EVALUATION OF THE RETURN ON INVESTMENT SUPPORT IN AGRICULTURE USING THE CEM METHOD

***Armands Veveris, Juris Hazners, Elita Benga**
Institute of Agricultural Resources and Economics, Latvia
*Corresponding author's e-mail: armands.veveris@arei.lv

Abstract
The purpose of the study is the assessment of the effectiveness and efficiency of the investment measure M04 'Investments in physical assets' of the RDP (Rural Development Program) 2014-2020 (2022) in Latvia, regarding the economic performance of agricultural farms. To do this, the CEM (Coarsened Exact Matching) method is used. This method was chosen because it is well applicable to a small number of units and pre-support variables. The data panel includes FADN (Farm Accountancy Data Network) units that have received support only under the support measure 'Investments in physical assets', which are compared with the control group. The results obtained indicate a significant impact of support on the improvement of economic indicators of farms. The indicative impact of support is estimated at around 40% of the total labor productivity growth in the reporting period and 60% of the income increase. Compared to non-recipients of support, the largest positive impact is obtained in the group of small farms, as well as in grazing livestock specializations. The average deadweight on investments is 47%. The results of the study and the discussion show that the CEM method can be successfully used in assessing the impact of support, including for smaller groups, and the results obtained can be used in improving support policy.
Keywords: agriculture, support, investment, economics.

Introduction

Since Rural Development Program (RDP) is an essential part of Common Agricultural Policy (CAP) of the EU, RDP evaluation is an essential and necessary component of the Programme implementation to assess the achievement of objectives and the efficiency and effectiveness of the use of public funding. The measure 'Investments in physical assets' is the largest in terms of funding (38% of the total RDP 2014-2020 (2022) funding), as well as with a complex structure, different beneficiaries and investment in five focus areas of three priorities. Therefore, its detailed evaluation is particularly important.

The aim of the work is to assess the effectiveness and efficiency of the investment measure M04 'Investments in physical assets' implemented within the framework of the programme, considering the set objectives and achievable results. The structure of the work is created considering the purpose and format constraints.

In accordance with the aim, the following tasks were set for the work - to evaluate the results of the support of the investment measure; to evaluate the achieved objectives; to provide conclusions and recommendations for further support in achieving similar objectives.

According to the evaluation guidelines, the net value of the indicators must be assessed, i.e. the net impact of the support. Theoretically, it could be determined by subtracting from the actual results of the aid recipients the results that would have been achieved without the aid being evaluated. Since this is not possible in practice, a hypothetical or counterfactual analysis is performed. This is done by matching - the aid recipients are compared with enterprises (farms) that have not received the relevant aid, which are as similar as possible to the aid recipients according to various parameters. To match the aid recipients and non-recipients, the CEM or Coarsened Exact Matching method was chosen for the relevant task of the study (Iacus et al., 2011).

Materials and Methods

One of the most popular methods for causality in observational studies is the Propensity Score Matching (PSM) method developed by Rosenbaum and Rubin (Rosenbaum & Rubin, 1983). It recommends including as many pre-support covariates as possible in the calculation of the propensity score. In contrast, King and Nielsen argue that PSM often increases imbalance, inefficiency, and bias, depending on the model (King & Nielsen, 2019). The CEM was developed by Iacus, King, and Porro (Iacus et al., 2011). According to the authors, CEM generates appropriate solutions that are better balanced and have a smaller mean square error. At the same time, Black et al. points out that CEM can produce very different results from other methods, and the estimated full sample results may not be consistent with the results of subsamples (Black et al., 2020). Comparing the performance of PSM and CEM based on randomized clinical trials, the authors found that both methods produce greater balance of pre-aid covariates while preserving most of the original data. When there are few pre-aid variables, CEM produces satisfactory results (Guy et al., 2021). Since the available FADN data do not have large number of variables with all items having non-zero values, the CEM method was chosen for the purpose of the study. The difference-in-difference method was used to obtain matched recipients and non-recipients and determine the direct effect.

In the data panel, the support group includes FADN units that have received support only and exclusively in the corresponding measure, and the control group includes units that have not received support in any measure. Receiving support is considered a binary support variable, the value of which is 1 for recipients and 0 for non-recipients. Since participation in the

measure is not randomized, there are differences in the pre-support covariates in the support and control groups. To reduce the overall imbalance of covariates, the pre-support covariates are granulated into 'bins'. The user can either choose the bin sizes arbitrarily or use one of the recommended formulas. There are several methods for determining the bin sizes (Scott, 2010), but they are not used this time because the data panel is not that large. Bins are determined arbitrarily. In the data panel, the FADN units that have received support only and exclusively in the corresponding measure are included in the support group, and the control group - units that have not received support in any measure. Receiving support in the M04 measure is treated as a binary support variable, with the value 1 for recipients and 0 for non-recipients. Since participation in the measure is not randomized, there are differences in pre-support covariates between the support and control groups. To reduce overall covariate imbalance, pre-support covariates are granulated into strata.

