Bulgarian Journal of Agricultural Science, 19 (No 5) 2013, 929-938
Agricultural Academy

SELECTED SOCIOECONOMIC IMPACTS OF PUBLIC SUPPORT FOR AGRICULTURAL BIOGAS PLANTS: THE CASE OF THE CZECH REPUBLIC

J. SPICKA and J. KRAUSE
University of Economics, Faculty of Business Administration, Department of Business Economics, 130 67 Prague 3, Czech Republic

Abstract

SPICKA, J. and J. KRAUSE, 2013. Selected socioeconomic impacts of public support for agricultural biogas plants: the case of the Czech Republic. *Bulg. J. Agric. Sci.,* 19: 929-938

The main goal of the article is to assess selected socioeconomic impacts of public support for investments and effects of investments in biogas plants in the CR. The need for this analysis arises from requirements for impact evaluation of public subsidies from the Rural Development Programme. The quantification of economic effects of investment support of biogas plants is based on counterfactual analysis. Propensity score matching (PSM) with Mahalanobis distance was used to create treatment-control matches based on propensity scores and/or observed covariate variables. Mann-Whitney U test was used to compare selected indicators between supported and not supported agricultural enterprises. Regarding economic performance of agricultural enterprises, analysis revealed that investments and investment subsidies targeted at biogas plants have positive effect on EBIT, cash flow and value added per hectare of agricultural enterprises. On the other side, there is no significant impact on ROA, ROE and ROCE even if these indicators have been considered as key indicators of companies' economic performance. Setting up biogas plants does not create any new working positions in most cases, so supported enterprises with biogas plant in operation significantly increased labour productivity compared to companies without biogas plant.

Key words: agricultural biogas plants, counterfactual analysis, investment subsidy, impact evaluation, propensity score matching, Rural Development Programme

Abbreviations: EBIT – Earnings before Interests and Taxes; LPIS - Land Parcel Identification System;
PSM – Propensity Score Matching; ROA – Return on Assets; ROCE – Return on Capital Employed;
RDP – Rural Development Program; ROE – Return on Equity

Introduction

An agriculture biogas plant is an anaerobic digester that converts intentionally grown biomass, secondary crop and livestock materials (incl. bedding) into biogas. A rapid expansion of the biogas plants in the Czech Republic (CR) results from a public support of renewable energy production and it is also a response to the long-term structural changes in agriculture. Investments in biogas plants are important for agricultural enterprises in relation to their own financial capabilities. Therefore, it is important to assess socioeconomic impacts of biogas plant support.

Investments in biogas plants are supported by Rural Development Programme (RDP), namely by measure III.1.1 Diversification into non-agricultural activities and III.1.2 Support for business creation and development. The support is focused on building decentralised facilities for processing and use of renewable energy sources with goal of energetic self-sufficiency of the countryside and fulfilment of the Czech Republic obligations to achieve 8 % energy from renewable sources (Ministry of Agriculture, 2008).

The results by Poeschl et al. (2010) support the development and foster of policies and framework for development of biogas as environmentally friendly energy resource, among a mix of renewable energy sources, hence, compete favourably with fossil fuels to enhance the prospects for expanded utilization.

E-mail: jindrich.spicka@vse.cz; josef.krause@vse.cz

Reise et al. (2012) conducted a survey focused on decision-making behaviour of farmers regarding investments in renewable energy systems that generate energy from biomass and farmers' reactions to investment-support measures. They found that only about half of the amount of the subsidy — as expected according to normative forecast models — is reflected in an increased willingness to invest. Furthermore, farmers who have previously invested in biogas plants show lower investment thresholds and have stronger reactions to the subsidy.

Golusin et al. (2012) worked on the assumption that only economically viable construction and operation can result in long-term sustainability, which is initially the goal when deciding upon such investments. Based on the case study they concluded that the investment in biogas electricity plant could be considered as economically viable and acceptable.

Menind and Olt (2009) were interested in economic incentives of investing in biogas plants in Estonia. They concluded that when the objective of RDP is to support as many projects as possible the obstacle can become the curtailing of these projects for economic reasons, and the fund may become unused, or its means will not be used for establishing biogas factories. Similarly, if to support establishing a smaller number of biogas factories in a range that would be sufficient to attain an optimal investment payoff period these factories would fulfil their objective answering the environmental and energy problems.

New method for assessing the performance of agricultural biogas plants presented Djatkov et al. (2012). The method developed for assessing the overall performance of biogas plants is focused on four assessment aspects: biogas production, biogas utilization, environmental impact and socioeconomic efficiency. Among the assessed biogas plants, the main deficits were related to the aspect of biogas utilization, caused by low level of external heat utilization. By improving this aspect of performance, environmental impact would be minimized and economic efficiency significantly improved.

