agriculture

MDPI

Article

The Impact of Agricultural Investments on the Economic Efficiency of Production Factors: An Empirical Study of the Wielkopolska Voivodeship

Wawrzyniec Czubak and Krzysztof Piotr Pawłowski *

Department of Economics and Economic Policy in Agribusiness, Faculty of Economics, Poznan University of Life Sciences, Wojska Polskiego 28, 60-637 Poznan, Poland; wawrzyniec.czubak@up.poznan.pl
* Correspondence: krzysztof.pawlowski@up.poznan.pl

Abstract: The functioning and development of each economic entity requires the implementation of investments. In the case of farms in Poland, which are characterised by structural problems and a lack of capital, it is essential to undertake investment activities of a modern nature. The main objective of this research was to assess agricultural investments made in farms, considering the example of the Wielkopolska Voivodship in Poland, from the point of view of their impacts on changes in the economic efficiency of production factors. The data source was unpublished individual data from the agricultural accounting "Polish FADN" results for all farms in the Wielkopolska Voivodship who had continuously participated in the data collection system from 2009 to 2021. The project's complexity was determined by measuring the scale of investments, relating the sum of investment expenditures to the average annual value of fixed assets (reduced by land value). Farmers endowed with a greater asset base had the ability to invest more comprehensively (i.e., in their most desirable scale regarding the value of possessed fixed assets) in a manner primarily concerning the value of fixed assets, especially the agricultural area, as a primary agricultural production factor. In terms of the effects of differentiating the scale of investment outlays (which was the aim of the study), a better initial state allowed farms to increase their area significantly, with an average annual rate of change of 3%. On the other hand, a lack of investment led to the decapitalisation of assets (−6.7% per year), which also concerned land sales (−1.5% per year). These research results indicate that not only does the undertaking of investments, in general, impact the development possibilities of farms—and, therefore, improvements in the resource situation of farms—but also the scale of investment (with respect to the value of possessed fixed assets).

Keywords: farms in Poland; investments in farms; farm development; production factors; FADN; Wielkopolska Voivodeship

Citation: Czubak, W.; Pawłowski, K.P. The Impact of Agricultural Investments on the Economic Efficiency of Production Factors: An Empirical Study of the Wielkopolska Voivodeship. *Agriculture* **2024**, *14*, 2217. https://doi.org/10.3390/agriculture14122217

Academic Editor: Katerina Melfou

Received: 11 November 2024
Revised: 28 November 2024
Accepted: 3 December 2024
Published: 5 December 2024

1. Introduction

An essential element affecting the activity of every enterprise is investment. Implementing investments in agricultural holdings is a critical activity that increases their competitiveness and development opportunities [1]. Investments in agriculture are crucial for improving the competitiveness, resilience, and sustainable development of agricultural holdings [2]. The fixed capital (machinery, equipment, tools, buildings, and land) reproduced and increased in this way creates production potential and, therefore, maximises the production capacity of an entity. This is a necessary condition for increasing production and improving efficiency and, in the long term, promotes its development. If we assume the maximisation of the producer function—that is, the increase in income—as a measure of development, then the necessary condition is to improve the efficiency of the use of production factors, particularly labour.

The scale and structure of investment are primarily derived from the initial situation, in terms of the entity's held fixed assets, financial capital, human resources, the availability

of technology, investment risk [3], forecasts of changes in demand for manufactured products, the ratio of the prices of production means to the prices of finished products, and the stability of the institutional environment, mainly including agricultural policy [4,5], changes in regulations and legal norms, and social expectations [6–8].

In Poland, after the period of the functioning of the centrally planned economy, the introduction of the principles of the market economy in 1989 caused a collapse in agriculture, which was reflected in a drastic decrease in its investment expenditure [9]. Farms in central and eastern Europe were burdened with limitations inherited from the institutional limitations of the previous system [10]. The low level of investment, especially in transforming economies (e.g., ECC), is most often explained in the literature as due to the imperfect nature of the capital market and risk aversion [11].

Numerous studies have proven that investments in farms improve their economic situation [12]. While there have been several studies on the factors affecting the creation of investments and their effects [10,13–16], there is a research gap relating to the importance of the complexity of investments made and their effectiveness. The validity of researching investments in agriculture based on the microeconomic data of farms has been confirmed by Petrick [14]. Detailed research on farm investments is justified, mainly due to the large share of public funds from the CAP in their creation, which is why it is essential from a social point of view [17]. Studying the investment behaviours of agricultural producers is particularly important for them, as well as for agricultural policymakers and other agricultural sector stakeholders who influence their long-term condition and sustainable development [18].

Therefore, this study aims to determine the effects of differentiating the scale of investment outlays in Polish farms on the efficiency of using production factors. This is not only an analysis of the selected economic phenomenon, but also of the fundamental issue of structural changes in agriculture, including the application of agricultural policy mechanisms in forecasting and creating changes. The study takes the Wielkopolska province as an example; this choice of area for analysis was not accidental, as it concerns a region that—both historically [19,20] and presently [21–25]—is characterised as the best agricultural region in Poland. For the purpose of this study, assessing the impacts of investments on changes in the efficiency of using production factors was crucial. An essential element of the study is that it was conducted at the microeconomic level, considering the individual data of economic entities. In contrast to aggregate data, this allowed for the separation of groups of farms according to their authorial division in the context of the research problem: the scale of investment outlays.

The remainder of this paper is organised as follows: Section 2 describes the unique FADN source data and the research methods employed. Section 3 presents and discusses the key findings. Section 4 presents the summary, conclusions, relevant political implications, and guidelines for further research.

2. Literature Review

Agricultural production is a function of various inputs, including the level of capital, which depends on previous investment decisions [26,27]. Investment decisions affect current and future agricultural production [27]. Investments allow farmers to adapt to external conditions, including price fluctuations, political reforms, climate change, and environmental and animal welfare regulations. Hence, it is crucial to understand how farmers make investment decisions [2] and their effects. The ability of the agricultural sector to maintain an appropriate level of farm investment is crucial for the achievement of long-term goals, primarily by ensuring food security while reducing its environmental footprint [28]. Furthermore, taking the EU's climate and environmental policy into account, it will be increasingly important to implement investments in agriculture based on technical criteria that make a significant contribution to mitigating climate and environmental change [29].

In the agricultural economics literature, there are divergent views on the factors influencing investment decisions and the effects of their implementation [2], indicating a need for further research in this area. Serrasqueiro et al. [30] indicated that various factors determine investments in economic entities; moreover, these factors affect entities differently depending on how long they have been operating in the market. Investments in agricultural holdings are influenced by their financial situation [13], and income obtained outside farms is essential to farm investments, especially for family farms.

Bojnec and Ferto [1] showed that, on farms, income obtained outside farms is often not necessary for creating investment processes. In turn, the results obtained by Key [31] indicated that higher non-farm income leads to increased liabilities, investments in physical capital, and the more efficient use of capital outlays and labour resources on the farm and, consequently, to increased production, farm income, and productivity. The increase in investment opportunities due to an increase in non-farm income has also been confirmed by Briggeman [32]. Higher income obtained outside farms can increase farmers' access to capital, thanks to the financial resources at their disposal and the increase in their creditworthiness [31]. Income from non-farm sources can also be used for investments in more advanced technologies, which increase the technical efficiency of farms [33]. Employment and earning income outside farms may also affect investments in tangible fixed assets, depending on access to agricultural services [34]. In turn, the research by Su et al. [35] showed, using the example of Chinese farms, that employment outside farms hurts investments and, consequently, the value of fixed assets on farms. This may indicate a gradual abandonment of agricultural activities and the phasing out of agricultural production on some farms.

A significant limitation in implementing productivity-enhancing investments in family farms is the limited possibility of external financing [36]. In agriculture, investing in physical assets requires significant financial and land resources, which often constitute security for external sources of financing. This significantly reduces the investment possibilities of smaller farms [18]. In turn, larger farms have more extensive resources and tend to over-invest to manage risk [37].

