Structural Change and Farm Investment Support in Austria

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Abstract

The effects of policy supported farm investments on structural change in agriculture have been studied rarely. The heterogeneity of farms and the problem of self-selection are challenging the evaluation of treatments in agriculture. Econometric methods can help to overcome these problems. In this paper, we apply a conditional Difference-in-Difference (DiD) estimation, where we combine Direct Covariate Matching with a DiD estimation. Our dataset consist of more than 90,000 farms. In order to measure the development and the heterogeneity of the effects after the investment we look at several years and different farm groups separately. Our results show that investing farms significantly enlarge and intensify their production more than non-investing farms. Furthermore, the results indicate that investments are often not completely implemented short-term but require a certain implementation period. This applies in particular to cattle farming.

Keywords Farm investment support, structural change, evaluation, conditional difference-in-difference, Matching

JEL code **Q10, Q12, Q18**

Introduction

Structural change in agriculture is an adjustment of the agricultural sector to changing conditions of demand and supply. It is a complex and dynamic process and basically a reallocation among farms, as well as between the agricultural sector and other sectors of the economy (Happe et al., 2011, OECD, 1994, Blanford and Hill, 2006). Structural adjustments in agriculture occur in various ways. It takes places in terms of farm growth (Weiss, 1999, Bartolini and Viaggi, 2013, Mann, 2005), specialisation or diversification of farms (OECD, 1994, Weiss and Thiele, 2002) and in increasingly applied capital-intensive farming methods (OECD, 1994). Lastly, exit and entry from the agricultural sector is possible (Weiss, 1999, Mann, 2003).

The determinants of structural change have been studied by various authors, who have detected several farm-external and farm-internal factors. (Happe et al., 2011, Zimmermann et al., 2009, Breustedt and Glauben, 2007, Weiss, 1999). Zimmermann, et al. (2009) point out that in particular long-term investment decisions have a great influence on the structural adjustment of a farm. This is especially the case for husbandry farming, where on the one hand existing investments might force farmers to remain in husbandry as they have to deal with so-called sunken costs; on the other hand, new investments allow farmers to increase production in order to reduce fixed costs.

Investment decisions are influenced by governmental farm-investment support, which is part of the European Rural Development (RD) programme. The farm-investment programme is part of the second pillar of the Common Agriculture Policy (CAP). It supports the investments of farmers by covering a certain percentage of their investment costs or by subsidising interest rates. The aim of the programme is to improve the competitiveness of farms, the on-farm work conditions, animal welfare and environmental conditions. The European Investment Support Programme has an 11.5% share of the total budget for European Rural Development (RD) from 2007 to 2013 and is therefore one of the most important RD programmes (EC, 2011). In contrast to agri-environmental measures, this programme clearly increased its budget in the last period. This applies especially to Austria, where in general the RD programme is of extraordinary importance.

Farm-investment support programmes are of great significance for agricultural structures, aggregate production levels as well as agri-environmental interactions (Zimmermann et al., 2009). Consequently, the evaluation of structural impacts of farm-investment programmes is highly relevant. But despite the increasing relevance of these programmes, their structural effects have rarely been studied.

In order to analyse the causal effects of farm interventions, it has to be considered that the impact on farms clearly depends on farm-specific conditions such as the farm size, farm type and site conditions. Consequently, investment decisions by farmers are very individual and result in a high heterogeneity. This heterogeneity and voluntary participation, which might lead to a “selection bias”, challenge the empirical evaluation of investment support programmes. In order to estimate causal effects, it is particularly necessary to control for variables which cause the selection bias. An appropriate method to control for observational factors is the *matching* approach (Rubin, 1977). The further combination of *matching* with a DiD estimation allows us to control even for unobservable factors.

In this paper we analyse the effects of government-supported farm investments on structural change in Austrian agriculture. Specifically, we ask the question how supported investment affects in-farm structural development as well as the production intensity of farms. In order to capture even the dynamic consequences of government-supported investment activities on these structural aspects, we apply our analysis to a period of seven years. In doing this we have structured our paper as follows: in Section 2, we describe our conditional *matching* approach. In Section 3 we present the case study, the data set and our model specifications. The results of the conditional DiD-estimation are displayed in Section 4. Finally, in Section 5 we discuss our results and draw conclusions for decision makers and further research.