In the literature, the authors also touched the economic analysis of sub-processes in the production of biogas (e.g. Madlener et al., 2009; Murphy and Power, 2009; Gebrezgabher et al., 2010). However, this article does not deal with detailed technological and economical aspects of biogas production.

The main goal of the article is to assess selected socio-economic impacts of public support for investments and effects of investments in biogas plants in the CR. The need for this analysis arises from requirements for impact evaluation of public subsidies from the Rural Development Programme. The increasing importance of investment subsidies in rural areas and in agriculture as well as measures to improve human capital raise the need for not only qualitative but also quantitative assessment of effects of these public measures. The effects cannot be immediate and are combined with other processes and activities of agricultural enterprises. Therefore, direct measurement of effects is very difficult (Michalek, 2009; Božík, 2012).

According to the EC Guidelines, questions and indicators have to be answered comparing supported with non-supported farms (counterfactual situation), and the previous situation with the resulting situation after the support (Cueto, 2006). The quantification of economic effects of investment support of biogas plants is based on counterfactual analysis. Counterfactual analysis enables evaluators to attribute cause and effect between real interventions and possible outcomes. It compares two groups of farms – farms supported by investments subsidies (and with biogas plant) and farms without investment support (and without biogas plant). The question is whether there are statistically significant differences in effects on some groups of supported enterprises with biogas plant in operation.

The paper is organized as follows. The first part is devoted to data and methods used in analysis. We especially focus on the propensity score marching as the method suitable for setting two similar groups of farms for counterfactual analysis. The second part is devoted to characteristics of supported investments in biogas plants from RDP during 2007 - 2011. The third part describes results of counterfactual analysis. The final section contains conclusions about main findings.

Material and Methods

Data on investment projects in biogas plants was obtained from the Ministry of Agriculture. The database provides information about project assessment process, total investment expenditures, eligible investment expenditures, absolute and relative amount of the investment subsidy, number of newly created working positions, and information about installed power of biogas plants. The database includes data on 142 individual applications approved between 2007 and 2011. This database was linked with information from a database Soliditet - Albertina, which contains data from financial statements of companies in the CR as well as an overview of the company headquarters, industry, number of employees and total turnover. The area of agricultural land was set based on LPIS database (Land Parcel Identification System). Thus, we obtained the basic information about 119 companies whose applications were approved for investment between 2007 and 2011.

For the counterfactual analysis, it was necessary to have one sample of supported agricultural enterprises and sample of agricultural enterprises with similar structural characteristics that were not supported by RDP (2007 – 2013). Because accounting data are available with the lag of t-2, it is possible to use data only for the period 2007 - 2010. Total 56 of 119 supported applicants received payment between 2007 and 2010, so they can be considered as supported and it may be assumed that the investment was put into operation until 2010. Nevertheless, complete full accounting data in 2007 and 2010 are available only for 39 companies. Therefore, it is the basic set of supported subjects for counterfactual analysis (labelled as "participants").

Then, 551 agricultural enterprises without investment support from RDP between 2007 and 2010 and with available full accounting, data in both years were identified. From this group of no participants it was necessary to select companies with similar characteristics as supported companies. The characteristics should express farm size, natural conditions, business activity, number of employees, capital endowment and capital structure in basic year 2007 (i.e. before public intervention). On the other side, characteristics should not include covariates based on economic results (like EBIT, cash flow, value added etc.) because they serve as result indicators for subsequent counterfactual analysis. Following six available structural indicators for matching participants and no participants were selected:

- agricultural land under LPIS (ha) as an indicator of farm size,
- share of permanent grassland as an approximation of natural conditions,
- asset turnover as an indicator of business activity,
- staff costs (thousands CZK) as an indicator of the use of paid labour,
- depreciation and amortization (thousands CZK),
- credit debt ratio as the share of bank loans and financial accommodations to total assets (indicator representing capital structure).

Data matching procedure was used to create treatment-control matches based on propensity scores and/or observed covariate variables. Propensity score matching (PSM) constructs a statistical comparison group that is based on a model of the probability of participating in the treatment, using observed characteristics (Khandker et al., 2010). Ideally, one would match each treatment subject with a control subject (or subjects) that was an exact match on each of the observed covariates. As the number of covariates increases or the ratio of the number of control subjects to treatment subjects decreases, it becomes less and less likely that an exact match will be found for each treatment subject. Propensity scores can be used in this situation to simultaneously control for the presence of several covariate factors. Rosenbaum and Rubin (1983, 1985) introduced the propensity score. The propensity score for subject i ($i = 1,\ldots, N$) was defined as the conditional probability of assignment to a treatment ($Z_i = 1$) versus the control ($Z_i = 0$), given a set (or vector) of observed covariates, x_i. Mathematically, the propensity score for subject i can be express as