Capital market imperfections mean that financial constraints play a vital role in the investment behaviour of small- and medium-sized economic entities [38,39]. Shute's [40] research also showed that farmers consider barriers to obtaining capital as the greatest obstacle to establishing and developing agricultural activities. Studies of Polish farms conducted by Petrick [14] have also indicated that access to credit plays a statistically significant role in shaping the investment behaviour of agricultural producers. These studies also showed that the volume of investment is negatively correlated with the size of the farm. In turn, the studies by Hertz [41], who analysed Bulgarian farms, showed that credit availability did not limit investments. Many of these farms took out large credits and loans for consumption purposes, which meant that financing investments was possible; however, the farmers did not want to use external funds.

Financial liquidity can also affect the level of investment in farms [42]. When examining Irish farms, O'Toole et al. [43] reported a significant positive relationship between an entity's internal financial capabilities and its investment level. They also proved that, while the relationship is more minor in large- than in medium-sized farms, the type of farming is not significant. In turn, Jensen's theory of free cash flows states that if an entity has a large amount of free cash, it may over-invest in physical capital [44]. In the case of liquidity, land ownership is also essential; as research shows [45], investments are positively correlated with the level of liquidity in the case of farms with leased land while for entities with their land resources this variable is not significant.

The absolute level of debt and its relation to the value of assets may also influence investment decisions [18]. In the case of a high level of debt, investment decisions depend on the cash flow capacity of the farm. On one hand, a high level of debt may reduce investments due to the difficulty of access to credit and loans; conversely, it may indicate low risk aversion and, consequently, increased investments [46]. The investment model for farms developed by Benjamin and Phimister [47], among others, indicates that the

investment behaviour of farms with significant debt differs significantly from that of other farms. The research by Weersink and Tauer [48] and the model they developed indicated significant delays between the need for investment and incurring actual investment expenditures, which may indicate the often time-consuming acquisition of external funds. Some investments in innovative technologies are realised with an unavoidable delay, as indicated by the current value of investments [49]. Ensuring the attractiveness of investments in the agricultural sector is becoming more and more important under the conditions of the limited financial resources of farms [50]. One of the key elements influencing the attractiveness of investments in agriculture is interactive marketing, which can largely influence investment decisions on farms [51].

Bojnec and Ferto [1], examining Slovenian farms, also rejected the hypothesis that farms with higher technical efficiency invest more than less efficient farms, which could be allowed by an efficiency advantage. This may, however, result from the order of actions taken; those implemented earlier may impact higher efficiency in subsequent years. On the other hand, after implementing significant investments, farms will not always undertake further ones, even if only due to financial constraints and the need to repay liabilities incurred for investments. This was also confirmed by the results of the research conducted by Bojnec and Ferto [1], who showed that the level of debt significantly impacted the size of investments.

Active actions ensuring the high profitability of a business are also a factor ensuring increased investments in agriculture [50]. In this way, it will be possible to develop not only a given farm but also the region and the entire industry [50]. Investment decisions may also affect production and income which, due to the existence of an investment multiplier, may result in a decrease in the value of investment that may result in a several-fold decrease in production or income [52]. Therefore, the development of agriculture requires the creation of mechanisms through agricultural policy that will enable optimal conditions for financing investments. This includes pro-investment support that improves the economic results of farms [53–55] and preferential interest rates on loans [1].

Therefore, farm investments are significant, especially in central and eastern European countries, for which the impulse for their growth was their accession to the EU in 2004 [1]. Especially in Poland, the hope for reversing the unfavourable trend was accession to the European Union and the inclusion of agriculture in the standard agricultural policy. Studies of Polish farms by Latruffe [56] have shown that, at the time of accession to the EU, some farms were forced to finance investments exclusively from internal sources as the costs of debt servicing were too high, where this situation concerned both small and large farms. The lack of agricultural investment in central and eastern European countries may cause difficulties in catching up with western European countries and ensuring appropriate sustainable development in rural areas [1]. Investments in rural areas that influence the level of development of technical infrastructure allow for the optimal use of available resources and, thus, not only economic progress but also the sustainable development of these areas [57]. Investments in these areas improve the gross value added and encourage the use of available resources which, in turn, makes rural areas more sustainable.

Despite pre-accession concerns, many farms have effectively used the opportunity provided by participation in the single European market and the possibility of using EU aid funds. This has been particularly visible in the Wielkopolska province [15,58–61]. Although a farm's funds are the primary source of investment financing [62], an important role is played by funds provided for agriculture from standard agricultural policies. The relationship between agricultural policy and the level of investment is particularly noticeable in central and eastern European countries [63]. Considering the investment needs, it is not without reason that support for farm investments occupies a significant position in the funds of the second pillar in Poland. Studies show that direct payments also form an essential component of the financial assembly for co-financing and pre-financing [64–68]. The general trend did not apply to all farms, and the universal desire of producers to

optimise production factors in order to maximise the economic effect does not mean that there are identical investment behaviours [12].

3. Materials and Methods

To assess the impact of investments on the productivity of production factors in agriculture, the relationship between the improvement of labour productivity and the technical equipment of labour was used [12]. As investments concern fixed assets, the value of fixed capital was assumed as the equipment of labour (i.e., by the FADN definition, farm buildings, machines and equipment, plantings, and animals of the primary herd, reduced by land value (The omission of land results from its specificity as a production factor and, in the context of investment, from the specificity of the land market, especially in the analysed Wielkopolska province. In this region, there is a "land hunger"; that is, the supply is very limited and only a few entities have the opportunity to invest by increasing the area. In addition, the assessment of investments in other assets apart from land can be a measure of capital-intensive intensification of production, understood as an increase in capital outlays on the area of agricultural land. The justification also includes the fact that the measurement of the profitability of production factors concerns the profitability of land separately; therefore, its re-inclusion in the total value of fixed assets would be a kind of duplication in the analysis)).

The average rate of change (ARoC) index expresses annual changes in the parameters studied. This index is used to determine the rate of change in the value of a feature based on all terms of the time series, calculated as follows [69]:

$$ARoC = \frac{-3m + \sqrt{9m^2 + 24m(n-1)\left(\frac{1}{y_1}\sum_{t=1}^{n} y_t - n\right)}}{2m(n-1)}100\%$$

where

$y_1, y_2, \ldots, y_t$ are the values of the variable in subsequent periods (years);
n is the number of periods (years);
$m = n(n+1)$.

These calculations were based on unique research material and unpublished unit data on the results of agricultural accounting, "Polish FADN", for all farms (except TF2) in the Greater Poland Voivodeship who had continuously participated in the FADN system from 2009 to 2021. There were 359 such farms. Due to the purpose of this work (i.e., determining the consequences of various scales of investment), three groups of farms were distinguished, depending on the complexity of the investment projects carried out. The comprehensiveness measure (KI) was the ratio of the sum of gross investment expenditures (SE516) to the average annual value of fixed assets (SE441), less than the value of land (SE446) on farms. The surveyed farms were divided into three groups (non-investing means that there was a decrease (decapitalization) in assets as, according to the FADN definition, gross investments are the value of purchased and manufactured fixed assets reduced by the value of fixed assets sold and transferred free of charge in the accounting year ± the difference in the value of the basic herd):

$$KI = \begin{cases} \text{comprehensive, if } \frac{\sum_{t_{2009}}^{t_{2021}} \text{SE516}_t}{\overline{x}(\text{SE441} - \text{SE446})} \geq 50\%, \text{ N} = 97 \\ \text{non-comprehensive, if } \frac{\sum_{t_{2009}}^{t_{2021}} \text{SE516}_t}{\overline{x}(\text{SE441} - \text{SE446})} \geq 0 < 50\%, \text{ N} = 217 \\ \text{non-investing, if } \frac{\sum_{t_{2009}}^{t_{2021}} \text{SE516}_t}{\overline{x}(\text{SE441} - \text{SE446})} < 0, \text{ N} = 45 \end{cases}$$

As the distribution of variables did not meet the assumptions concerning the use of parametric tests (normal distribution and homogeneity of variance), the non-parametric Kruskal–Wallis test was used to demonstrate statistically significant differences in capital

and land resources between the initial and final periods of analysis. The only assumption necessary to apply this test was the randomness and independence of the samples taken from the population, guaranteed by the methodology of selecting farms for research in FADN accounting. The test was performed based on the null hypothesis of the equality of all group means μ (1, 2, . . ., i), H0: μ1 = μ2 = μ3 = . . . = μi, against the alternative hypothesis, H1, that at least two group means differ from each other. Therefore, the alternative hypothesis states at least two populations exist where the compared means differ [70]. The Kruskal–Wallis test statistic has the following form [71]:

$$H = \frac{12}{n(n+1)}\left(\sum_{j=1}^{k}\frac{R_j^2}{n_j}\right) - 3(n+1),$$

where

$n = n_1 + n_2 + \ldots + n_j$,

$(n_1, \ldots, N_j)$ is the number of subsequent attempts,

R_j is the sum of ranks within the sample j.