The initial data panel includes 270 non-recipient and 337 beneficiary units. The group of beneficiaries includes those farms in the FADN cluster that have received support under sub-measures M04.1 or M04.3 by the end of 2020 (so that the support effect would have been manifested by 2022). In turn, the group of non-recipients includes those farms in the FADN cluster that have not received any investment support (including in other measures) during the entire period under analysis (2014-2022).

Since automated software is not used in the calculations, a simple distribution of covariates into three groups is chosen for granulating pre-support covariates in strata. The first group (crop growing) includes units specializing in field farming, vegetable growing, mixed crop growing, and growing permanent crops. The second group includes dairy farms. The third group (other livestock) includes farms specializing in grazing livestock, mixed cropping and livestock, mixed livestock, pig farming and poultry farming.

The size groups of farms are also created differently, with three strata including farms of two adjacent size groups. Under small farms we assume farms with Standard Output (SO) from 4,000 to 25,000 EUR, medium farms – SO from 25,000 to 100,000 EUR, and large farms – those with SO more than 100,000 EUR.

The calculations have been made using individual FADN data for the years 2014-2022. The initial data panel with 607 units is divided into 151 strata. After excluding the unsuitable strata from the granular data panel, 57 strata with 193 non-recipient units and 255 beneficiary units are retained for further calculations.

The analysis of the results of the beneficiaries and the control group has been carried out using the Austrian experience in the evaluation of the RDP 2007-2013 measure no. 121 (European Commission, 2014).

Farm characteristics used to compare the beneficiary group with the control group: Type of farming; farm size group; standard output; labour input; net turnover; output.

The main indicator used to measure the impact of the support is the increase in labour productivity (R2), which is calculated as the output of agricultural products per full-time employee (FTE). The increase in the farm's net income is used as an additional indicator. The increase in labour productivity for all supported farms is calculated using the characteristics of the entire beneficiary group according to the Rural Support Service (RSS) data - average agricultural product output and average labour consumption in full-time units (before the project, as well as the calculated increase). This corrects for the shift that would occur due to the fact, that the average size of farms in the FADN group is approximately 20% larger than in the entire beneficiary group according to the RSS data. The calculated total output of the supported farms both before and after the support is divided by the total labour force utilization in them, thus obtaining the average labour productivity in the beginning and end year in the group of supported farmers. By applying the previously calculated % ratio between the increase in labour productivity of the supported farmers and non-supported farmers to this, the impact of the support is calculated. The impact of the support at the national level is assessed by applying the impact at the level of the beneficiaries to the entire agricultural sector of the country in proportion to the number of employees.

The changes in net income in the entire set of supported farms are calculated using data on the total income of farmers in the country (from Economic Accounts for Agriculture – EAA), dividing it by the share of supported farms. Income in supported farms before the support is obtained by taking data on one average farm from the assimilated FADN set, applied to the entire number of beneficiaries, before making a correction proportional to the differences in the value of agricultural output in the RSS data and the FADN set (coefficient 0.77). Incomes in supported farms after support were obtained by applying a coefficient obtained from calculations, which shows by how much percentage the income of the beneficiaries of support grew faster than in all farms.

The effectiveness of the support is analysed by comparing the results obtained for the beneficiaries against the same indicators for the non-beneficiaries (%), which is equivalent to the increase in a certain result indicator for the group of beneficiaries compared to the increase in the same indicator for the control group. In addition, we analyse the percentage structure of the increase obtained (what % of the increase can be attributed to the support of the specific measure).

The efficiency of the support is calculated as the ratio between the achieved result indicator value and the corresponding amount of support paid. The support paid in this calculation is included until the end of 2020, because the assessment was made with 2022 data. It is done for assessing the impact of the support provided, although the time frame when it manifests itself may vary depending on the sector.

The second indicator used to assess the efficiency of

the support is the deadweight. This means what proportion of farms would have made similar investments if the support had not been granted. This indicator is also calculated by evaluating the matched groups of beneficiaries and non-beneficiaries and evaluating the amount of investment made in them before and after the support period.

