EFFICIENCY OF REPRODUCTION OF FIXED ASSETS IN POLISH AGRICULTURE

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Abstract

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The article includes research on the efficiency of the increase in gross value of newly introduced fixed assets and the net value of held fixed assets in Polish agriculture in the years 2010, 2011 and 2012. The efficiency (average and marginal productivity) of the increase in gross value of newly introduced fixed assets (restoration) was in the area of rational management. Whereas the efficiency of the net value of held fixed assets (basis) was at the beginning of entry into the area of rational management of this resource. The average rate of growth of the increase in gross value of newly introduced fixed assets was eleven times faster than the average rate of growth of sold market output. The changes that occurred during the aforementioned restoration of fixed assets also changed the organization and the existing conditions of market output. Whereas the average rate of growth of the net value of held fixed assets was similar to the average rate of growth of sold market output. The aforementioned is in accordance with the theory of the application of fixed assets, which states that the increase in fixed assets should be connected with the increase in sold market output.

Key words: reproduction (restoration) of fixed assets, average and marginal productivity, average rate of growth, functional dependence

Introduction

In the literature on the subject the restoration of fixed assets is connected with the change, improvement, or introduction of specified types of fixed assets[1]. However, such changes had one shared characteristic concerning the functional and material form reflected in the structural and qualitative transformation of fixed assets[2]. In the research, the notion of a circular flow of fixed assets was narrowed to the economic category of the reproduction cycle of fixed assets which defines the reconstruction of use value (as well as valuable one) of fixed assets in time. Thus, this category represents the rate and periodicity of full restoration of fixed assets[3].

The objective of the research was to determine the functional relation of the value of sold market output to the increase in newly introduced fixed assets (their gross investment outlays) and the net value of held fixed assets in Polish agriculture in the years 2010, 2011, and 2012. A further objective was the determination of the efficiency of fixed assets reproduction with the use of average and marginal productivity of the gross value of the increase in newly introduced fixed assets and the net value of held fixed assets in total.

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[1] According to A. Lissits, A. Balmann (2003, pp. 439-449), the technological changes increased the effectiveness of agricultural enterprises in Eastern Germany and total productivity of factors in the years 1995-2001.

[2] The development of fixed assets and their allocation effects create endogenous conditions for the growth of output (productivity) of other factors (K. J. Carlaw, R. G. Lipsey, 2003, p. 457).

[3] As a result of irreversibility, uncertainty decreases the investment. Yet when the option is real it leads to investment. In turn, the negative association between uncertainty and investment is the impact of the degree of irreversibility (Khuong Ninh L. et al. 2004, pp. 307–332).

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Notes on the Methodology

In the long term, the basis for the assessment of investment outlays on fixed assets is the profitability of fixed assets. In agriculture, it would be the relation of agricultural income and investment outlays to fixed assets. However, due to EU subsidies, for 1 ha of agricultural land the share of subsidy in agricultural income is equal to up to 70%[4]. Therefore, it is not possible to assess the profitability of investment outlays on fixed assets in agriculture based on agricultural income. Thus, the approach applied is the market approach of the assessment of economic effectiveness of reproduction of fixed assets in Polish agriculture in the years 2010, 2011, and 2012[5].

The potential resource of fixed assets in agriculture[6] corresponds to the net value of fixed assets. It is an important economic category because of the existing high level of wear and tear of fixed assets in Polish agriculture (77%). The accounting amortization of fixed assets limits its application in the calculation of the efficiency of fixed assets reproduction[7].

Results of Research

The adopted characteristics of the examined variables are as follows: arithmetic mean, coefficient of variation, and range. The statistical description of the characteristics of variables is included in Table 1.