For samples of no less than five observations (as is the case in this study, with a sample size of 359), the distribution of the H test statistic is well approximated by the chi-square distribution with k − 1 degrees of freedom. Hence, the calculated value of the H test was compared with the critical value of the distribution for the assumed significance level $\alpha = 0.05$ and for k − 1 degrees of freedom, and we made one of two possible decisions:

- If $H < \chi^2_{\alpha,k-1}$, then there are no significant grounds for rejecting H_0;
- If $H \geq \chi^2_{\alpha,k-1}$, then we reject H_0 in favour of H_1.

The analysed differences concerned the resources of the successively analysed factors of production, and the grouping factor was the previously described division into three groups, depending on the complexity of the investment.

As this research aimed to assess the effects of differentiating the scale of investment outlays on the efficiency of using factors of production (i.e., dynamic analysis), the significance of differences was calculated for the initial and final periods of the analysis. The results for one year would not give a reliable result, due to possible (especially in agriculture) accidentality; therefore, the calculations concerned the average results for the years 2009–2011 for the initial period (T_0) and 2019–2021 for the final period (T_1). Economic values were expressed in constant prices of the last year of the analysis, using the index of changes in the prices of goods and services.

4. Results

4.1. Classification of Farms Due to Complexity of Investments

The research assumption was to divide farms depending on the level of investments accumulated throughout the analysis period and the average state of fixed assets. This ratio was above 50% in farms carrying out comprehensive investments that required systematically incurring investment expenditures at a high level. In absolute values, it was about PLN 125,000 in the first year of analysis; in subsequent years, these expenditures remained at this level with some fluctuations, and the general trend was growing. A comparative analysis of the farm expenditures in the two remaining groups indicated a larger scale of investments. In the group of farms carrying out investments with a total value not exceeding half of the value of assets (non-comprehensive), expenditures were low, about several thousand PLN per year. According to the definition of non-investing, in the last group of entities, there was a decapitalisation of assets (i.e., the sale of fixed assets exceeded investments). This situation, which has persisted for many years, means that these farms cannot operate on the market in the long term, because (as will be shown in the further part of the analysis) their resources and production capacity are shrinking. Moreover, in all groups of farms, it can be seen that the characteristic feature of the scale

of investment expenditure in agricultural farms is large fluctuations (Figure 1), which has also been confirmed by Szymańska et al. [8].

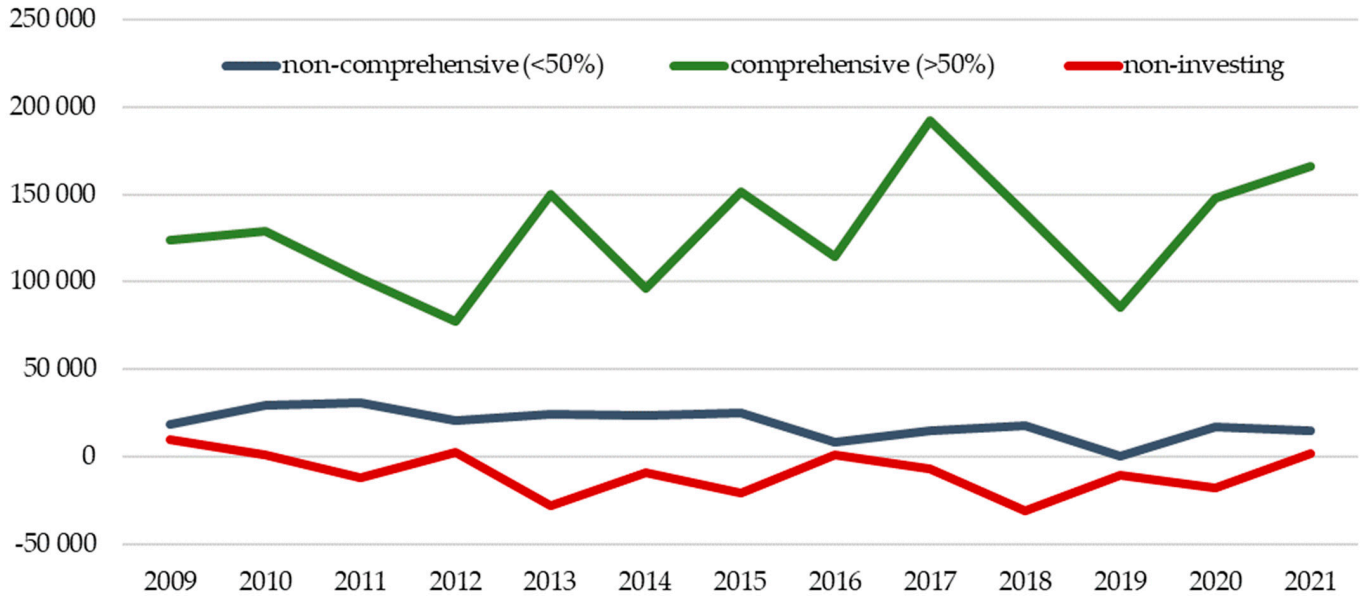

Figure 1. Average value of gross investments (PLN) in farms grouped depending on complexity of investments (N = 359). Source: own study based on unpublished FADN data.

4.2. Resources of Production Factors

In agriculture, the land is the essential resource determining the potential production capacity. Based on the results of the conducted research, it should be noted first that comprehensive investments (i.e., in their most desirable scale about the value of the possessed fixed assets) concerned farms more significantly in terms of the agricultural area (Table 1). Already at the beginning of the analysis period (in 2009), these farms had a larger area (average 38 ha, median 30 ha) than farms included in the other two groups. This difference was statistically significant (Table 1). This confirms the indications of Tey and Brindal [72], in that farmers endowed with a more extensive asset base can invest more. Large-scale farms were more likely to be cost-efficient and could raise capital for expansion and investment purposes. On the other hand, the average size of farms that implemented non-comprehensive investments and did not invest (non-investing) was around 27 ha. In dynamic terms, it can be seen that comprehensive investment allowed farms to increase their area significantly, and the average annual rate of change (ARoC) was 3%. On the other hand, if the sum of investments in the entire analysis period was less than half of the average value of the assets (i.e., the group of non-complex farms), this only allowed for maintaining the area of agricultural land at an unchanged level (ARoC was 0.8%). Farms classified in the non-investing group were in the worst situation. A lack of investment meant the decapitalisation of assets, which also concerned land sale. The area of the agricultural land in 2009–2021 decreased on average by 1.5% per year, from 27 ha to 21 ha.

Similar trends were noted in the change in the value of assets (Table 1). Comprehensive investment made it possible to increase the value of assets (excluding land) by 50%, with an average annual change of around 3%. Farms that invested in the period under review but at a level lower than half of the value of fixed assets reduced the value of capital at their disposal by PLN 11,000 per year (the ARoC was −2.6%). An even more significant decrease, exceeding PLN 16,000 per year, was observed for farms that did not invest (the ARoC was −6.7%). Therefore, maintaining the production capacity of a farm requires investing for a dozen or so years (in the farms under review, it was 13 years) on a scale exceeding the average value of assets by 50%. These conclusions stem primarily from changes in

farms investing below this threshold. While these farms could maintain agricultural land resources, the value of the remaining part of fixed capital decreased by one-third (from PLN 412,000 to PLN 271,000). Thus, the technical equipment of land (i.e., the value of fixed assets per 1 ha) dropped on average from around PLN 15,000 per ha in 2009 to PLN 8700 per ha in 2021 (calculations based on Table 1). For comparison, in farms investing comprehensively, the increase in land resources was accompanied by expenses on other asset components large enough that the technical equipment of the land increased from PLN 19,000 to PLN 20,000 per ha. These positive and necessary changes should lead to an economically practical improvement in the capital–labour and capital–land ratios [73]. In developed countries, increases in farm efficiency have been shown to result from technological progress, changes in the relationship between production factors, and changes in the level of inputs [74]. Investment introduces progress in agriculture through new technologies and modern fixed assets, which usually leads to permanent changes in the relationships between factors of production.