$$e(X_i) = pr(Z_i = 1|X_i = x_i) \qquad (1)$$

It is assumed that the Z_i's are independent, given the X's. The observed covariates, x_i, are not necessarily the same covariates used in the matching algorithm, y_i, although they could be. Rosenbaum and Rubin (1985) suggest using the logit of the estimated propensity score for matching because the distribution of transformed scores is often approximately normal. The logit of the propensity score is defined as

$$q(x) = \log\left(\frac{1-e(x)}{e(x)}\right) \qquad (2)$$

Different approaches can be used to match participants and no participants based on the propensity score. Greedy data matching was used for propensity score data matching procedure in this paper (like in Božík, 2012). Several different distance calculation methods are available in the matching procedures. Gu and Rosenbaum (1993) compared the imbalance of Mahalanobis distance metrics versus the propensity score difference in optimal 1:1 matching for numbers of covariates (P) between 2 and 20 and control/treatment subject ratios between 2 and 6. Mahalanobis distance within propensity score callipers was always best or second best, so *Mahalanobis distance within propensity score calipers (no matches outside callipers)* was used in this paper as distance calculation method. P. C. Mahalanobis (1936) suggested Mahalanobis distance.

According to Khandker et al. (2010) the main advantage (and drawback) of PSM relies on the degree to which observed characteristics drive program participation. If selection bias from unobserved characteristics is likely to be negligible, then PSM may provide a good comparison with randomized estimates. To the degree participation, variables are incomplete, the PSM results can be suspect. This condition is, as mentioned earlier, not a directly testable criteria; it requires careful examination of the factors driving program participation.

Table 1 shows results of data matching including mean and standardized differences. One subject of participants was excluded because of extreme values of characteristic variables. After matching, it seems to have really similar control group (Table 1).

After creating group of participants (38 agricultural enterprises) and no participants (38 agricultural enterprises), the

Table 1
Results of PSM – data source for counterfactual analysis

Variable	Units	Group type	Supported	N	Mean	SD	Mean difference	Standardized difference, %
Agricultural land	ha	Before matching	Yes	39	2 117.5	1 209.5	1 019.2	96.28%
			No	551	1 098.3	882.2		
		After matching	Yes	38	2 071.4	1 190.6	152.8	13.96%
			No	38	1 918.6	990.0		
Share of grasslands		Before matching	Yes	39	0.22373	0.23	-0.01542	-5.71%
			No	551	0.23915	0.31		
		After matching	Yes	38	0.22780	0.23	-0.01094	-4.62%
			No	38	0.23874	0.24		
Asset turnover		Before matching	Yes	39	0.57905	0.37	-0.02251	-6.38%
			No	551	0.60156	0.33		
		After matching	Yes	38	0.58006	0.38	0.00758	2.13%
			No	38	0.57248	0.33		
Staff costs	´000 CZK	Before matching	Yes	39	24 247.1	15 642.7	14 532.7	111.88%
			No	551	9 714.5	9 631.8		
		After matching	Yes	38	23 526.1	15 181.6	1 772.0	12.27%
			No	38	21 754.1	13 657.6		
Depreciation and amortization	´000 CZK	Before matching	Yes	39	11 644.3	7 111.6	7 723.6	134.05%
			No	551	3 920.6	3 977.0		
		After matching	Yes	38	11 020.4	6 029.2	970.3	16.56%
			No	38	10 050.1	5 686.0		
Credit debt ratio		Before matching	Yes	39	0.14345	0.10	0.02965	27.56%
			No	551	0.11380	0.11		
		After matching	Yes	38	0.14652	0.10	0.01502	15.58%
			No	38	0.13150	0.09		

Source: Own calculation

next step is to make counterfactual analysis, i.e. to make impact evaluation of investment and investment support in biogas energy. First, the relevant indicators need to be selected. In order to make complex impact evaluation mainly based on financial statements, following indicators of profitability, liquidity, activity, capital structure, value added and productivity were identified as suitable for counterfactual analysis.

A) Indicators of profitability
- Return on assets (ROA) = EBIT/Total assets
- Return on capital employed (ROCE) = EBIT/(Equity + Provisions + Long-term payables + Long-term bank loans)
- Return on equity (ROE) = EAT/Equity
- EBIT per hectare
- Cash flow per hectare = (EAT + depreciation)/hectares

B) Indicators of liquidity
- Current ratio = Current assets/Current liabilities
- Cash ratio = Short-term financial assets/Current liabilities

C) Indicators of activity
- Long-term asset turnover = (Sales of production + Sales of goods)/Fixed assets
- Inventory turnover = (Sales of production + Sales of goods)/Inventory

D) Debt ratios
- Debt ratio = Total debt/Total assets
- Credit debt ratio = Bank loans & overdrafts/Total assets

E) Value added indicators[1]
- Value added per hectare
- Value added per staff costs

F) Other indicators
- Fixed assets per hectare
- Depreciation per hectare
- Sales of production per hectare
- Cost of sales per hectare
- Cost of sales per sales of production

[1] Value added = (Sales of goods – Cost on goods sold) + (Sales of production – Cost of sales)

Counterfactual analysis was processed using difference-in-differences method (DID). The method compares groups of participants and no participants before intervention in 2007, i.e. first difference, and after intervention in 2010, i.e. second difference (Božík, 2012). It means that method calculates differences of indicators before and after implementation of investment (after pay out of the subsidy). The effect of support occurs, when the second difference is significantly different from the first difference.