Applied methodology

In the following section we describe in brief the evaluation problem and the formulation of our conditional DiD-estimation model.

The evaluation problem

Quantitative evaluation asks for the causal effect. Therefore the Neyman-Rubin-Holland model has been developed. In this model, the causal effect (ΔA) for one individual (A) is computed by comparing the outcome in the state of participation (Y_A^1) and the outcome in the state without participation (Y_A^0). This can be formulated as

$$\Delta A = Y_A^1 - Y_A^0 \qquad (1)$$

A fundamental problem arises, however, as one of these outcomes is counterfactual because one unit can either be participant or non-participant. When we look for counterfactual for treated units, one solution to this problem is the use of observable non-participants. The treatment effect can then be computed by simply comparing treated and non-treated units; but to follow causal claims, treatment must be independent of the potential outcome and treated and non-treated must be homogenous, only differing by the analysed variable. If these are not fulfilled, the results are biased and/or have high variability. This is not a major issue in randomised experiments, as randomisation of treatment insures the independence of treatment and outcome. To reduce variability, the pairing of treated and untreated units can be used and number of observations can be increased (Rosenbaum, 2005).

As experiments have hardly been used in agricultural treatment evaluation, we have to rely on observational data (Henning and Michalek, 2008). Observational studies differ from experiments, as the researcher cannot control the assignment of treatment to individuals (Rosenbaum, 2010). Therefore, participants select themselves voluntarily for a certain treatment, which leads to a selection bias in the results. This bias is mainly due to variables (Z) disturbing the causal inference of the treatment (T) on the outcome (Y) and therefore violates the independence assumption. Figure 1 illustrates a causal relationship between the treatment T and the outcome Y, but Y is biased through the mutual dependence of T and Y on Z.

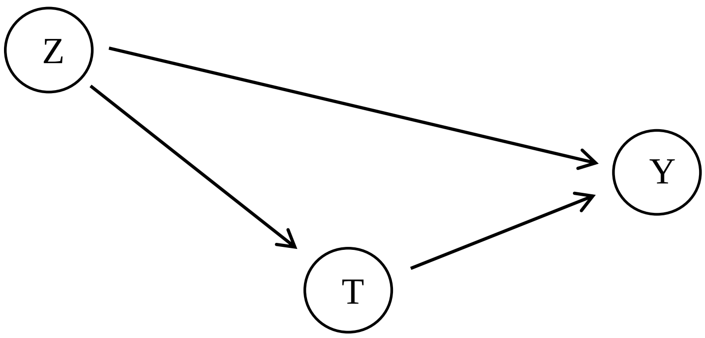

Figure 1: A causal diagram in which the effect of T on Y is disturbed through the back-door path, a mutual dependence on Z. (Source: Morgan and Winship, 2010)

As in heterogeneous observational studies, the increase in observations cannot reduce variability; more homogenous samples are needed (Rosenbaum, 2005). Therefore econometric methods are needed to reduce both, bias and variability. One approach is the *matching* procedure, where, based on the Conditional Independence Assumption (CIA), treated and untreated are paired on similar observable covariates (Rubin, 1977). Therefore, *matching* controls for the selection bias by balancing the determinants Z of the treatment T (Morgan and Winship, 2010).

Matching procedure

Our *matching* model is based on the nearest neighbour approach: for each treated unit, we determine the non-treated (control) unit with the smallest distance to the treated unit with regard to the selected covariates. In order to detect the influence of the chosen matching approaches on results, we apply the so-called Direct Covariate *Matching* (DCM) model to identify the nearest neighbours. This model represents a very straightforward, non-parametric *matching* procedure and matches directly the covariates Z.

We apply a Greedy Pair *matching* algorithm without replacement. This means that each non-participant can serve only once as control. With regard to maximum selection boundaries, we apply exact cut-off values for dummy and multinomial covariates and calipers in the case of continuous variables. These calipers define the maximum allowed divergence between the treated unit and respective control unit. If there is no control unit within the boundary defined by the caliper, the treated unit will be dropped from the sample.

