of their application in econometric analysis of the net final output on the growth in the gross value of newly introduced fixed assets and the net value of fixed assets already held in total in Polish agriculture in 2010, 2011 and 2012.

Regression coefficients (Table 2), regression parameters at X1 and X2 are interpreted as elasticity (Maddala, 2001) of the net final output intended for sale in relation to the growth in the gross value of newly introduced fixed assets and the net value of fixed assets already held in total. In the subject literature, regression coefficients (parameters) are also called elasticity coefficients. In the power regression, exponents at independent (explanatory) variables are interpreted as the elasticity of endogenous variables in relation to respective factors (X1 and X2). The elasticity coefficient shows the average % change (increase or decrease) in the dependent variable when the Xj growth factor increases by 1%, on the assumption that the remaining factors remain constant (Solow, 1956).

The elasticity of the value of the net final output intended for sale was higher than the net value of fixed assets already held in total than to the growth in the gross value of newly introduced fixed assets (Table 2). It results from the relation of elasticity coefficients that the net final output in relation to the growth in the gross value of newly introduced fixed assets was over 13 times lower than the net value of fixed assets already held in total. It results from the total of elasticity coefficients (powers) higher than unity (1.20) that the net final output intended for sale in relation to the total impact of the gross value of newly introduced fixed assets and the net value of fixed assets already held in total, at the constant level of other factors rose more than pro-

portionally. Also, in relation to the net value of fixed assets already held alone it rose more than proportionally (1.12). The combined increase of growth in the gross value of newly introduced fixed assets and the net value of fixed assets already held by 10% contributed to the increase of the net final output by 12.04%, at the constant level of other factors, whereas the increase in the net value of fixed assets already held alone by 10% caused the growth in the net final output by 11.20%. It results from the relative relation presented above that only the growth of the net value of fixed assets already held alone ensured the minimum annual growth in the net final output by 1.20%, at the constant level of other production factors in Polish agriculture.

**Table 2. Power regression of the net final output intended for sale (Y1) on the growth in the gross value of newly introduced fixed assets (their gross investment outlays) (X1) and the net value of fixed assets already held in total in Polish agriculture in 2010, 2011 and 2012 (prices as of 2010)**

a*	Regression coefficient		Standard error		t-test		Significance level		R <sup>2</sup>
	X1	X2	X1	X2	X1	X2	X1	X2	
0.7025	0.084	1.12	0.039	0.099	2.1	11.3	0.04	0.00	0.87

Source: Agricultural statistical yearbooks 2011, 2012 and 2013, Central Statistical Office, Warsaw, Poland. Author's own numerical computations.

a\* – the delogarithmed constant of equation.

It results from the sum of elasticity = 100% that the impact of the gross value of newly introduced fixed assets on the growth in the net final output intended for sale was 7%, and in the net value of fixed assets already held in total – 93%. The above relationship can be explained with the theory of cumulative changes, where the change in one factor significantly enhances the impulses which provide reverse stimulation for this change.

Also, an important role here is played by the economy of transition; when real options emerge, the irreversibility of investment occurs. Therefore, it can be stated that there is no evidence of the negative association between uncertainty and investment when the impact of the irreversibility degree increases (Ninh et al., 2004).

Technical dependencies and the complexity of information contained in empirical data, as well as the limit of their recognition, induce the measurement of the sector's productivity factors (Nin et al., 2003). Increase in productivity factors was not appreciated in European countries. Thus, the author raised this issue, but in the very important area of the productivity of the gross value of newly introduced fixed assets and the net value of fixed assets already held in Polish agriculture.

The net final output intended for sale as the important measure expresses the real agricultural production in a given year. This production makes a group of many business entities, where each had own preferences and selection criteria. Therefore, the final criterion was not the optimum of the entire system but the result of many aspirations. The net final output is the synthetic production category of agriculture. Moreover, it is a good measure of assessment of the agricultural production growth rate. The average and marginal productivity of the gross value of newly introduced fixed assets and the net value of fixed assets already held expressed by the net final output constitutes the real effectiveness of fixed asset restitution (restoration) in Polish agriculture.

Average and marginal productivity demonstrate proportional associations in relation to each other by the constant elasticity of the net final output in relation to the growth in the gross value of the newly introduced fixed assets and the net value of fixed assets already held in total. At the same time, marginal productivity constitutes the standard of effectiveness of the fixed assets newly introduced and already held in total.

The data presented in Table 3 indicate that in Polish agriculture the gross value of newly introduced fixed assets grew with the increase in the value of net final output, while average and marginal productivity of newly introduced fixed assets decreased. The investment demand should be favourable at least for small as well as large scale of producers, and the supply of loans at rural market will tend towards the large scale producers if internal concentration of capital occurred there (Carter and Olinto, 2003).

**Table 3. Average and marginal productivity of the growth in the gross value of newly introduced fixed assets in Polish agriculture in 2010, 2011 and 2012 (prices as of 2010)**

Value of net final output intended for sale, mln PLN (Y1)	Growth in gross value of newly introduced fixed assets, mln PLN (X1)	Productivity	
		average, mln PLN (Y1/X1)	marginal, mln PLN (Y1/X1) 0.084*
3909.87	21.83	179.11	15.04
4136.22	42.66	96.96	8.14
4276.71	63.49	67.36	5.66
4379.86	84.32	51.94	4.36
4461.84	105.15	42.43	3.56
4530.10	125.98	35.96	3.02
4588.70	146.81	31.26	2.63
4640.13	167.64	27.68	2.33

Source: Data from Tables 1 and 2. Author's own calculations.