Mann-Whitney U test was used to compare above-mentioned indicators between two groups – participants (Y = 1) and no participants (Y = 0). Mann-Whitney test is the non-parametric substitute for the equal-variance t-test when the assumption of normality is not valid (as in this case). The null and alternative hypotheses are: H_0: Median $_{(Y = 1)}$ = Median Y $_{(Y = 0)}$, H_a: Median $_{(Y = 1)}$ ≠ Median $_{(Y = 0)}$. A normal approximation method was used for the distribution of the sum of ranks, which corrects for ties and does have the correction factor for continuity. The null hypothesis was tested at the significance level of 0.05.

Results and Discussion

Overview of supported agricultural biogas plants in 2007 - 2011

In the period 2007 to 2011, most new biogas plants were supported in regions Vysočina (22.6%), Jihočeský (15.0 %), Středočeský (14.3 %) a Jihomoravský (10.5 %). It corresponds to the regional importance of agriculture in the CR. Of the 142 approved projects, 9 projects were aimed at upgrading already operating biogas plants, 133 projects targeted for construction of new biogas plants. The total volume of investment spending was 9.8 mil. CZK, of which 2.5 mil. CZK was investment support by RDP.

An average agricultural area of supported farms was 1 860 ha with an average of 21 % share of permanent grasslands. Most agricultural biogas plants are located in regions with no or low natural handicap (non-LFA or LFA O). Size characteristics of supported farms were different (Figure 1) – it ranges from 0 ha to more than 7 200 ha. In terms of type of farming, the sample of supported farms was relatively homogeneous, because 85.7 % of farms have mixed type of farming. It corresponds to the fact that mainly larger agricultural farms invest in construction and upgrading of biogas plants. Mixed production is suitable for the operation of agricultural biogas plants because the biogas plants use manure.

In terms of a farm size expressed by a number of workers, approximately 75 % of the farms have more than 25 workers. It is consistent with a larger size of farms and mixed type of farming. Table 2 shows characteristics of farms by legal forms. It is obvious that legal entities (mainly cooperatives and joint-stock companies) are typical enterprises operating agricultural biogas plants.

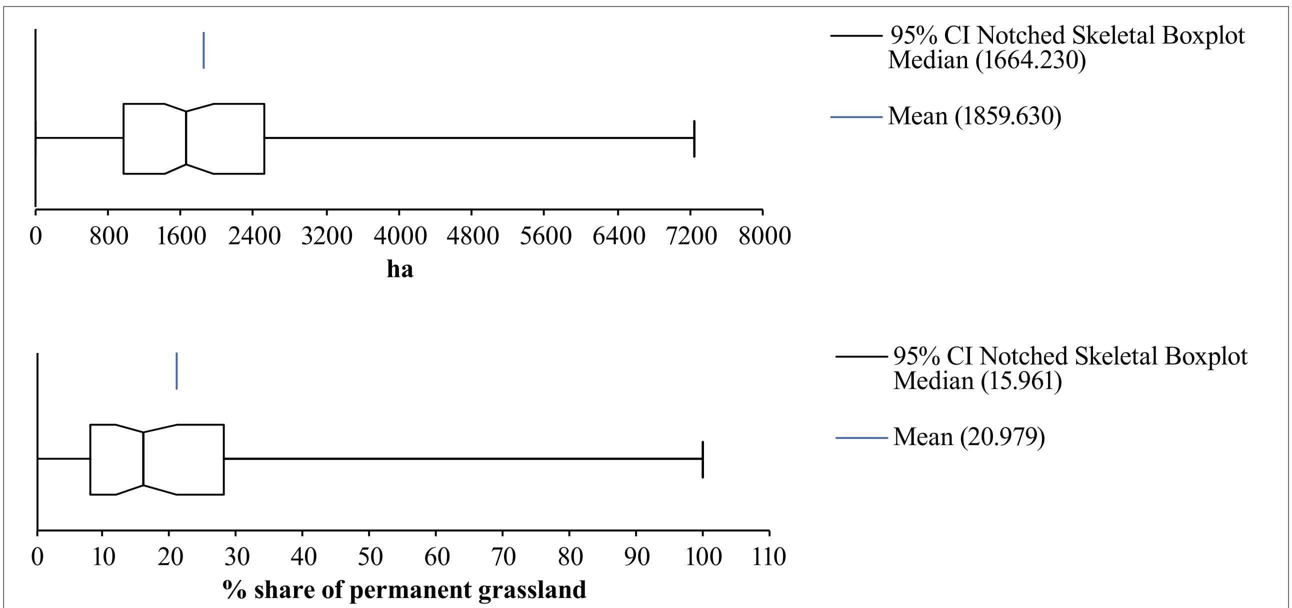

Fig. 1. Agricultural area of supported farms and share of grassland (LPIS)