Basically, narrow calipers entail a high similarity of treated unit and control unit. Consequently, narrow calipers raise the quality of *matching* (Caliendo and Kopeinig, 2008) and safeguard the compliance of the common support condition. However, overly narrow calipers lead to a loss of treated units. In this context, it is better to choose a caliper width which is not too narrow when heterogeneous effects of treatment are expected, even when this might reduce the effect of bias reduction (Augurzky and Kluve, 2007). It becomes clear that there is no general optimal caliper size. Optimal size depends on the data set and respective indicators are necessary to judge the chosen caliper size. In our case we use the number of excluded units and quality of matching as indicators. Matching quality can be considered successful when the mean of the covariates between treated and control group is balanced.

Conditional Difference-in-Difference (DiD) Estimator

Based on the matched datasets we calculate the average treatment effect on the treated (ATT) by using a DiD Estimator. Through this, the estimator merges the advantages of both methods (Imbens and Wooldridge, 2009) by eliminating the self-selection bias caused by observable variables, as well as by controlling for unobservable variables. The DiD Estimation relies on the assumption that the differences of participants and non-participants are stable over time. It is computed as the difference between the progress of the participant and the non-participant from one point before (t') to one point after (t) the time of treatment (Heckman et al., 1998). The implementation of such an estimator allows us to integrate a before-after-analysis into our model and to monitor therefore for unobservable, linear and time-invariant effects such as price fluctuations. We apply a DiD Estimation, since our covariates are weak predictors of participation, which makes conditional DiD Estimations preferable over cross-sectional *matching* (Smith and Todd, 2005).

A positive (or negative) ATT indicates a better (or worse) development of outcome variables for participating farms in comparison to similar non-participating farms. This can be expressed as:

$$\tau \,\big|\, (\mathrm{T}=1) = \sum_{\mathrm{A}=1}^{\mathrm{n}} (\mathrm{Y}_{\mathrm{A,t}}^{1} - \mathrm{Y}_{\mathrm{A,t'}}^{1}) \,\big|\, \mathrm{Z}/\mathrm{n}_{\mathrm{A}} - \sum_{\mathrm{B}=1}^{\mathrm{n}} (\mathrm{Y}_{\mathrm{B,t}}^{0} - \mathrm{Y}_{\mathrm{B,t'}}^{0}) \,\big|\, \mathrm{Z}/\mathrm{n}_{\mathrm{B}} \quad (2)$$

where $Y_{A,t}^{1}$ is the outcome for a treated unit after the treatment and $Y_{A,t'}^{1}$ before the treatment, Z a vector of observable covariates and n_A the number of used particpants. The second term expresses the same but for controls. In conclusion, we would note that we execute our analysis with the help of the R-CRAN package "*Matching*" (Sekhon, 2011).

The Austrian case study - data and model specifications

Our analysis is based on the Integrated Administration and Control System (IACS) data of 94,192 farms in Austria for the period 2000 to 2011. Within this dataset, there are 3,555 treated farms (T=1), participating in the time period 2002 to 2004, and 90,637 potential control farms (T=0), which did not receive any investment support payments between 2000 and 2011. Farms which attended farm-investment programmes in 2000 and 2001 as well as from 2005 to 2011 are excluded from the analysis in order to avoid the farm-investment programme having an influence on *matching* variables and the after-treatment situation. Furthermore, we do not consider farms receiving less than €5,000 in investment subsidy.

Participants and controls are matched on selected *matching* variables, based on the year 2000. Next to site-specific variables (mountain farm cadaster, mountain farm zone, state), we check for the farm-specific variables farm type in husbandry, livestock density, share of arable land, area for fruit and wine, alpine and organic farming, as well as participation in agri-environmental programmes, since these variables influence the decision to participate in the programme and the outcome variables.

ATT values are then calculated for the period 2000 to 2005, as well as for the periods 2000 to 2006, 2007, 2008, 2009, 2010 and 2011, respectively. As outcome variables we use UAA and total livestock units, as well as intensity and diversity parameters for arable land, grassland and husbandry[1]. Furthermore, we analyse entry and exit processes in organic farming and animal husbandry. As well as showing the mean effect, the DCM procedure allows through stratification an estimation of the effects for the farm types in animal husbandry: dairy farms, cattle farms, pig farms and poultry farms.