The data in Table 1 reveals that the highest coefficient of variation was for the increase in the gross value of newly introduced fixed assets (their gross investment outlays). It seems that their role should be the leading one in the process of estimating the function parameters. However, it was conditioned by the impact of the net value of held fixed assets[8] (basis), although its internal variability was almost 2.5 times lower than the increase in value of newly introduced fixed assets. The proportions of effects of the two aforementioned independent variables shaped the internal variability of the value of market output sold in the market given the fixed level of the remaining production factors.

Starting from the break-even point, at which the volume of production provides the income from sales that will still be equal to the costs of production, the value of sold output, may be assumed as a dependent variable. Whereas, the independent variables representing the rationality of achievement of sold market output (goal) are as follows: the increase in gross value of newly introduced fixed assets (increase in value of investment outlays on fixed assets), and the net value of held fixed assets in total (basis) (Table 2). The achieved effects of sales related to the aforementioned independent variables represent the (average and marginal) efficiency of the increase in newly introduced fixed assets (their outlays) and the net value of held fixed assets (basis), which enabled the determination of the efficiency of reproduction of fixed assets in total in Polish agriculture in the years 2010, 2011 and 2012.

The randomness of the distribution of a random variable was examined with the use of graphical analysis and test runs with the significance level set at 0.05. Graphical analysis and test runs confirmed the verification of the hypothesis about the accuracy of the selected analytical form of a model (Table 2), whereas the normality of a random variable was examined with the use of the Kolmogorov-Lilliefors test. The calculated values compared with critical values with the significance level set at 0.05 did not give grounds for rejecting the hypothesis that the distribution of random variables was normal. The autocorrelation was examined with the use of the Durbin-Watson test, and this provided the grounds for stating the lack of autocorrelation of a random variable with the significance level set at 0.05. The hypothesis of the homoscedasticity of random variables was verified with the use of the Goldfeld-Quandt test. Given the assumed significance level set at 0.05 the critical values read from Snedecor's F distribution were higher than the calculated ones, and therefore there were no grounds for rejecting the hypothesis of the homoscedasticity of random variables[9].

In Table 2 the tabular form of presentation includes the dependence of sold market output (Y1) on the increase in newly introduced fixed assets (their outlays) and the net value of held fixed assets in Polish agriculture in the years 2010, 2011, and 2012[10].

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[4] The income is positively associated with technological efficiency in agriculture (Bojeniec, 2014).

[5] The increase in fixed assets is accompanied with their liquidation, and therefore there are no breaks in the production process. The cyclical nature of investment processes causes research to be carried out in periods longer than one year.

[6] The analyses prove that the influence of politics in the market of stable income on the majority of investors is low. It causes growth in productivity and also an increase in the amount of resources that will be the object of investment in the private sector (Bomfim 2003, pp. 10-21).

[7] The efficiency-based approach leads to the satisfaction of on-going needs but does not also limit the satisfaction of the needs expressed by future generations (Estes, 1993, pp. 1–29).

[8] This value was reduced by the liquidation of fixed assets within each year. In order to prevent the distortion of the basis for comparison, all values were represented in absolute values and not relative ones with the use of prices from 2010. Furthermore, for the whole period covered by the research (2010, 2011, and 2012), we have assumed the (maximum and minimum) values of each type of empirical data.

[9] A. D. Aczel, J. Sounderpandian, 2002, Complete Business Statistics, McGraw-Hill/Irwin, 586.

[10] The aforementioned independent variables have the character of inactive production factors (Moosa 1997, pp. 335–356).