Source: Own calculation

In the CR, currently more than 260 biogas plants producing electricity and heat from energy crops, manure and bio waste (264 biogas plants on 1st January 2012 with total installed power of 167.67 MWe, according to the MoA). Dynamic growth of biogas plants can be documented by the fact that at the beginning of 2007 there were only 56 stations in operation with a total installed power of 17.33 MW. Most of the biogas plants apply substrate from agricultural land and permanent grassland as well as using manure for anaerobe digestion. Maize silage is the main substrate, followed by manure and whole crop and grass silage.

The following overview provides an outline of agricultural biogas plants, which were supported under the RDP. The average size of 133 analyzed new biogas plants is about 636 kWe (in the range of 171 to 1 600 kWe) which exactly represents the average power of all biogas plants in CR for electricity production. Figure 2 shows histogram of installed electricity power of 133 supported new biogas plants (9 supported upgraded biogas plants were not included).

Agricultural biogas plants are most often built with an installed power 400 – 600 kWe. Knowing the relations of agricultural land and power biogas plant can be calculated that about 2 - 4 ha of agricultural land on average is needed per 1 kWe installed power. Of course, there are extremes on both sides; it depends on the structure of production in agricultural enterprise. The heating power is similar to the electricity power on average, but there are less number of supported biogas plants with installed heating power between 800 – 1 000 kW and, on the other side, there is more biogas plants with heating power between 600 – 800 kW.

The average total investment expenditures for both building and upgrading biogas plants were 69 CZK million per 1 biogas plant. Because investment expenditures significantly correlate with an installed power (Pearson correlation coefficient $r = 0.80$ with p-value < 0.0001), it is preferable to express the investment expenditures per 1 kWe. It ranged most frequently from 100 000 to 160 000 CZK (in 67 % of cases). About 15 % of projects had total investment expenditures between 75 000 and 100 000 CZK per 1 kWe.

Relation between total investment subsidies and installed power is not as strong as in case of total investment expenditures because the share of investment support is assessed individually based on the applicant's preference criteria. So in this sample the investment subsidies varied from 25 % to 60 % (applicants received most often 30 % of total eligible investment expenditures). Average amount of investment subsidy was about 17 000 CZK per hectare, 30 000 CZK per 1 kWe respectively.

Due to the availability of data about plan of newly created working positions, it is possible to make a short description of results. About 85 % of applications contain information that investment will not be associated with the creation of new working positions, 12 % of them planned 1 new working position. More than 1 new working position is very seldom. Because of specifics of operating biogas plants is obvious that at least one worker must monitor its operation. It is evident that most agricultural enterprises are able to use available labour forces for biogas plant operation. Thus, investments in biogas plants are not primarily focused on increasing employment in

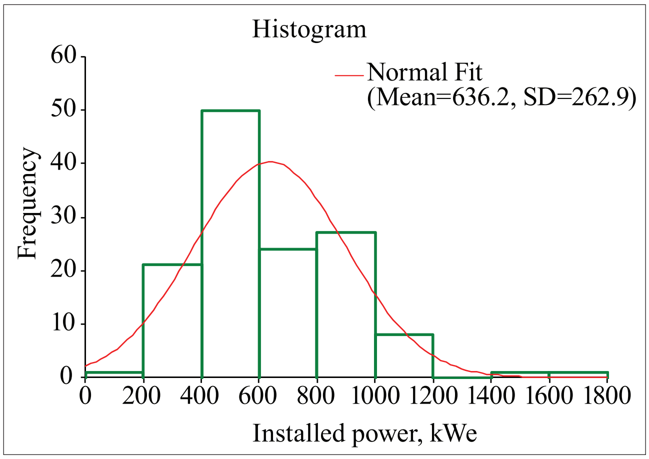

Fig. 2. Installed power of supported new biogas plants in the CR (2007 – 2011)
Source: Own calculation

Table 2
Average characteristics of supported farms by legal form (2007 – 2011)

Legal form	Number of companies	Agricultural area, ha	Share of grasslands, %	Turnover, CZK mil
Joint-stock company	47	2 305	16.9	129.0
Cooperative	30	2 363	19.6	117.3
Limited liability company	27	1 211	25.8	72.3
Individual farm	15	624	27.5	27.8
Total	119	1 860	18.3	100.5

Source: Own calculation

the country, but on maintaining employment and maximizing the use of working capacity.