Results

As result of the *matching* procedure, our farm sample exists of 3555 pairs of participating (investing) and control (non-investing) farms. The sample shows a good balance between participants and control group with regard to all variables of interest, since remaining differences in mean values are small and not significant (see Table A2, Columns 3 and 4).

Table 1 displays the Average Treatment Effect on the Treated (ATT) for the total sample. We observe a positive mean effect on total livestock units (LUs), which increases constantly over time. So investing farms increase their LUs in the shortest possible period from 2000 to 2005 by 3.24 units more than their control farms; this distance increases with regard to the longest possible period from 2005 to 2011 to 5.57 LUs. Similar results but lower values are found with regard to the total utilised agricultural area (UAA). Here the estimated ATT amounts to 1.33 ha for the period 2000 to 2005 and 2.26 for 2000 to 2011. The UAA effects can be split into an arable-land effect (0.84 ha for 2000 to 2005) and into a grassland effect (0.49 ha for

[1] Variable and parameter description is shown in the Annex.

2000 to 2005). In addition, the ATT values for both land types increase over the years, whereas the highest values on arable land can be observed for the period 2000 to 2010 (1.24 ha) and for grassland for 2000 to 2011 (1.07 ha).

As ATT values are higher with regard to LUs than in UAA, intensification in husbandry can be concluded. This is clarified by the development of ATT values of livestock density, which amounts to 0.08 LU/ha in the 2000-5 period and to 0.10 LU/ha in the 2000-9/-10/-11 periods. With regard to intensity on arable land, we do find positive significant ATT values not before the 2000-8 period; from this point on, ATT values increase slightly. On grassland we do not find any significant values at all. Furthermore, our analysis shows that government-supported investment activities significantly increase both the entry into organic farming and the abandonment of husbandry (exiting husbandry). With regard to organic farming, we observe stable ATT values of 0.04, with regard to husbandry abandonment ATT values start -0.01 and quickly decrease to -0.03. Therefore the conversion rate of investing farms is 4% higher than for non-investing farms. Lastly, we assess the effects of government-supported investment activities on livestock diversity and diversity of arable-land use. With regard to both parameters we do not find any significant correlation.

Table 1: Mean ATT values for selected outcome variables and for the years 2005-2011 (n=3555 pairs).

	2005		2006		2007		2008		2009		2010		2011	
	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.
Total livestock units (LU)	3.24	***	3.99	***	4.43	***	4.82	***	5.20	***	5.49	***	5.57	***
UAA (ha)	1.33	***	1.53	***	1.89	***	2.01	***	2.14	***	2.25	***	2.26	***
Arable land (ha)	0.84	***	0.91	***	1.14	***	1.17	***	1.21	***	1.24	***	1.18	***
Grassland (ha)	0.49	***	0.62	***	0.75	***	0.84	***	0.94	***	1.01	***	1.07	***
Intensity in husbandry (LU/ha) [1)]	0.08	***	0.08	***	0.08	***	0.09	***	0.10	***	0.10	***	0.10	***
Intensity on arable land (Pt.) [2)]	0.01		0.01		0.02		0.03	***	0.02	***	0.04	***	0.04	**
Intensity on grassland (%) [3)]	0		0		0		0		0		0		0	
Entering organic farming (%)	4	***	4	***	3	***	4	***	4	***	4	***	4	***
Exiting husbandry (%)	-1	***	-2	***	-2	***	-3	***	-3	***	-3	***	-3	***
Diversity in husbandry [1)]	0.00		0.00		0.00		0.00		0.00		0.00		0.00	
Diversity on arable land (Pt.) [2)]	0.00		0.00		0.00		0.00		0.00		0.00		0.00	

Notes: [1)] Estimation is done only for farms with continuous husbandry (n=2688 pairs); [2)] Estimation is done only for farms with continuous arable land (n=2269 pairs); [3)] Estimation is done only for farms with continuous grassland (n=2991 pairs); [4)] T-test and McNemar test are used for equally of means: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 ' ' 1; Source: Own calculations