Table 1. Average area (ha), value of fixed assets without land (PLN), and total labour input (AWU *) of farms grouped depending on complexity of investments (N = 359).

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Agricultural Area [ha]													
comprehensive (>50%)	37.7	39.2	40.2	42.1	43.1	47.7	47.1	51.5	52.0	53.0	52.9	51.6	52.7
non-comprehensive (≤50%)	27.6	28.0	28.3	29.4	28.7	28.9	29.0	29.4	29.8	30.1	30.3	29.8	31.0
non-investing	27.3	27.6	27.1	26.8	26.3	25.2	24.2	24.9	23.2	21.8	21.5	21.7	21.4
Total Fixed Assets—Land [PLN * thousand]													
comprehensive (>50%)	718.0	742.6	791.9	776.0	803.7	835.3	879.8	893.8	940.4	976.8	986.8	1028.2	1049.4
non-comprehensive (≤50%)	412.7	396.1	394.0	372.1	361.0	358.4	355.9	346.9	334.2	317.4	297.8	285.8	271.0
non-investing	332.3	299.5	286.0	264.1	238.1	223.8	211.4	197.7	186.1	169.7	156.0	140.3	128.4
Labour Input [AWU **]													
comprehensive (>50%)	2.09	2.06	2.11	2.14	2.19	2.19	1.94	2.20	2.22	2.28	2.27	2.32	2.25
non-comprehensive (≤50%)	1.89	1.89	1.89	1.98	1.97	1.97	1.81	1.93	1.88	1.92	1.79	1.78	1.76
non-investing	1.74	1.70	1.73	1.77	1.75	1.72	1.65	1.73	1.68	1.60	1.50	1.45	1.46

* EUR 1 = PLN 4.2791 (exchange rate as of 30 September 2024); ** Annual work unit (AWU) is full-time equivalent of employment. Source: own study based on unpublished FADN data.

Regarding changes in labour resources, only investment at an appropriate level and an increase in fixed capital resources allowed for increased employment. Therefore, it was observed only in the case of farms investing comprehensively (Table 1). Farms investing on a smaller scale reduced employment from 1.89 to 1.76. Although this scale of change seems small, it is only apparent. Changes in the scale of employment are a long-term process of slow transformation, and the marked trend is significant. An even deeper reduction concerns labour resources in non-investing farms. Considering the previously indicated decreases in land and capital resources, this, in combination with labour, means a general withdrawal of these entities from the market.

4.3. Profitability of Production Factors

The profitability of production factors is a crucial element in assessing the situations of economic entities. For Polish farms, it is several times lower than that observed in more-developed EU countries [75,76]. Therefore, farmers should focus on improving the efficiency of farming, which would favour an improvement in income [77]. The measure of

economic effects on farms is the income from the family farm. As in any economic entity, its maximisation is the primary function of economic activity. In comparative analysis, comparing income in absolute values is imperfect. Only a relative reference is appropriate, namely with respect to factors whose involvement results in income creation. For the analysed groups of farms, the earlier diagnosis of changes in the resources of production factors was not without significance, as only together could changes in the profitability of production factors be assessed (Table 2).

Table 2. Profitability (measured by family farm income) of production factors of farms grouped depending on complexity of investments (N = 359).

Wyszczególnienie	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	ARoC
Profitability of Land [PLN * thousand/ha]														
comprehensive (>50%)	3.2	3.9	4.4	4.3	4.3	4.2	3.3	3.8	4.8	4.0	4.9	5.3	6.5	4.5
non-comprehensive (≤50%)	2.5	2.9	3.1	3.2	3.0	2.7	2.4	2.9	3.7	2.8	3.1	3.1	4.0	2.6
non-investing	1.9	2.5	2.6	2.7	2.4	2.4	1.8	2.0	3.0	2.4	2.6	2.6	3.0	3.5
Profitability of Capital [PLN/PLN]														
comprehensive (>50%)	0.24	0.28	0.30	0.31	0.31	0.32	0.26	0.31	0.36	0.31	0.35	0.35	0.41	3.8
non-comprehensive (≤50%)	0.26	0.30	0.32	0.36	0.35	0.32	0.30	0.35	0.43	0.38	0.43	0.44	0.58	5.1
non-investing	0.24	0.32	0.34	0.37	0.38	0.37	0.32	0.36	0.49	0.44	0.47	0.52	0.63	7.3
Profitability of Labour [PLN thousand/AWU **]														
comprehensive (>50%)	57.4	74.9	83.3	85.3	83.9	91.2	78.8	90.2	113.3	94.2	113.2	116.9	152.0	7.2
non-comprehensive (≤50%)	36.9	43.0	46.4	48.1	44.5	40.3	38.7	43.9	57.9	44.0	52.0	51.8	69.6	3.6
non-investing	30.0	40.7	40.8	40.5	36.3	34.5	26.0	28.5	41.3	33.1	37.3	38.4	43.7	2.7

* EUR 1 = PLN 4.2791 (exchange rate as of 30 September 2024); ** Annual work unit (AWU) is full-time equivalent of employment. Source: own study based on unpublished FADN data.

The obtained profitability results (Tables 2 and 3) correspond to the conclusions from the assessment of resources (Table 1). The change in labour profitability is crucial as it measures the remuneration of a farmer as an entrepreneur and owner of production factors. Thus, it allows for the assessment of the quality of the management of production factors at the farmer's disposal. As a result of the analysis, the most significant increase in labour profitability was characteristic of farms that invested comprehensively. The managers of these farms managed to triple their profitability in 13 years, and the average rate of change was 7.2; notably, these were much higher results than those in the other groups. This difference was statistically significant (Table 3) in the first years of the analysis (average for 2009–2011) and even more so in the recent period (average for 2019–2021). This means that farms made large-scale investments in the assets held (comprehensive) and managed more efficiently and, over time, their advantages in this respect increased. It is also visible (Table 2) that the profitability of fixed assets in all three distinguished groups of farms was similar for the T_0 period (there were no statistically significant differences; Table 3), and the changes for farms investing comprehensively were the slowest, and in the final period (T1), the profitability of capital was the lowest. However, this was not a surprising and negative result because, simultaneously, the scale of fixed asset growth was the largest for these entities. Despite this, they maintained an improvement in the income and profitability of fixed assets, although the latter was relatively minor. The change in the profitability of land and the changes in land resources even more clearly illustrate this point. It turns out that farms implementing comprehensive investments had a larger area at the beginning and increased this resources the most (Table 1), but this was accompanied

by such a significant positive change in income that ultimately (T_1) the profitability of the land was the highest (Table 2), where the differences with respect to the other two groups of farms were statistically significant (Table 3).

Table 3. The results of the Kruskal–Wallis variance analysis test for the profitability of land, capital, and labour in the two measurement periods: T_0 and T_1 (N = 359).

Kruskal–Wallis Test T_0 (2009–2011)			**Kruskal–Wallis Test Mean T_1 (2019–2021)**		
Land Profitability					
H(2, N = 359) = 26.7218; p = 0.0000			H(2, N = 359) = 51.0161; ***p* = 0.0000**		
Farm groups	**Comprehensive** (Me * = 3645)	**Non-investing** (Me = 2506)	Farm groups	**Comprehensive** (Me = 5422)	**Non-investing** (Me = 2515)
Non-comprehensive (Me = 2411)	0.000007	0.974138	**Non-comprehensive** (Me = 2970)	0.000000	1.000000
Comprehensive (Me = 3645)	-	0.000132	**Comprehensive** (Me = 5422)	-	0.000000
Fixed Assets Profitability (Excluding Land Value)					
H(2, N = 359) = 1.0788; p = 0.5831			H(2, N = 359) = 12.0495; p = 0.0024		
Farm groups	**Comprehensive** (Me = 0.21)	**Non-investing** (Me = 0.18)	Farm groups	**Comprehensive** (Me = 0.30)	**Non-investing** (Me = 0.40)
Non-comprehensive (Me = 0.20)	0.897355	1.000000	**Non-comprehensive** (Me = 0.37)	0.046712	0.186287
Comprehensive (Me = 0.21)	-	1.000000	**Comprehensive** (Me = 0.30)	-	0.002585
Labour Profitability					
H(2, N = 359) = 36.2715; p = 0.0000			H(2, N = 359) = 69.1780; p = 0.0000		
Farm groups	**Comprehensive** (Me = 57,430)	**Non-investing** (Me = 31,478)	Farm groups	**Comprehensive** (Me = 113,199)	**Non-investing** (Me = 34,801)
Non-comprehensive (Me = 33,885.9)	0.000000	1.000000	**Non-comprehensive** (Me = 45,053)	0.000000	0.165923
Comprehensive (Me = 57,430)	-	0.000040	**Comprehensive** (Me = 113,199)	-	0.000000

* Me = median. Source: own study based on unpublished FADN data.