Results of the counterfactual analysis

Results of counterfactual analysis present comparison of indicators between similar groups of participants (n = 38) and no participants (n = 38). First, there is question, if the support had any impact on the area of agricultural land and fixed assets. Table 3 shows medians of agricultural area and fixed assets in 2007 and 2010.

There is no significant difference in the total agricultural area between participants and no participants. The participants reduced the total agricultural area no participants extended their acreage. Nevertheless, neither the investment support nor investment in biogas plant had any impact on acreage of agricultural enterprises.

Investments in new biogas plants are relatively high and should increase value of fixed assets. This assumption was confirmed by statistical analysis. Participants had significantly higher fixed assets per hectare in 2010 when biogas has already been in operation. On the contrary, the value of fixed assets per hectare in no participants had not significantly changed. Table 4 presents the results of test assessing impacts on profitability and cash flow indicators.

Investments in biogas plants had not significant impact on ROA, ROCE and ROE. However, the decline of these indicators between 2007 and 2010 was greater in the sample of no participants. When economic results are related to the to-

Table 3
Results of test of differences in agricultural area and fixed assets

Indicator	Units	Year	Median (Y = 1)	Median (Y = 0)	Mann Whitney Z-value	p-value	Reject H_0 at 0.05
Agricultural area	ha	2007	1 948	1 915	0.4519	0.6513	No
		2010	1 924	1 968	0.6908	0.4897	No
		DID (1-0)			0.0260	0.9793	No
Fixed assets per hectare	CZK	2007	45 614	45 080	0.9298	0.3525	No
		2010	70 011	44 903	4.1607	0.0000	**Yes**
		DID (1-0)			-2.2492	0.0245	**Yes**

Source: Own calculation

Table 4
Results of test of differences in profitability and cash flow indicators

Indicator	Units	Year	Median (Y = 1)	Median (Y = 0)	Mann Whitney Z-value	p-value	Reject H_0 at 0.05
ROA	%	2007	5.53	5.45	-0.4207	0.6739	No
		2010	4.92	2.92	1.0337	0.3013	No
		DID (1-0)			-1.1064	0.2686	No
ROCE	%	2007	6.47	6.46	-0.2649	0.7911	No
		2010	5.51	3.28	1.0025	0.3161	No
		DID (1-0)			-1.1687	0.2425	No
ROE		2007	7.13	8.13	0.4727	0.6364	No
		2010	8.50	3.29	1.7505	0.0800	No
		DID (1-0)			-0.6285	0.5297	No
EBIT per hectare	CZK	2007	3 837	3 256	0.4623	0.6439	No
		2010	4 773	2 370	2.5089	0.0121	**Yes**
		DID (1-0)			-1.9998	0.0455	**Yes**
Cash flow per hectare	CZK	2007	9 073	8 771	1.1791	0.2384	No
		2010	12 125	7 160	3.1218	0.0018	**Yes**
		DID (1-0)			-1.9894	0.0467	**Yes**

Source: Own calculation

tal agricultural area, significant effects of investment can be observed. Investment in biogas plants has positive effect on EBIT and cash flow per hectare. While median of EBIT and cash flow per hectare increased in the group of participants, is decreased in the sample of no participants. The positive effect of investments on indicators related to the area, no impact on conventional indicators of profitability can be justified by different impact of investments on agricultural area, and fixed assets (Table 3).

Now it is time to look at main cost and yield effects of biogas plants. Table 5 resumes output of statistical analysis of differences in value added determinants and depreciation between participants and no participants.

As seen in Table 5, investments in biogas plants have significant impact on the value added per hectare as well as on labour productivity expressed by the indicator value added per staff costs. The group of supported agricultural enterprises increased the value added and labour productivity after setting up the investment, unlike no participants. This very important finding could affect the competitiveness of agricultural enterprises.

Regarding cost and yields, results are not clear like in case of the value added. Investments have no significant impact on cost of sales per hectare. It is somewhat surprising given that the biogas plant heats some buildings and operations within the farm, and this leads to savings of purchased heat. Some more noticeable savings in cost of sales are obvious in the sample of participants, but the difference towards no participants is not statistically significant.

Higher depreciation per hectare in the group of participants is related to higher value of fixed assets as the consequence of the investment in biogas plant.

In the group of participants, median of sales of production per hectare in 2010 was at the same level as in 2007, whereas the no participants had lower output. The difference between median sales of production per hectare between the two groups in 2010 is statistically significant, unlike difference-in-differences, which is not statistically significant. Thus, support of biogas plants performs one of its purpose, which is the diversification of farm income stabilization and support their income. Table 6 contains ratio indicators of liquidity, activity and capital structure.