The stratification of the sample with regard to the husbandry farm types, namely dairy, cattle, pig and poultry, reveals farm-type specific structural developments (stratified results are displayed in detail in Table 2, 3, 4 and 5). As Figure 2 shows, we observe such a farm-type specific dynamic with regard to LU values: for the overall sample, the initial ATT is quite low and increases in almost linear fashion over the complete observation period. Almost similar linear increases in LU ATT can be found for specialised cattle farms and specialised dairy farms, whereas the ATT level of dairy farms is generally lower. Higher effects become apparent for poultry farms as well as for pig farms. Furthermore, we observe in both cases that the ATT values reach a maximum in the observation period and drop again beyond this point. On poultry farms this effect is more characteristic: ATTs initially increase very sharply, show a maximum and drop afterwards quite acutely again.

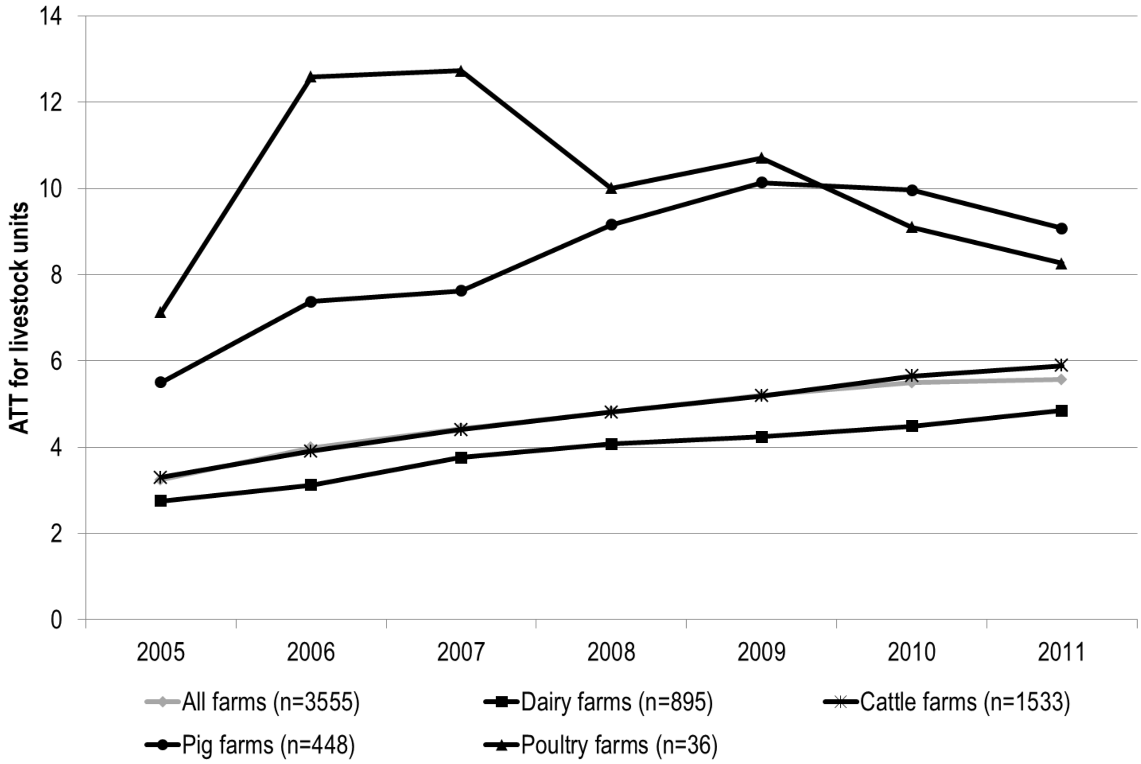

Figure 1: The development of mean ATT values for livestock units in the sample of all farms and selected farm types. (Source: Own Calculations)