Results and Discussion

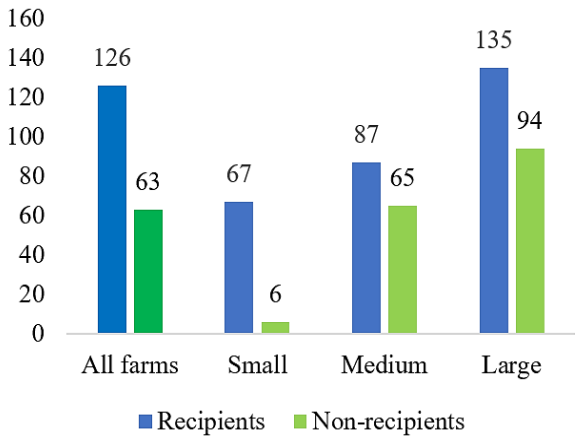
The percentage changes in labour productivity, comparing recipients and non-recipients of support, are summarized in Figure 1. Since the goal was to increase the competitiveness of especially small and medium-sized farms, the impact of support has also been assessed in farm groups.

Expressing the impact of support as a percentage of the results of farms that did not receive support, it can be concluded that the largest impact was in the small farm group, where the impact of support accounted for 91% of the total increase in labour productivity in the reporting period. In medium-sized farms, labour productivity has also increased significantly for those who did not receive support, therefore the importance of investment support in the medium-sized farm group is significantly lower – only 25%. In turn, large farms have the fastest growth in both groups, and it is precisely the growth in the large farm group that has contributed the most to the growth of the average indicators of all farms. It should be noted that the results in the farm groups can only be assessed indicatively, since there are few representatives in the small farm recipient group and the large farm non-recipient group, therefore their representativeness is limited.

The efficiency of the support at the farm level is calculated by applying the estimated increase in output for all beneficiaries (481 million EUR) to the total support paid out up to and including 2020 (354 million EUR). This means that 1 EUR of support has resulted in an increase in output of 1.36 EUR, while also slightly increasing employment. In turn, the increase in labour productivity per 1 EUR of support is 32 cents per FTE, i.e. the effectiveness is 32%.

Figure 1

Changes in agricultural output per work unit depending on the support of the M04 measure by farm size in Latvia (% increase in 2022 compared to 2014)



The relevant numerical indicators in farm size groups are summarized in Table 1. This table also shows the calculations for direct effect of support.

By size group, the efficiency of support in relation to the amount of support paid decreases as the size of farms increases: the highest impact is in the small farm group (1 EUR of support gives an increase of 41 cents), in the medium-sized farm group, it is 25 cents, but in the large group, it is only 15 cents per 1 EUR of support.

By applying the increase in labour productivity affected by the support to the agricultural sector of the entire country, we obtain that the total increase in labour productivity due to the support has increased by 8.3 thousand EUR per FTE, or 41% of the total increase.

Table 1

Increase in labour productivity due to investment support in Latvia on average FADN farm by size

Farm group	Output EUR/AWU			Average support, EUR
	2014	2022	Increase (2022-2014)	
	SO 4000 - 25 000 EUR			
Recipients	15114	25322	10208 (67%)	22326
Non-recipients	15410	16564	1155 (6%)	
Support effect %			**91%** (67-6)/67	**41%**
	SO 25 000 - 100 000 EUR			
Recipients	31212	58534	27322 (87%)	32241
Non-recipients	29115	48252	19137 (65%)	
Support effect %			**25%** (87-65)/87	**25%**
	SO over 100 000 EUR			
Recipients	55808	131586	75778 (135%)	158860
Non-recipients	46974	91581	44607 (94%)	
Support effect %			**30%** (135-94)/135	**15%**

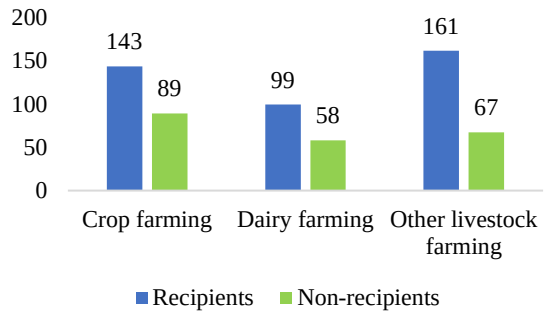
According to the calculation, on average, each 1 million EUR of support under this measure increases labour productivity in agriculture by 23.5 EUR per FTE. Since the indicator R2 (change in output per full-time employee) was introduced only in this programming period, there is a lack of correct comparisons, including with the RDPs of other countries. Indicatively, considering the contribution of this one measure to the total CAP support, the overall results of the measure in terms of the increase in the indicator R2 can be assessed positively.

Similarly, the relationship between the impact of support and farm specialization has been assessed, creating three main groups.