Investments in biogas plants have no significant impact on liquidity ratios. Of course, the current and cash ratios are lower after investment apparently because participants have to repay loan for investment, but any statistically significant differences were not found. Questionable are effects of investments on turnover ratios, some significant differences

Table 5
Results of test of differences in value added determinants and depreciation

Indicator	Units	Year	Median (Y = 1)	Median (Y = 0)	Mann Whitney Z-value	p-value	Reject H_0 at 0.05
Value added per hectare	CZK	2007	14 379	13 551	0.0883	0.9296	No
		2010	15 227	10 577	3.0387	0.0024	**Yes**
		DID (1-0)			-2.0102	0.0444	**Yes**
Value added per staff costs	CZK	2007	1.18	1.13	0.8425	0.3995	No
		2010	1.36	0.97	4.0640	0.0000	**Yes**
		DID (1-0)			-2.5405	0.0111	**Yes**
Sales of production per hectare	CZK	2007	42 029	39 379	0.4831	0.6290	No
		2010	42 227	33 826	2.2388	0.0252	**Yes**
		DID (1-0)			-1.0648	0.2869	No
Cost of sales per hectare	CZK	2007	28 712	24 824	0.8986	0.3689	No
		2010	26 269	23 323	1.4181	0.1562	No
		DID (1-0)			0.2441	0.8071	No
Cost of sales per sales of production		2007	0.68	0.67	0.4822	0.6297	No
		2010	0.64	0.70	-2.7182	0.0066	**Yes**
		DID (1-0)			1.8054	0.0710	No
Depreciation per hectare	CZK	2007	5 248	5 375	0.4623	0.6439	No
		2010	7 196	5 467	2.3738	0.0176	**Yes**
		DID (1-0)			-1.2311	0.2183	No

Source: Own calculation

Table 6
Results of test of differences in liquidity, activity and capital structure

Indicator	Units	Year	Median (Y = 1)	Median (Y = 0)	Mann Whitney Z-value	p-value	Reject H_0 at 0.05
Current ratio		2007	4.12	2.47	1.2934	0.1959	No
		2010	2.56	3.07	-1.2622	0.2069	No
		DID (1-0)			1.7817	0.0748	No
Cash ratio		2007	0.51	0.41	0.6908	0.4897	No
		2010	0.30	0.53	-1.3921	0.1639	No
		DID (1-0)			1.4596	0.1444	No
Long-term asset turnover		2007	0.90	0.94	-0.3896	0.6968	No
		2010	0.56	0.84	-3.2570	0.0011	**Yes**
		DID (1-0)			1.5427	0.1229	No
Inventory turnover		2007	2.63	2.54	-0.3020	0.7626	No
		2010	2.71	2.21	1.2830	0.1995	No
		DID (1-0)			-0.2702	0.7870	No
Debt ratio	%	2007	36.25	37.15	-0.6857	0.4929	No
		2010	47.25	32.60	3.1115	0.0019	**Yes**
		DID (1-0)			-2.5038	0.0123	**Yes**
Credit debt ratio	%	2007	11.70	11.10	0.5818	0.5607	No
		2010	30.20	10.40	5.0282	0.0000	**Yes**
		DID (1-0)			-4.2646	0.0000	**Yes**

Source: Own calculation

were revealed only in long-term asset turnover as the result of higher fixed assets after setting up biogas plants.

On the other hand, clear effects of investments are observable in capital structure. Because such financially demanding investments like biogas plants need to be co-financed by taking a commercial credit, the debt ratios significantly increased in the group of participants. Difference-in-differences were also statistically significant. The median level of debt ratio was still under recommended level of 50 % in 2010, which indicates no severe problems with indebtedness of supported agricultural enterprises, but it also depends on the future development of the economic situation of agricultural enterprises.

Conclusion

The main goal of the article was to assess selected socioeconomic impacts of public support for investments and effects of investments in biogas plants in the Czech Republic. The main findings are following:

- Investments and investment subsidies targeted at biogas plants have positive effect on EBIT, cash flow and value added per hectare of agricultural enterprises. On the other side, there is no significant impact on ROA, ROE and ROCE even if these indicators have been considered as key indicators of companies' economic performance.

- Biogas plants have rather revenue stabilization effect than cost savings effect. So investment support for building and modernization of biogas plants helps to achieve one of goal of RDP aimed at diversification of non-farm income.

- Investing in biogas plants has not significant impact on liquidity of agricultural enterprises.

- Setting up biogas plants does not create any new working positions in most cases. Operation of biogas plants is mostly ensured by using own workers available.

- Supported enterprises with biogas plant in operation significantly increased labour productivity compared to companies without biogas plant.