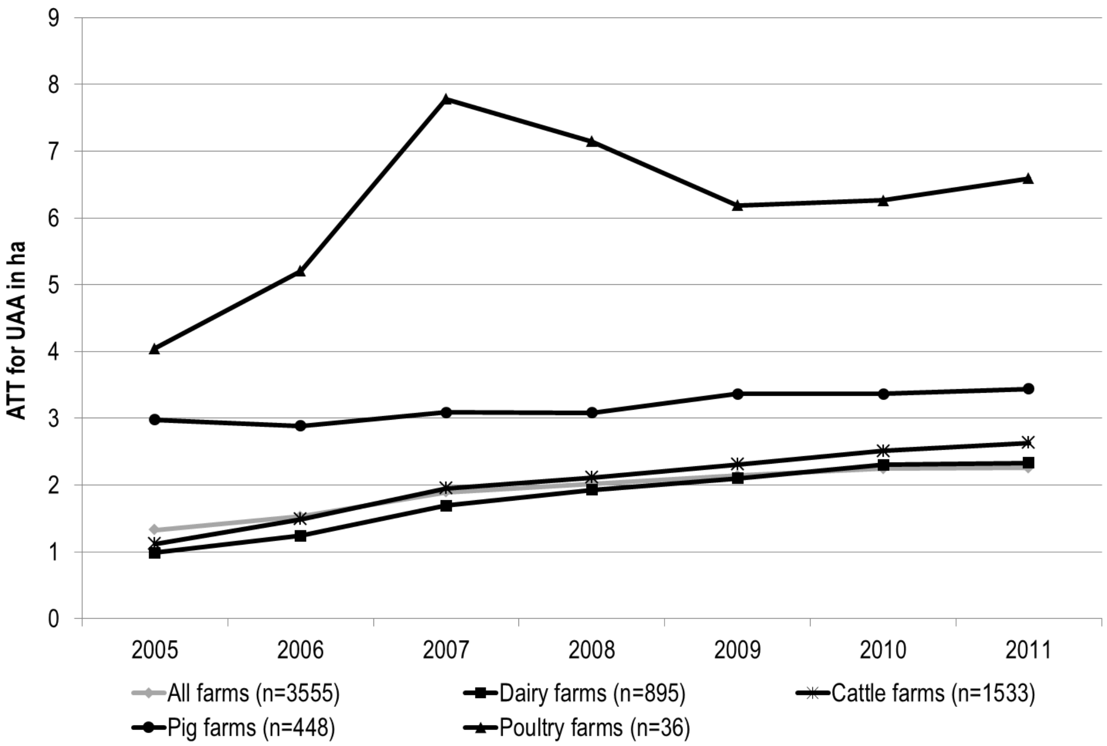

Figure 2: The development of mean ATT values for utilized agricultural area in the sample of all farms and selected farm types. (Source: Own Calculations)

The results are very similar with regard to UAA (Figure 3): ATT values for the overall sample start quite low and show an almost linear increase over the complete observation period. The curves for cattle farms and dairy farms are almost identical. Pig farms are able to increase their acreage by 2.98 ha more than their control farms already in the first observation period. However, in contrast to LU results, this initial effect remains almost constant over the entire period and no further sharp increase can be observed. Very similar to the LU results, poultry farms also show with regard to UAA the most characteristic curve of all farm types: once again ATT values increase very sharply in the beginning, show a quick maximum and drop afterwards quite quickly.

A closer look to the stratified results displayed in Tables 2 to 5 allows us to sub-divide the UAA effect into arable land and grassland effects also for the stratified samples. This analysis reveals that investing dairy farms differ from their control group particularly with regard to grassland growth; growth of arable land is also positive, but of minor importance. The initial ATT value for grassland is 0.7 ha in the 2000-5 period, whereas the distance to the respective control group is constantly growing and finally reaches a value of 1.64 ha (period 2000-11). Cattle farms show a fairly similar development, but arable land is increasing more dynamically (0.51 ha in 2005 and 1.25 ha in 2011). Not surprisingly, UAA ATT values of pig farms are dominated by arable land growth: ATT values rise from initially 2.9 ha in the 2000-5 period to 3.38 ha in the 2000-11 period. As expected, grassland-related ATT values are not significant. Similar effects can be observed for poultry farms, but in contrast to pig farms arable land growth is much higher already in the beginning (4.18 ha in the 2000-5 period) and further increases with a longer lasting observation period very quickly to the maximum of 7.38 ha (reached in the 2000-8 period). Beyond the 2000-8 period, ATT values remain high but are statistically insignificant.