4.4. The Relationship Between the Dynamics of Changes in Production Techniques and Farm Production and Income

Bezat-Jarzębowska and Rembisz [12] assumed that the condition determining changes in income in agriculture is the improvement of the efficiency of using production factors. The decisive factor here is, of course, the improvement in labour productivity. Linking labour resources with capital resources in a dynamic approach gives an increase in technical equipment ($\Delta K/\Delta L$) and leads to an increase in labour productivity. The measurement of the effect can be expressed in the form of production (i.e., labour productivity; $\Delta P/\Delta L$) or income (i.e., labour profitability; $\Delta D/\Delta L$). The differentiations of these relations for farms, grouped depending on the scale of investment, are presented in Figures 2 and 3. Based on theoretical assumptions, labour productivity increases with an increase in technical equipment. Of course, the response of labour productivity will be stronger than that of profitability, as the measurement of production value is not burdened with the values subsequently taken into account (e.g., the costs of using external factors, production costs, general economic costs, and taxes), which lead to the calculation of income as the final result category.

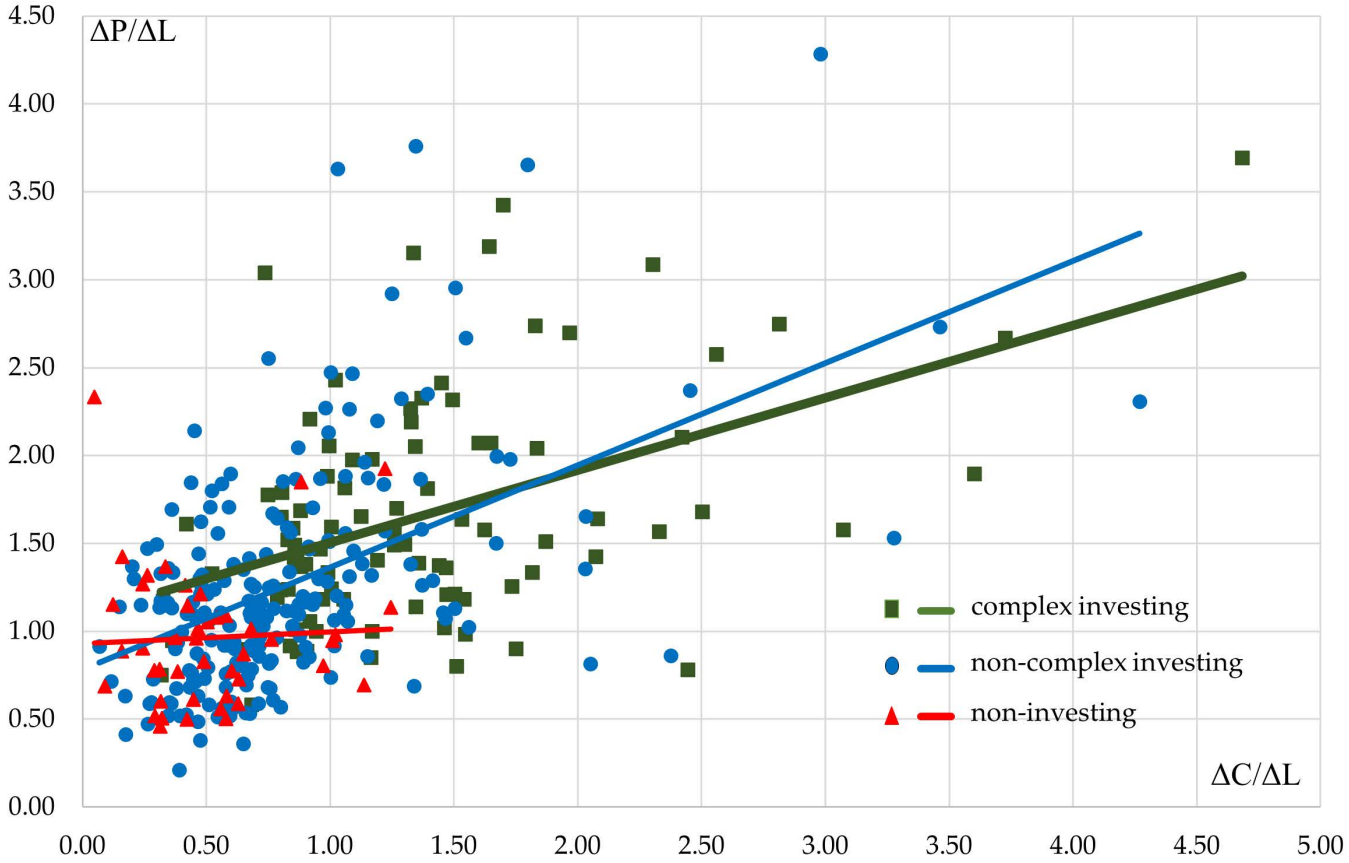

Figure 2. Relationships between the dynamics of changes in production technology (ΔC/ΔL) and the productivity of the labour factor measured by production (ΔP/ΔL). Source: our own study based on unpublished FADN data.

In order to illustrate the phenomena studied, full studies were conducted (i.e., considering all farms in the FADN database for the selected region). In this situation, outliers should be expected, due to the diversity of situations in individual farms. Further division into types of farming or other detailed classifications could lead to a reduction in the number of objects studied, potentially below the number required to guarantee statistical confidentiality. Therefore, it was decided to present the results indicating a general tendency in the entire group, and any outliers did not change the general conclusions. With the increase in technical equipment, labour productivity increases, and the strength of this relationship depends on capital productivity. The improvement of labour efficiency in agriculture is positively influenced by the level of investment [78]. Even if the trend between variables in these graphs seems weak, the effects of changes in technical equipment on labour productivity or profitability do not occur dynamically. On farms, even small changes in these relationships can determine the effectiveness of investment decisions. Compared to all three groups of farms, it was characteristic that investments implemented on a comprehensive or a more minor (non-comprehensive) scale, increasing technical equipment for labour was positively correlated with labour productivity. This is in line with the findings of Hamilton et al. [79], who reported that mechanisation complements labour inputs, raising labour productivity, or Onegina et al. [80], who concluded that an increase in the fixed capital per worker caused the growth of labour productivity in agricultural enterprises. The positive relation between the productivity and labour equipment was the smallest for farms for which investments were smaller than their capital depreciation (i.e., non-investing).