\* Marginal productivity = average productivity x constant elasticity of a given production factor (power).

However, marginal productivity decreased at an increasingly slower pace and tended towards zero; it also caused the decrease in average productivity, but at a slower pace. The aforementioned changes were typical for the sphere of rational management. Increasing the outlays for the newly introduced fixed assets was justified because the elasticity of the net value of fixed assets already held in total was higher than unity ( $E_{X2} > 1$ ), and increasing the outlays for newly introduced fixed assets caused increasingly higher marginal growths in fixed assets already held in total (Table 4).

At the same time it results from the data presented in Table 4 that together with the increase in the value of the net final output intended for sale, the net value of fixed assets already held in total in the agriculture increased. Also, marginal and average productivity of the net value of fixed assets already held in total increased. Marginal productivity equalled average productivity which attained the maximum. The aforementioned changes were typical for the beginnings of the entry into the sphere of rational management of the net value of fixed assets already held in total in agriculture ( $E_{X2} > 1$ ). Increasing the outlays for newly introduced fixed assets was favourable

for marginal and average productivity of the net value of fixed assets already held in total.

**Table 4. Average and marginal productivity of the net value of fixed assets already held in total in Polish agriculture in 2010, 2011 and 2012 (prices as of 2010)**

Value of the net final output intended for sale, mln PLN (Y1)	Net value of fixed assets already held in total, mln PLN (X2)	Productivity	
		average, mln PLN (Y1/X2)	marginal, mln PLN (Y1/X2) 1.12*
2116.40	981.80	2.16	2.41
3057.10	1363.40	2.24	2.51
4030.35	1745.00	2.31	2.59
5029.67	2126.60	2.37	2.65
6050.86	2508.20	2.41	2.70
7091.21	2889.90	2.45	2.75
8147.67	3271.40	2.49	2.79
9219.33	3653.00	2.52	2.83

Source: Data from Tables 1 and 2. Author's own calculations.

\* as in Table 3.

Industrialisation in agriculture leads to product differentiation, more transparently coordinated production, marketing channels, contracts, expanded lease (McDonald et al., 2004) broadened range of services, and growing dimensions of economic entities. Land markets are capable of moving land to more effective producers, and this way they increase agricultural productivity (Deininger, 2003). Technical innovations are capable of producing the same output at lower cost and improve agricultural effectiveness (DiPietre, 2000).

Therefore, any development in the agricultural issues described above allows growth in production scale, reduction in unit costs of production, improved production quality, and increased marginal productivity, which results in the increase of average productivity.

**Table 5. Average growth rate within the extremes of evaluated variables and their productivity in Polish agriculture in 2010, 2011 and 2012, %**

No.	Specification	Range min-max	
		Table 3	Table 4
1.	Value of the net final output intended for sale	2.48	23.40
2.	Growth in the gross value of newly introduced fixed assets	33.81	
3.	Net value of fixed assets already held in total		20.65
4.	Productivity average	-23.41	2.28
5.	Productivity marginal	-23.41	2.28

Source: Data from Tables 3 and 4. Author's own calculations.

It results from the data presented in Table 5 that the growth in gross value of newly introduced fixed assets was nearly 14 times faster than that of the value of net final output; as a result, the average growth rate of marginal and average productivity was negative (Galvez et al., 2013). It has to be noted, however, that the role of growth in gross value of newly introduced fixed assets consisted in restoration (restitution) of fixed assets already held in total in agriculture. Restoration by means of growth in the gross value of newly introduced fixed assets proceeded at the fastest average growth

rate (33.8%). This rate ensured rational exploitation of fixed assets already held in total in agriculture. This is evidenced by faster average growth rate of the value of net final output (23.4%) than the net value of fixed assets already held in total. This ensured the same average growth rate of average and marginal productivity (2.28%).

#### Conclusions:

1. The growth in gross value of newly introduced fixed assets and the net value of fixed assets already held explained the variability of net final output intended for sale in 87%. This was a relatively high explanation. The power of the relationship between the aforementioned variables reached 93%.

2. In relation to the combined impact of growth in the gross value of newly introduced fixed assets and the net value of fixed assets already held in total, at the constant level of other factors, the net final output rose more than proportionally (1.20). In addition, the net final output rose more than proportionally in relation to the net value of fixed assets already held in total in Polish agriculture in 2010, 2011 and 2012 (1.120).

3. Marginal productivity of the growth in the gross value of newly introduced fixed assets decreased at an increasingly slower pace and tended towards zero; it also caused the decrease in average productivity, but at a slower pace. The aforementioned changes were typical for the sphere of rational management. Restoration of fixed assets in Polish agriculture was compliant with the principle of rational fixed assets management.

4. Marginal productivity of the net value of fixed assets already held in total equalled their average productivity which attained the maximum. The aforementioned changes were typical for the beginnings of the entry into the sphere of rational management of the net value of fixed assets already held in total ( $E_{X_2} > 1$ ). The nature of changes as stated above indicates the usefulness of the restitution of fixed assets already held in agriculture.

5. The fastest average growth rate of the gross value of newly introduced fixed assets (33.8%) ensured rational exploitation of fixed assets already held in total in agriculture. This led to the fastest average growth rate of the value of net final output (23.4%), and ensured the same average growth rate of average and marginal productivity of fixed assets already held in Polish agriculture in 2010, 2011 and 2012.

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