With regard to livestock density, we observe for all stratified samples a statistical significant increase in comparison to the respective control groups. With regard to dairy farms and cattle farms the level of the respective ATT values is moderate (0.07 and 0.08 in the 2000-5 period, respectively) and remains on almost the same level over the complete observation period. With regard to pig farms and poultry farms, we observe distinct differences: the level of livestock intensity increase is in general higher and further increases over the observation period. With regard to pig farms this increase and the high level achieved is sustained over the complete observation period. With regard to poultry farms, results are different: ATT values increase very rapidly and drop again after a couple of years. Finally, this results in the fact that no difference in livestock density remains over the complete observation period (period 2000-11). In conclusion, our results emphasise that growth on dairy and cattle farms is highly dependent on the availability of land, in contrast to pig and poultry farms.

With regard to the entry in organic farming, the stratified analysis shows only significant results with regard to dairy and cattle farms: both clearly are distinguished by higher entry rates in comparison to their respective control groups, which even slightly increase over time. Additionally, with regard to poultry farms we observe clearly positive, but not significant ATT values. It should be pointed out that the missing value-significance could be in comparison to the other groups – also a consequence of the small group size. With regard to pig farms, we clearly observe no impact of government-supported investments on entry rates to organic farming. Furthermore, our stratified results show that the impact of government-supported investments on the abandonment of husbandry differs with regard to farm types. The most relevant impact we observe with regard to pig farms is that they show ATT values which start in the 2000-5 period with -0.05 and reach, in the 2000-9 period, a maximum ATT value of -0.10. In addition, with regard to dairy and cattle farms we obverse significant negative ATT values. However, these remain on a comparatively low level and show significance only in the long term. High ATT values with regard to the reduction in exiting husbandry are also found in poultry farms (ranging between 0.06 and 0.25), but only the result for the 2000-5 period is statistically significant.

Table 2: Mean ATT values for selected outcome variables and for the years 2005-2011 in the dairy farm sample (n=895 pairs).

	2005		2006		2007		2008		2009		2010		2011	
	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.
Total livestock units (LU)	2.75	***	3.12	***	3.76	***	4.07	***	4.24	***	4.48	***	4.85	***
UAA (ha)	0.98	***	1.24	***	1.69	***	1.93	***	2.10	***	2.30	***	2.33	***
Arable land (ha)	0.29	**	0.34	**	0.56	***	0.56	***	0.64	**	0.72	***	0.69	**
Grassland (ha)	0.70	***	0.90	***	1.13	***	1.36	***	1.46	***	1.58	***	1.64	***
Intensity in husbandry (LU/ha) [1)]	0.07	***	0.06	***	0.08	***	0.09	***	0.09	***	0.09	***	0.09	***
Entering organic farming (%)	4	***	4	***	4	***	5	***	5	***	5	***	5	***
Exiting husbandry (%)	-1		-1		-1		-1		-2	***	-2	***	-2	***

Notes: [1)] Estimation is done only for farms with continuous husbandry (n=840 pairs); [2)] T-test and McNemar test are used for equally of means: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 ' ' 1; Source: Own calculations

Table 3: Mean ATT values for selected outcome variables and for the years 2005-2011 in the cattle farm sample (n=1533 pairs).

	2005		2006		2007		2008		2009		2010		2011	
	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.
Total livestock units (LU)	3.30	***	3.90	***	4.41	***	4.81	***	5.19	***	5.65	***	5.89	***
UAA (ha)	1.12	***	1.49	***	1.95	***	2.11	***	2.31	***	2.51	***	2.63	***
Arable land (ha)	0.51	***	0.70	***	0.93	***	1.00	***	1.08	***	1.21	***	1.25	***
Grassland (ha)	0.61	***	0.79	***	1.02	***	1.11	***	1.23	***	1.30	***	1.38	***
Intensity in husbandry (LU/ha) [1)]	0.08	***	0.07	**	0.06	***	0.07	***	0.08	***	0.08	***	0.08	***
Entering organic farming (%)	6	***	6	***	6	***	6	***	6	***	6	***	6	***
Exiting husbandry (%)	-1		-1		-1		-1	***	-2	**	-2	***	-3	***