Calculations show that the impact of support, both in percentage and to compare with non-recipients, is higher in the livestock farming group, which includes grazing livestock, pig farming and poultry farming, as well as mixed farms. The impact of support assessed in this group is 58% of the total increase in labour productivity. In dairy farming it is 41%, while in the crop farming group it is 38%. This indicatively shows that it is economically efficient to set livestock farming as one of the investment support priorities. Farms in this group are on average smaller than in other groups. However, in general, the differences between the three analysed groups are not very significant. Due to the small number of representatives in the FADN sample, it is not possible to separate fruit and vegetable farms; therefore, in this classification, they are counted together with agricultural farms, Figure 2.

Figure 2

Changes in agricultural output per work unit depending on the support of the M04 measure by specialization in Latvia (% increase in 2022 compared to 2014)



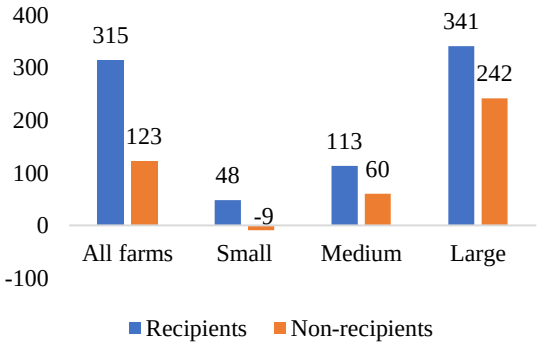
Since output alone does not provide a complete picture of the effectiveness of support, additional indicators have been selected. This assessment looks at changes in net income and the weight of long-term investments. Changes in net income of farms due to support are summarized in Figure 3. The calculation is for one average farm in the entire FADN sample total and within each group.

The results show that on average, the income of one support recipient has increased significantly faster than that of a non-recipient between 2014 and 2022.

It is estimated that 61% of the increase in income can be attributed to the impact of M04 support. When the results obtained are applied to all beneficiaries, we obtain that on average, income has increased by 78,7 thousand EUR in one farm due to support over the entire period, or by 9,834 EUR per year. When the achieved increase in income is attributed to public funding, we obtain that the effectiveness of the support is 78%, or 1 EUR of support has resulted in 0.78 EUR of increase in income in the net income of agricultural holdings. The results of the calculations, broken down by SO groups, show that the percentage of income increase attributable to support decreases rapidly as the size of the holdings increases. In the group of small farms, the impact of support is even more than 100% of the increase in income, because without support, income has decreased. In the group of large farms, however, only 29% of the increase in income can be explained by the impact of support. In contrast, total income growth becomes faster as farm size increases.

Figure 3

Changes in net income depending on the support of the M04 measure by farm size in Latvia (% increase in 2022 compared to 2014



This means that although investment support is a very important factor for income growth in small farms, the increase is still significantly smaller than in large farms even without support. The effectiveness of support in terms of income growth also increases with the size of the farms. According to the calculation, 1 EUR of support increased income by 21 cents in small farms, by 31 cents in medium farms, and by 56 cents in large farms. These results should be evaluated with caution due to the small sample, but they show that in terms of income growth, the return is greater with increasing farm size. Since the obtained trend is different from the increase in output, it is related to the ability of large farms to reduce costs more effectively, as well as to the distribution of subsidies. In turn, the results in the main specialization groups indicate that the percentage significance of support was greatest in other livestock farms, where support contributed to 87% of the total income increase. In turn, the fastest income growth is

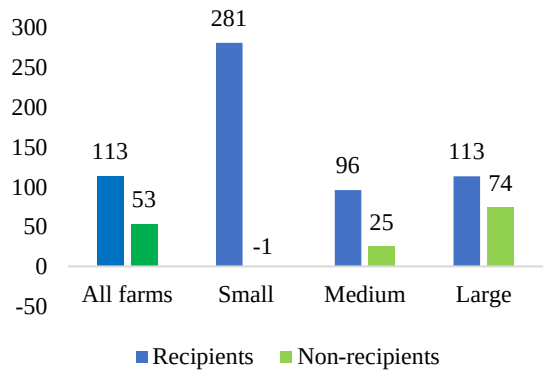
in crop farms, but this occurred for both recipients and non-recipients, so the support has contributed to only 34% of the total income growth. In dairy farms, this figure is 41%. Applying the obtained results to all recipients, we obtain that the impact of the M04 measure support can be assessed at 276 million EUR on farmers' income in 2022, which constitutes 29% of the total income value in this year and 57% of the income growth compared to 2014. It can be provisionally concluded that at the national level, M04 support has had a very significant positive impact on farmers' income, as it accounts for the majority of the entire increase in farm income.