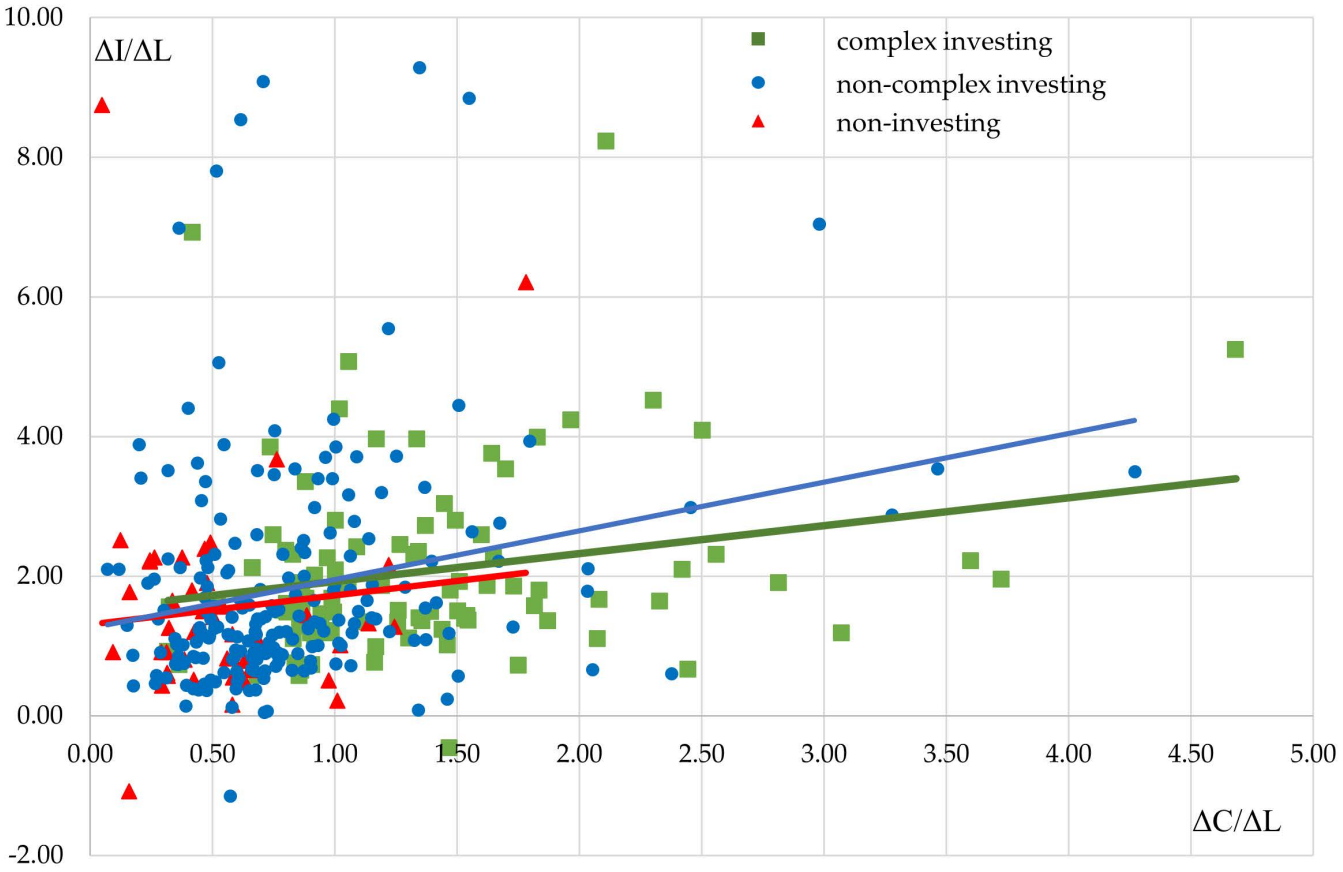

Figure 3. Relationships between dynamics of changes in production technology (ΔC/ΔL) and labour productivity measured by income (ΔI/ΔL). Source: own study based on unpublished FADN data.

5. Conclusions

Increasing the production capacity of farms through investments for the modernisation of production is an essential microeconomic requirement. This is in line with contemporary expectations of production, consistent with the challenges of reducing the impacts of agriculture on the environment and climate and the scarcity of resources, especially land. Investment challenges in the context of Polish agriculture are unique because, as Kusz [65] wrote, the ability of a farm to undertake investments depends to a large extent on its production potential, scale of production, and economic strength, which faces the problem of agrarian solid fragmentation. The obtained research results indicate, taking the Wielkopolska province as an example, a significant diversification of the scale of investment in agriculture. An important conclusion from the analyses is that the initial state of a farm (represented by the value of fixed assets and the area of agricultural land) provides the ability to invest more comprehensively. This effectively allows farms to develop better, which applies to both the potential (land and capital resources) and efficiency of their use (land and labour profitability). In the context of structural changes, it can be seen that the size of a farm, including the resources of the primary production factor—that is, land—allows an appropriately significant and relatively stable investment to be incurred in the subsequent years of operation. Not only is the implementation of investments, in general, essential for the development possibilities of farms but also their scale (with respect to the value of assets).

In farms investing comprehensively, the increase in land resources was accompanied by expenditure on other sufficiently large assets so that the technical equipment of the land increased. Additionally, they were able to increase employment, thus stabilising growth and their market position. Investments of a large scale into the assets held (i.e., comprehensive) were made by farms that managed more effectively and, over time, their

advantages over farms with a lower scale of investment increased. The results prove that employment reductions and land sales also occur in farms where the scale of investment did not exceed the depreciation and sale of part of the assets (i.e., non-investing). This meant a general withdrawal of these entities from agricultural activities.

In the context of the stated goal and hypothesis of this work, it can be assumed that an appropriate starting strength of a farm and only comprehensive investment allow for development, the improvement of work efficiency, and the strengthening of the market position. Further deepening of differences between entities will become a factor that accelerate the emergence of a group of developmental commercial farms. Insufficient investment will cause weaker farms to release work and owned capital but, above all, land will flow to the investing farms. These entities will eventually become the central element of agricultural structures.

Some limitations of this study resulted from its reliance solely on quantitative data regarding basic microeconomic indicators. However, it seems reasonable that it would be crucial to extend them with qualitative data from agricultural farms, which would allow for the identification of not only differences in the effects of investment decisions but also the reasons for the different investment behaviours of agricultural producers. It could turn out that the deterioration of the economic situation of farms results directly from the lack of investments but is also indirectly influenced by other, non-economic factors. Therefore, in subsequent studies, we intend to expand the scope of research to include surveys conducted among the currently surveyed group of farms, which is made possible by the FADN agricultural accounting system. In this way, it will be possible to learn not only the effects of investment activities but also their particular causes.

Author Contributions: Conceptualization, W.C. and K.P.P.; methodology, W.C. and K.P.P.; software, W.C. and K.P.P.; validation, W.C. and K.P.P.; formal analysis, W.C. and K.P.P.; investigation, W.C. and K.P.P.; resources, W.C. and K.P.P.; data curation, W.C. and K.P.P.; writing—original draft preparation, W.C. and K.P.P.; writing—review and editing, W.C. and K.P.P.; visualisation, W.C. and K.P.P.; supervision, W.C. and K.P.P.; project administration, W.C. and K.P.P.; funding acquisition, W.C. and K.P.P. All authors have read and agreed to the published version of the manuscript.

Funding: The publication was financed by the Polish Minister of Science and Higher Education as part of the Poznan University of Life Sciences' Strategy for 2024–2026 to improve scientific research and development work in priority research areas.

Institutional Review Board Statement: Not applicable.

Data Availability Statement: The availability of these data is subject to limitations. The data were obtained from the Farm Accountancy Data Network (FADN) and are available from the authors with permission from the FADN. The data are confidential.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Bojnec, Š.; Fertő, I. Financial constraints and farm investments in Slovenia. *New Medit* **2016**, *15*, 2–9.
2. Femenia, F.; Latruffe, L.; Chavas, J.-P. Responsiveness of farm investment to price changes: Evidence from the French crop sector. *Appl. Econ.* **2021**, *53*, 3972–3983. [CrossRef]
3. Manocha, S.; Bhullar, P.S.; Sachdeva, T. Factors determining the investment behaviour of farmers–the moderating role of socioeconomic demographics. *J. Indian Bus. Res.* **2023**, *15*, 301–317. [CrossRef]
4. Publishing, O. *Policy Framework for Investment in Agriculture in Burkina Faso*; OECD Publishing: Paris, France, 2014.
5. Schulte, H.; Musshoff, O.; Meuwissen, M. Considering milk price volatility for investment decisions on the farm level after European milk quota abolition. *J. Dairy Sci.* **2018**, *101*, 7531–7539. [CrossRef]
6. Kusz, D. Egzogeniczne i endogeniczne uwarunkowania procesu modernizacji rolnictwa. *Rocz. Nauk. Ekon. Rol. I Rozw. Obsz. Wiej.* **2012**, *99*, 53–67. [CrossRef]
7. Wang, S.; Tian, Y.; Liu, X.; Foley, M. How farmers make investment decisions: Evidence from a farmer survey in China. *Sustainability* **2019**, *12*, 247. [CrossRef]
8. Szymańska, E.J.; Dziwulski, M.; Kruszyński, M. Determinants of fixed asset investment in the Polish farms. *Sustainability* **2021**, *13*, 13741. [CrossRef]