Table 1

Statistical description of the characteristics of variables in Polish agriculture in the years 2010, 2011, and 2012 (prices in 2010)

Item	Description	Unit of measure	Symbol	Arithmetic mean	Range min. max.	Coefficient of variation
1.	Value of sold market output	in millions of PLN	Y1	3508.8	1111.2 – 10064.4	69.6
2.	Increase in gross value of newly introduced fixed assets (their gross investment outlays)	in millions of PLN	X1	33.3	1.0 – 188.5	126.7
3.	Net value of held fixed assets in total*	in millions of PLN	X2	1753.0	600.2 – 4034.6	51.5

Source: Statistical Yearbook of Agriculture of 2011, 2012, and 2013, Central Statistical Office, Warsaw, Poland.
*In the value of investment outlays made by agriculture and hunting, the share of investment outlays made by hunting equalled: 0.09% in 2010, 0.15% in 2011, and 0.09% in 2012. While in the gross value of fixed assets of agriculture and hunting, the share of fixed assets of hunting equalled: 0.01% in 2010, 2011 and 2012. Source: Appendix to the letter dated March 29, 2013, of ZG PZŁ in Warsaw. It has not influenced the results of calculations

Table 2

Power regression of sold market output (Y1) from the increase in newly introduced fixed assets (their gross investment outlays) (X1) and the net value of held fixed assets in Polish agriculture in the years 2010, 2011, and 2012 (prices in 2010)

a*	Regression coefficient		Standard error		t-Test		Significance level		R2
	X1	X2	X1	X2	X1	X2	X1	X2	
0.6194	0.105	1.106	0.044	0.109	2.4	10.1	0.02	0.00	0.85

Source: Statistical Yearbook of Agriculture of 2011, 2012, and 2013, Central Statistical Office, Warsaw, Poland. Author's own numerical calculations
a* – constant of an equation converted back from logarithm to original form

The data in Table 2 reveal that the increase in newly introduced fixed assets and the net value of held fixed assets explained 85% of the variability of the value of sold market output. Thus, a high degree of explanation of the variability of sold market output was obtained. The remaining unexplained share was caused by other factors which were not taken into account in the function model given above. The correlation power represented with the correlation coefficient (R) between the value of market output and the increase in newly introduced fixed assets and the net value of held fixed assets equalled 92%. Standard errors of function parameters (regression coefficients) were lower than 50% of their absolute values, whereas the t-Test values were several times higher than the values of regression coefficients (parameters), while the significance level of regression coefficients was from 0.00–0.02. The aforementioned statistical evaluations of regression coefficients (parameters) justify their use in econometric analysis, i.e. an evaluation of the variability of values of the sold market output in Polish agriculture in the years 2010, 2011, and 2012.

The regression coefficients, function parameters at X1 and X2, are easily interpretable as flexibilities [11] of sold market output in relation to the increase in gross value of newly

introduced fixed assets and the net value of held fixed assets in total. Thus, the regression coefficients (parameters) can also be named the flexibility coefficients. In the power function, the exponents at independent (explanatory) variables are interpreted as flexibilities of an endogenous variable in relation to relevant factors (X1 and X2). The flexibility coefficient defines the average percentage value of change (increase or decrease) of dependent variable in the case of increase of the Xj growth factor by 1% with the assumption of constancy for other factors.

The average flexibility of the value of sold market output was lower in relation to the increase in the gross value of newly introduced fixed assets than the net value of held fixed assets in total (Table 2). The relation of flexibility (regression) coefficients reveals that the market output in relation to the increase in value of newly introduced fixed assets was more than 10.5 times lower than the net value of held fixed assets. This results from the total of flexibility coefficients (powers) being higher than a unit (1.211) that the sold market output in relation to the total impact of the increase in value of newly introduced fixed assets, and the net value of fixed assets increased more than proportionally given the constant level of other factors. Also, in relation to the net value of held fixed assets, it increased more than proportionally (1.106). The simultaneous growth of the increase in the gross value of newly

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[11] G. S. Maddala, Introduction to Econometrics, Wiley, New York (2001, p. 260).