- Investments in biogas plants significantly change capital structure because of commercial credit indispensable for financing investment expenditures.

- Investments in biogas plants do not lead to significant change of farm agricultural area. They rather increase fixed assets and depreciation.

Public support of investment in biogas plants in the Czech Republic should continue because it has positive effects on competitiveness of agricultural enterprises. Besides discovered effects it also helps to use secondary raw materials from animal production (like manure) and use part of the agricultural land formerly intended for the production of animal feed (when the livestock numbers in the Czech Republic have been getting lower for the long time).

Acknowledgements

Supported by long-term institutional support to the conceptual development of research organization (project VŠE IP300040).

References

Božík, M., 2012. Impacts assessment of the agroenvironmental support in the Rural Development Programme 2007-2013 at the farm level. *Economics of Agriculture*, **1**: 34-46.

Cueto, L. A. C., 2006. Effectiveness and Impacts of Farm Investment Support in Spain – The Experience of the Updated Mid-Term Evaluation (2000 – 2006). In: Bergschmidt, A., Dirksmeyer, W., Efken, J., Forstner, B. and Uetrecht, I. (Editors): *Evaluation of Farm Investment Support, Investment Support for Improvement of Processing and Marketing of Agricultural Products*. (Proceedings of the European Workshop, Working Papers in Agricultural Economics, No. 03/2006), Braunschweig, August 2006, pp. 105-120.

Djatkov, D., M. Effenberger, A. Lehner, M. Martinov, M. Tesic and A. Gronauer, 2012. New method for assessing the performance of agricultural biogas plants. *Renewable Energy*, **40**: 104-112.

Gebrezgabher, S. A., M. P. M. Meuwissen, B. A. M. Prins, Lansink and A. G. J. M. Oude, 2010. Economic analysis of anaerobic digestion - A case of Green power biogas plant in The Netherlands. *NJAS - Wageningen Journal of Life Sciences*, **57**: 109–115.

Golusin, M., A. Ostojic, S. Latinovic, M. Jandric and O. M. Ivanovic, 2012. Review of the economic viability of investing and exploiting biogas electricity plant – Case study Vizelj, Serbia. *Renewable and Sustainable Energy Reviews*, **16**: 1127–1134.

Gu, X. S. and P. R. Rosenbaum, 1993. Comparison of Multivariate Matching Methods: Structures, Distances and Algorithms. *Journal of Computational and Graphical Statistics*, **2**: 405-420.

Khandker, S. R., G. B. Koolwal and H. A. **Samad,** 2010. Handbook on Impact Evaluation. Quantitative Methods and Practices. Washington: The World Bank, 262 pp. ISBN 978-0-8213-8029-1 (electronic).

Mahalanobis, P. C., 1936. On the generalised distance in statistics. *Proceedings of the National Institute of Sciences of India*, **2**: 49–55.

Madlener, R., C. H. Antunes and L. C. **Dias,** 2009. Assessing the performance of biogas plants with multi-criteria and data envelopment analysis. *European Journal of Operational Research*, **197**: 1084–1094.

Menind, A. and J. Olt, 2009. Biogas Plant Investment Analysis, Cost Benefit and Main Factors. In: Malinovska, L., Meote, A., Kronbergs, E., Nulle, I. (Editors), *Engineering for Rural Development* (Proceeding of the International Conference, Latvia, Jelgava, May 28-29), Latvia University of Agriculture, Faculty of Engineering pp. 339-343.

Michalek, J., 2009. Application of the Rural Development Index and the generalized propensity score matching to the evaluation of the impact of the SAPARD programme in Poland and Slovakia. *ADVANCED-EVAL Regional Report Series*, University of Kiel, 96 pp.

Ministry of Agriculture, 2008. Rural Development Programme of the Czech Republic for 2007 – 2013. Working Document. Prague: MoA, November 2008.

Murphy, J. D. and N. Power, 2009. Technical and economic analysis of biogas production in Ireland utilising three different crop rotations. *Applied Energy*, **86**: 25–36.

Poeschl, M., S. Ward and P. Owende, 2010. Prospects for expanded utilization of biogas in Germany. *Renewable and Sustainable Energy Reviews*, **14**: 1782–1797.

Reise, Ch., O. Musshoff, K. Granoszewski and A. Spiller, 2012. Which factors influence the expansion of bioenergy? An empirical study of the investment behaviors of German farmers. *Ecological Economics*, **73**: 133–141.

Rosenbaum, P. and D. Rubin, 1983. The central role of the propensity score in observational studie for causal effects. *Biometrica*, **70:** 41-55.

Rosenbaum, P. and D. Rubin, 1985. Construction a Control Group Using Multivariate Matched Sampling Methods that Incorporate the Propensity Score. *The American Statistician*, **39**: 33-38.

Received September, 5, 2012; accepted for printing June, 2, 2013.