9. Kisiel, R.; Babuchowska, K. Nakłady inwestycyjne w gospodarstwach rolnych–ujęcie regionalne. *Rocz. Nauk. Ekon. Rol. I Rozw. Obsz. Wiej.* **2013**, *100*, 62–69. [CrossRef]
10. Bojnec, Š.; Latruffe, L. Financing availability and investment decisions of Slovenian farms during the transition to a market economy. *J. Appl. Econ.* **2011**, *14*, 297–317. [CrossRef]
11. Hüttel, S.; Mußhoff, O.; Odening, M. Investment reluctance: Irreversibility or imperfect capital markets? *Eur. Rev. Agric. Econ.* **2010**, *37*, 51–76. [CrossRef]
12. Bezat-Jarzębowska, A.; Rembisz, W. *Wprowadzenie do Analizy Inwestycji, Produktywności, Efektywności i Zmian Technicznych w Rolnictwie*; Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej-Państwowy Instytut: Warszawie, Poland, 2015.
13. Zinych, N.; Odening, M. Capital market imperfections in economic transition: Empirical evidence from Ukrainian agriculture. *Agric. Econ.* **2009**, *40*, 677–689. [CrossRef]
14. Petrick, M. Empirical measurement of credit rationing in agriculture: A methodological survey. *Agric. Econ.* **2005**, *33*, 191–203. [CrossRef]
15. Kiryluk-Dryjska, E.; Beba, P.; Wojcieszak, M.M. Factors stimulating farmers in applying for the measure "setting up of young farmers" in the Wielkopolskie voivodeship". *Probl. Agric. Econ./Zagadnienia Ekon. Rolnej* **2018**, *4*, 103–116. [CrossRef]
16. Zalewski, K.; Bórawski, P.; Żuchowski, I.; Parzonko, A.; Holden, L.; Rokicki, T. The Efficiency of Public Financial Support Investments into Dairy Farms in Poland by the European Union. *Agriculture* **2022**, *12*, 186. [CrossRef]
17. Kirchweger, S.; Kantelhardt, J. The dynamic effects of government-supported farm-investment activities on structural change in Austrian agriculture. *Land Use Policy* **2015**, *48*, 73–93. [CrossRef]
18. Skevas, T.; Wu, F.; Guan, Z. Farm capital investment and deviations from the optimal path. *J. Agric. Econ.* **2018**, *69*, 561–577. [CrossRef]
19. Kostrowicki, J. Types of agriculture in Poland. A preliminary attempt at a typological classification. *Geogr. Pol.* **1970**, *19*, 99–110.
20. Topolski, J. *Stanisław Borowski Jako Badacz Dziejów Wielkopolski*; Wydział Prawa i Administracji UAM: Poznań, Poland, 1981.
21. Józefecka, M.; Cygan, K. Rozwój przedsiębiorczości na obszarach wiejskich w województwie wielkopolskim Rural entrepreneurship based on the example of the Wielkopolskie Voivodship. In *Ekonomiczne Uwarunkowania Rozwoju Przedsiębiorczości na Obszarach Wiejskich*; Fundacja Programów Pomocy dla Rolnictwa FAPA: Warszawa, Poland, 2009; p. 61.
22. Kisielińska, J. Voivodships ranking according to the potential of agriculture. *Ann. Agric. Econ. Rural. Dev.* **2017**, *104*, 56–71.
23. Pepliński, B. External Costs of Opencast Brown Coal Mining in Agriculture and Agri-Food Industry (on the Example of Wielkopolska). *Cent. Eur. Econ. J.* **2018**, *5*, 154–171.
24. Igliński, B.; Buczkowski, R.; Iglińska, A.; Cichosz, M.; Plaskacz-Dziuba, M. SWOT analysis of the renewable energy sector in Poland. Case study of Wielkopolskie region. *J. Power Technol.* **2015**, *95*, 143–157.
25. Czyżewski, A.; Smędzik-Ambroży, K. Specialization and diversification of agricultural production in the light of sustainable development. *J. Int. Stud.* **2015**, *8*, 63–73. [CrossRef]
26. Serra, T.; Stefanou, S.; Gil, J.M.; Featherstone, A. Investment rigidity and policy measures. *Eur. Rev. Agric. Econ.* **2009**, *36*, 103–120. [CrossRef]
27. Sckokai, P.; Moro, D. Modelling the impact of the CAP Single Farm Payment on farm investment and output. *Eur. Rev. Agric. Econ.* **2009**, *36*, 395–423. [CrossRef]
28. Stutzman, S.A. Differences across farm typologies in capital investment during 1996–2013. *Agric. Financ. Rev.* **2018**, *78*, 41–64. [CrossRef]
29. Ciuła, J.; Generowicz, A.; Oleksy-Gębczyk, A.; Gronba-Chyła, A.; Wiewiórska, I.; Kwaśnicki, P.; Herbut, P.; Koval, V. Technical and Economic Aspects of Environmentally Sustainable Investment in Terms of the EU Taxonomy. *Energies* **2024**, *17*, 2239. [CrossRef]
30. Serrasqueiro, Z.; Mendes, S.; Nunes, P.; Armada, M.D.R. Do the investment determinants of new SMEs differ from those of existing SMEs? Empirical evidence using panel data. *Invest. Anal. J.* **2012**, *41*, 51–67. [CrossRef]
31. Key, N. Off-farm income, credit constraints, and farm investment. *J. Agric. Appl. Econ.* **2020**, *52*, 642–663. [CrossRef]
32. Briggeman, B.C. *The Importance of off-Farm Income to Servicing Farm Debt*; Economic Review; Federal Reserve Bank of Kansas City: Kansas City, MO, USA, 2011; pp. 63–82.
33. Bojnec, Š.; Fertő, I. Farm income sources, farm size and farm technical efficiency in Slovenia. *Post-Communist Econ.* **2013**, *25*, 343–356. [CrossRef]
34. Ji, Y.; Yu, X.; Zhong, F. Machinery investment decision and off-farm employment in rural China. *China Econ. Rev.* **2012**, *23*, 71–80. [CrossRef]
35. Su, W.; Liu, C.; Zhang, L.; Luo, R.; Yi, H. Household-level linkages between off-farm employment and agricultural fixed assets in rural China. *China Agric. Econ. Rev.* **2015**, *7*, 185–196. [CrossRef]
36. Ghosh, P.; Mookherjee, D.; Ray, D. Credit rationing in developing countries: An overview of the theory. *Read. Theory Econ. Dev.* **2000**, *7*, 383–401.
37. Guan, Z.; Kumbhakar, S.C.; Myers, R.J.; Lansink, A.O. Measuring excess capital capacity in agricultural production. *Am. J. Agric. Econ.* **2009**, *91*, 765–776. [CrossRef]
38. Hubbard, R.G. Capital-market imperfections and investment. *J. Econ. Lit.* **1998**, *36*, 193–225. Available online: https://www.jstor.org/stable/2564955 (accessed on 28 November 2024).
39. Chirinko, R.S. Business fixed investment spending: Modeling strategies, empirical results, and policy implications. *J. Econ. Lit.* **1993**, *31*, 1875–1911.