An important indicator that shows the importance of support is the loss of deadweight. For this purpose, long-term changes in investments depending on the receipt of support are calculated. For the entire set of farms, the average deadweight (the proportion of investments that would have been made even without support) is calculated to be 47%. Such a loss of deadweight indicates that almost half of the investments would have been made even without support, or more than half of the investments would not have been made without support.

The division into three farm size groups in Figure 4 shows that the deadweight is significantly affected by the size of the farms.

Figure 4

Changes in long-term investments depending on the farm size and the M04 measure support in Latvia (% increase in 2022 compared to 2014)



The smaller the farms, the more important the role of support in promoting investments. The deadweight is calculated by dividing the indicators of farms operating without support in the relevant group by the indicators of supported farms.

In the group of small farms (size groups 1-2), the deadweight is 0, because the amount of capital investments has decreased for farms operating without support, so all additional investments were made with support. For medium-sized farms (size groups 3-4), the deadweight is estimated at 26%, which is also small, but in the group of large and very large farms – 65%. This means that in this group two-thirds of the investments would have been made even if the support had not been granted.

Thus, it is possible to conclude that agricultural output per FTE in supported farms has increased, and approximately half of this increase can be attributed to the support of the M04 measure. Although in absolute terms the output increase is faster in large farms, the importance of the possibility of receiving support for making investments for small farms is significantly higher. In the division by specialization, the specialization of grazing livestock can be distinguished as one in which support is required for investment. The presence of support for other specializations increases investment activity, however, they are partly carried out without investment support.

Compared to a similar study conducted in Latvia 10 years ago (Veveris, 2014), the economic return of large farms has improved; however, the context should be considered – differences in the changes in the general economic situation before and after receiving support, as well as differences in research methods. However, the trend that the return on support is higher in small and medium-sized farms persists.

In Slovakia, when assessing with the Conditional Difference in Differences (CDID) method, it was found that productivity of both beneficiaries and non-beneficiaries of the investment support slightly decreased over time. They found mixed evidence of investment support net effects on farm performance indicators. The authors suggest that investment support in Slovakia should be redesigned to target smaller farms with low capital endowment (Bartova & Hurnakova, 2016).

An example of the application of quasi-experimental methods for the assessment of Polish investment support is in the work of the Institute of Agricultural and Food Economics (Pawlowska et al., 2018). For matching, the different variables are used – economic size, type of farming, education and age of farmer, etc. The PSM method is used. The results show an increase in labour productivity under the support in terms of GVA per FTE by 44,000 PLN per FTE (about 10,000 EUR per FTE. Although no direct percentage effect has been calculated, this is still a significant effect.

A Czech study (Medonos et al., 2012) points out the importance of support in the economic development of farms, while noting possible significant deadweight. However, the situation in the Czech Republic is different from Latvia, as only a small part of the total investment volume is financed from European funds.

Since those studies were conducted for the previous period, the analysed indicators also differ. Previously, the main indicator was Gross Value Added (GVA), and productivity was measured as GVA per FTE. Since the indicators were changed in the currently evaluated program, the results are not directly comparable.

Conclusions

1. The effectiveness of the support on the competitiveness of the entire agricultural sector is significant. The support has contributed to approximately half of the total income and labour productivity growth in the RDP 2014-2020 (2022) period in Latvia.
2. The increase in labour productivity (R2) due to the support is estimated at 61% in medium-sized farms, 25% in medium-sized farms, and 41% in large farms. There is almost no growth for small farms operating without support, but there is an increase for medium-sized and especially large farms also among those not receiving support.
3. As a result of measure M04, the volume of long-term investments in agricultural farms has grown more than twice, compared to the hypothetical situation if this type of support had not been granted.
4. The efficiency of the support for investments in agricultural farms is assessed as high. 1 EUR of support has resulted in an average increase in production output of 1.36 EUR in supported farms in 2022, as well as an increase in net income of 0.78 EUR.
5. Labor productivity (output per full-time employee) in supported farms has increased by 0.32 EUR per 1 EUR of support. Of these, the highest increase is in small farms - 0.41 EUR.
6. The average loss of self-weight (% of investments that would have been made even without support) is 47%. Including in farms with SI up to 100 thousand EUR it is 21%, which means that 4/5 of investments would not have been made without support.
7. Support for investments is particularly important in the specialization of grazing livestock, both in attracting investments and in promoting income. However, it also plays an important role in other specializations.
8. Studies conducted in other countries generally confirm the positive impact of investment support on the economic performance of farms, however, due to different indicators, the results of different programs are difficult to compare. There is a lack of results on the impact of support on different farm groups.

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