Table 3

Average and marginal productivity of the increase in the gross value of newly introduced fixed assets in Polish agriculture in the years 2010, 2011, and 2012 (prices in 2010)

Value of sold market output, in millions of PLN	Increase in gross value of newly introduced fixed assets, in millions of PLN	Productivity	
		average millions of PLN/millions of PLN	marginal millions of PLN/millions of PLN
3323.05	21.83	152.22	16.14
3567.62	42.66	83.63	8.86
3721.20	63.49	58.61	6.21
3834.82	84.32	45.48	4.82
3925.62	105.15	37.33	3.96
4001.55	125.98	31.76	3.37
4066.99	146.81	27.70	2.94
4124.59	167.64	24.60	2.61

Source: data from tables 1 and 2

Table 4

Average and marginal productivity of the net value of held fixed assets in total in Polish agriculture in the years 2010, 2011, and 2012 (prices in 2010)

Value of sold output, in millions of PLN	Net value of held fixed assets in total, in millions of PLN	Productivity	
		average, millions of PLN/millions of PLN	marginal, millions of PLN/millions of PLN
1823.93	981.80	1.86	2.05
2622.55	1363.40	1.92	2.13
3445.53	1745.00	1.97	2.18
4287.96	2126.60	2.02	2.23
5146.66	2508.20	2.05	2.27
6019.36	2889.80	2.08	2.30
6904.40	3271.40	2.11	2.33
7800.48	3653.00	2.14	2.36

Source: data from tables 1 and 2

introduced fixed assets and the net value of held fixed assets by 10% caused the increase in sold market output by 12.11%, given the constant level of other factors. And given the increase in the net value of held fixed assets itself, this increase in sold market output equalled 11.06%. The proportion of impact (sum of flexibilities = 100%) reveals that the impact on the increase in sold market output of the increase in the gross value of newly introduced fixed assets equalled 1%, and of the net value of held fixed assets – 99%. This last relation may be explained with the use of the theory of cumulative changes, where the change of one factor significantly intensifies the signals which stimulate this change by feedback.

According to the acceleration principle, the growth in an economic situation leads to an increase in consumption, which in turn leads to the growth of investments in fixed assets[12]. The change of such relations leads to cyclical changes in the allocation of investment outlays on fixed assets.

The empirical research in the literature on the subject shows that the liquidation processes are not the source of decrease in the wear and tear degree of fixed assets. Likewise, the processes of restoration of fixed assets do not show any connections with their level (correlation calculation). Thus, the calculation of the efficiency of fixed assets reproduction in Polish agriculture becomes necessary.

The changes in the average and marginal productivity of the increase in the gross value of newly introduced fixed as-

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[12] M. N. Rothbard, 2004, Man, Economy and State with Power and Market, Ludwig von Mises Institute, p. 270.

Table 5

Average rate of growth in the range of extrema of examined variables and their productivity in Polish agriculture in the years 2010, 2011, and 2012, %

Description	Range: min. – max.	
	in table 3	in table 4
Value of sold market output	3.14	23.07
Increase in gross value of newly introduced fixed assets	33.81	
Net value of held fixed assets in total		20.65
Average productivity	–22.92	2.01
Marginal productivity	–22.92	2.01

Source: data from tables 3 and 4

sets and the net value of held fixed assets in total, given the average share of X1 or X2, are provided in Tables 3 and 4.

The average productivity and marginal productivity reveal relations proportional to each other through the constant flexibility of sold market output in relation to the increase in gross value of newly introduced fixed assets and the net value of held fixed assets in total. In turn, the marginal productivity constitutes the standard of efficiency of newly introduced and held fixed assets.

The data from Table 3 shows that alongside the growth of the increase in the gross value of newly introduced fixed assets and the corresponding value of sold market output, the average and marginal productivity of newly introduced fixed assets decreased in Polish agriculture in the years 2010, 2011, and 2012. The marginal productivity decreased increasingly slowly and was heading for zero, which also caused the decrease in the average productivity – though its rate was slower. The aforementioned relations show that their changes are characteristic of the area of rational management. The increase in outlays on newly introduced fixed assets was justified[13] because the flexibility of the net value of held fixed assets in total was higher than a unit ($E_{X2} > 1$); thus, the increase in outlays on newly introduced fixed assets caused increasingly high marginal increases in held fixed assets (Table 4).