40. Shute, L.L. Building a Future with Farmers. 2011. Available online: https://www.youngfarmers.org/building-a-future-with-farmers-october-2011/ (accessed on 28 November 2024).
41. Hertz, T. The effect of nonfarm income on investment in Bulgarian family farming. *Agric. Econ.* **2009**, *40*, 161–176. [CrossRef]
42. Lansink, A.O.; Verstegen, J.; Van den Hengel, J. Investment decision making in Dutch greenhouse horticulture. *NJAS-Wagening. J. Life Sci.* **2001**, *49*, 357–368. [CrossRef]
43. O'Toole, C.M.; Newman, C.; Hennessy, T. Financing constraints and agricultural investment: Effects of the Irish financial crisis. *J. Agric. Econ.* **2014**, *65*, 152–176. [CrossRef]
44. Zhengfei, G.; Lansink, A.O. The source of productivity growth in Dutch agriculture: A perspective from finance. *Am. J. Agric. Econ.* **2006**, *88*, 644–656. [CrossRef]
45. Bakucs, L.Z.; Fertő, I.; Fogarasi, J. Investment and financial constraints in Hungarian agriculture. *Econ. Lett.* **2009**, *104*, 122–124. [CrossRef]
46. Gardebroek, C.; Lansink, A.G.O. Farm-specific adjustment costs in Dutch pig farming. *J. Agric. Econ.* **2004**, *55*, 3–24. [CrossRef]
47. Benjamin, C.; Phimister, E. Transaction costs, farm finance and investment. *Eur. Rev. Agric. Econ.* **1997**, *24*, 453–466. [CrossRef]
48. Weersink, A.J.; Tauer, L.W. Comparative analysis of investment models for New York dairy farms. *Am. J. Agric. Econ.* **1989**, *71*, 136–146. [CrossRef]
49. Musshoff, O.; Hirschauer, N. Adoption of organic farming in Germany and Austria: An integrative dynamic investment perspective. *Agric. Econ.* **2008**, *39*, 135–145. [CrossRef]
50. Davydenko, N.; Titenko, Z.; Koval, V.; Skrypnyk, H. Investment trends in the development of the agricultural economy sector. In *BIO Web of Conferences*; EDP Sciences: Les Ulis, France, 2024; p. 01028.
51. Koval, V.; Kovshun, N.; Plekhanova, O.; Kvitka, S.; Haran, O. The role of interactive marketing in agricultural investment attraction. *Int. Multidiscip. Sci. GeoConference SGEM* **2019**, *19*, 877–884.
52. Koval, V.; Hrymalyk, A.; Kulish, A.; Kontseva, V.; Boiko, N.; Nesenenko, P. Economic policy of industrial development and investment approach to the analysis of the national economy. *Stud. Appl. Econ.* **2021**, *39*. [CrossRef]
53. Czubak, W.; Pawłowski, K.P. Sustainable economic development of farms in Central and Eastern European Countries driven by pro-investment mechanisms of the Common Agricultural Policy. *Agriculture* **2020**, *10*, 93. [CrossRef]
54. Pawłowski, K.P.; Czubak, W.; Zmyślona, J.; Sadowski, A. Overinvestment in selected Central and Eastern European countries: Production and economic effects. *PLoS ONE* **2021**, *16*, e0251394. [CrossRef]
55. Czubak, W.; Pawłowski, K.P.; Sadowski, A. Outcomes of farm investment in Central and Eastern Europe: The role of financial public support and investment scale. *Land Use Policy* **2021**, *108*, 105655. [CrossRef]
56. Latruffe, L. The impact of credit market imperfections on farm investment in Poland. *Post-Communist Econ.* **2005**, *17*, 349–362. [CrossRef]
57. Lazarova, E.; Pavlov, P.; Petrova, M.; Shalbayeva, S. Analysis and assessment of infrastructural potential in rural territories. *Econ. Ecol. Socium* **2023**, *7*, 1–14. [CrossRef]
58. Adamowicz, M.; Szepeluk, A. Regional convergence of labour productivity in rural sectors in the context of funds obtained for agriculture from the European Union. *Probl. Agric. Econ.* **2018**, *356*, 168–191. [CrossRef]
59. Biczkowski, M. Fundusze unijne jako czynnik rozwoju regionalnego w odniesieniu do koncepcji rozwoju neoendogenicznego. *Stud. Obsz. Wiej.* **2013**, *34*, 71–85.
60. Kołodziejczak, A. Znaczenie funduszy UE w rozwoju wielofunkcyjności rolnictwa w województwie wielkopolskim w latach 2004–2014. *Rozw. Reg. I Polityka Reg.* **2016**, *36*, 131–144.
61. Wicki, L.; Pietrzykowski, R. Regionalne zróżnicowanie wykorzystania środków z programów Wspólnej Polityki Rolnej na modernizację rolnictwa. *Rocz. Nauk. Ekon. Rol. I Rozw. Obsz. Wiej.* **2011**, *98*, 7–22. [CrossRef]
62. Marcysiak, A. Źródła finansowania działalności bieżącej i inwestycyjnej gospodarstw rolnych. *Zesz. Nauk. Szkoły Głównej Gospod. Wiej. W Warszawie. Probl. Rol. Światowego* **2009**, *9*, 119–127. [CrossRef]
63. Latruffe, L.; Davidova, S.; Douarin, E.; Gorton, M. Farm expansion in Lithuania after accession to the EU: The role of CAP payments in alleviating potential credit constraints. *Eur.-Asia Stud.* **2010**, *62*, 351–365. [CrossRef]
64. Czubak, W. Ocena dopłat bezpośrednich w gospodarstwach indywidualnych. *Rocz. Nauk. Stowarzyszenia Ekon. Rol. I Agrobiz.* **2006**, *1*, 131–144.
65. Czubak, W. Rozdysponowanie dopłat bezpośrednich w gospodarstwach rolnych korzystających z funduszy UE w Wielkopolsce. *Zagadnienia Ekon. Rolnej* **2008**, *4*, 118–127.
66. Czubak, W.; Jedrzejak, P. Wykorzystanie dopłat bezpośrednich w gospodarstwach rolnych. *Rocz. Nauk. Stowarzyszenia Ekon. Rol. I Agrobiz.* **2011**, *13*, 75–79.
67. Czubak, W.; Kiryluk-Dryjska, E.; Poczta, W.; Sadowski, A. *Wspólna Polityka Rolna a rozwój rolnictwa w Polsce*; Wyd. UP Poznań: Poznań, Poland, 2012.
68. Czubak, W. Zmiany aktywów trwałych w gospodarstwach rolnych o różnej skali inwestycji w województwie wielkopolskim. *Ann. Pol. Assoc. Agric. Agrobusiness Econ.* **2024**, *26*, 38–48. [CrossRef]
69. Wysocki, F.; Lira, J. *Statystyka Opisowa (Descriptive Statistics)*; Akademia Rolnicza: Poznań, Poland, 2003.
70. Stanisz, A. *Przystępny kurs Statystyki: Z Zastosowaniem STATISTICA PL na Przykładach z Medycyny*; Analizy Wielowymiarowe; StatSoft: Hamburg, Germany, 2007.

71. Donocik, M.; Kisiała, B.; Mróz, M.; Detyna, B.; Detyna, J. Przydatność testów nieparametrycznych Kruskala-Wallisa i mediany w długoterminowej ocenie parametrów kruszyw melafirowych. *Res. Pap. Wroc. Univ. Econ./Pr. Nauk. Uniw. Ekon. We Wroc.* **2013**, *309*, 27–41.
72. Tey, Y.S.; Brindal, M. Factors influencing farm profitability. *Sustain. Agric. Rev.* **2015**, *15*, 235–255.
73. Filipiak, T.; Wicki, L. The structure of production factors in farms and their productivity. The case of vegetable farms in Poland. *Roczniki* **2021**, *2021*, 9–19. [CrossRef]
74. Wicki, L. The role of technological progress in agricultural output growth in the NMS upon European Union accession. *Roczniki* **2021**, *2021*, 82–97. [CrossRef]
75. Jabłońska, L.; Filipiak, T.; Gunerka, L. Konkurencyjność kosztowa gospodarstw ogrodniczych w Polsce i wybranych krajach UE. *Probl. World Agric./Probl. Rol. Światowego* **2017**, *17*, 63–72. [CrossRef]
76. Cyburt, A.; Gałecka, A. The efficiency of production factors on agricultural farms of the Visegrad Group. *Zesz. Nauk. SGGW Polityki Eur. Finans. I Mark.* **2020**, *24*, 70–80. [CrossRef]
77. Kusz, B.; Kusz, D.; Bąk, I.; Oesterreich, M.; Wicki, L.; Zimon, G. Selected economic determinants of labor profitability in family farms in Poland in relation to economic size. *Sustainability* **2022**, *14*, 13819. [CrossRef]
78. Kusz, D. Level of investment expenditure versus changes in technical labour equipment and labour efficiency in agriculture in Poland. In Proceedings of the International Scientific Conference" Economic Sciences for Agribusiness and Rural Economy, Warsaw, Poland, 7–8 June 2018.
79. Hamilton, S.F.; Richards, T.J.; Shafran, A.P.; Vasilaky, K.N. Farm labor productivity and the impact of mechanization. *Am. J. Agric. Econ.* **2022**, *104*, 1435–1459. [CrossRef]
80. Onegina, V.; Megits, N.; Antoshchenkova, V.; Boblovskyi, O. Outcome of capital investment on labor productivity in agriculture sector of Ukraine. *J. East. Eur. Cent. Asian Res. (JEECAR)* **2020**, *7*, 12–25. [CrossRef]