In turn, the data in Table 4 show that alongside the growth of the net value of held fixed assets in total, and the corresponding value of market output, the average and marginal productivity increased. The marginal productivity became equal with the average productivity, which reached the maximum. The aforementioned relations were characteristic of the beginning of entry into the area of rational management of the net value of held fixed assets in Polish agriculture in the years 2010, 2011 and 2012 ($E_{X2} > 1$). The increase in in-

vestment outlays on newly introduced fixed assets was also favourable for the increasingly high marginal productivity of the net value of held fixed assets in total.

The average rate of growth of the examined variables and their efficiency is included in Table 5. The productivity of fixed assets (Table 5) enables the evaluation of the effects of growth of production dependent on the time factor. Fixed assets with higher technological level and higher value introduced to production are usually not fully used. However, they change and improve the production conditions. This is confirmed by the rate of growth of the increase in the gross value of newly introduced fixed assets, which is eleven times faster in relation to the average rate of growth of the value of sold market output, as well as by the substantial decline in the average rate of growth of average and marginal productivity of the increase in the gross value of newly introduced fixed assets in Polish agriculture in the years 2010, 2011, and 2012. Perhaps the level of increase in newly introduced fixed assets was too low to make the rate of increase in market output faster.

The use of changes in the technological level of fixed assets in their full range[14] occurs only after the lapse of some time. The length of such a period may significantly differ depending on the material type and the scope of changes, and may last from several months to several years. The average rate of growth of the net value of held fixed assets in total was close to the average rate of growth of the value of sold output, which in turn shaped the same average rate of growth of average and marginal productivity in Polish agriculture in the years 2010, 2011, and 2012.

Conclusions

The increase in the gross value of newly introduced fixed assets and the net value of held fixed assets explained 85% of the variability of sold market output. It was a high degree

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[13] The investment demand should be favourable at least to small- and large-scale producers, and the supply of credits in the rural markets will be directed to the large-scale producers if the internal concentration of capital is present there (Carter and Olinto 2003, p. 173).

[14] It creates favourable conditions for technological development (growth of carried out investments and capital) (Brem, 2002).

of explanation, whereas the correlation power between the aforementioned variables equalled 92%.

The sold market output in relation to the total impact of the increase in gross value of newly introduced fixed assets and the net value of held fixed assets given the constant level of the remaining production factors was growing more than proportionally in Polish agriculture in the years 2010, 2011, and 2012 (1.211).

The marginal productivity of the increase in the gross value of newly introduced fixed assets decreased increasingly slowly in the range of extremum and also caused the decrease in average productivity, though its rate was slower. The aforementioned changes were characteristic of the area of rational management of the increase in the gross value of newly introduced fixed assets in Polish agriculture in the years 2010, 2011, and 2012.

The marginal productivity of the net value of held fixed assets became equal to the average productivity, which reached the maximum. The character of those relations reveals that the management of the net value of held fixed assets in total was at the beginning of entry into the area of rational management of this resource. This indicates that the growth of the increase in the gross value of newly introduced fixed assets was rational and intentional in Polish agriculture in the years 2010, 2011, and 2012.

The average rate of growth of the increase in the gross value of newly introduced fixed assets, which is eleven times faster in relation to the average rate of growth of value of sold market output, indicates that the newly introduced fixed assets with higher technological level and higher value were not fully used. This resulted from the fact that they changed the organisation and the existing conditions of market output sold in the market.

The average rate of growth of the net value of held fixed assets was close to the average rate of growth of sold market output, and shaped the same average rate of the growth of average and marginal productivity of held fixed assets in to-

tal. This resulted from the fact that the average and marginal productivity of the net value of held fixed assets became equal in Polish agriculture in 2010, 2011 and 2012.

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