Notes: [1)] Estimation is done only for farms with continuous husbandry (n=1372 pairs); [2)] T-test and McNemar test are used for equally of means: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 ' ' 1; Source: Own calculations

Table 4: Mean ATT values for selected outcome variables and for the years 2005-2011 in the pig farm sample (n=448 pairs).

	2005		2006		2007		2008		2009		2010		2011	
	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.
Total livestock units (LU)	5.50	***	7.37	***	7.63	***	9.16	***	10.14	***	9.96	***	9.07	***
UAA (ha)	2.98	***	2.88	***	3.09	***	3.08	***	3.36	***	3.36	***	3.44	***
Arable land (ha)	2.90	***	2.83	***	3.08	***	3.10	***	3.34	***	3.31	***	3.38	**
Grassland (ha)	0.07		0.05		0.01		-0.02		0.03		0.05		0.06	
Intensity in husbandry (LU/ha)[1)]	0.09	***	0.14	***	0.15	***	0.14	***	0.20	***	0.19	***	0.19	***
Entering organic farming (%)	1		1		0		0		1		0		0	
Exiting husbandry (%)	-5	***	-6	**	-5	***	-8	***	-10	***	-7	**	-8	**

Notes: [1)] Estimation is done only for farms with continuous husbandry (n=254 pairs); [2)] T-test and McNemar test are used for equally of means: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 ' ' 1; Source: Own calculations

Table 5: Mean ATT values for selected outcome variables and for the years 2005-2011 in the poultry farm sample (n=36 pairs).

	2005		2006		2007		2008		2009		2010		2011	
	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.	ATT	sig.
Total livestock units (LU)	7.12	***	12.59	**	12.73	**	10.00	***	10.71	**	9.10	***	8.26	***
UAA (ha)	4.05	**	5.20	***	7.78	***	7.15	***	6.19		6.26		6.59	
Arable land (ha)	4.18	**	5.33	***	7.97	***	7.34	***	6.41		6.46		6.82	
Grassland (ha)	-0.13		-0.13		-0.19		-0.19		-0.22		-0.20		-0.23	
Intensity in husbandry (LU/ha) [1)]	0.44		0.67	**	0.40	**	0.27	**	0.29	**	0.00	**	0.01	**
Entering organic farming (%)	8		6		6		6		6		6		0	
Exiting husbandry (%)	-25	***	-17		-17		-25		-11		-6		-11	

Notes: [1)] Estimation is done only for farms with continuous husbandry (n=9 pairs); [2)] T-test and McNemar test are used for equally of means: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 ' ' 1; Source: Own calculations

Conclusions

The main challenges in estimating the effects from policy interventions in agriculture are the heterogeneity of participating farms and the resulting problem of selection bias. These challenges apply particularly in the case of the (Austrian) farm investment programme, since participating farms are very heterogeneous and participation is voluntary. In order to cope with these challenges in our study we combine *matching* with a DiD Estimation and use this approach to analyse the effects of supported farm-investment activities on structural adjustments in Austrian agriculture.

Our results indicate a positive effect of supported farm-investment activities on farm growth. This applies for both size measures we applied in our study, total livestock units and utilised agricultural area. Since the effect is higher for livestock units, we also find an increase of land-use intensity and animal husbandry. This is in line with the results of OECD (1994), which recognise intensification and competition trends on land as a matter of agricultural support policy. Furthermore, our results show that government-supported farm-investment activities reduce exit rates from husbandry and support farmers in entering organic farming. Therefore the supported investment activities contribute to the maintenance and to the increase of added value. In addition, this finding is in general supported by literature; for example, there is a study in the Czech Republic which detects an increase in gross added value from investment support (Medonos et al., 2012).

Our analysis shows that nearly all of the mentioned effects continuously increase in the time after investment. However, the stratification of the sample with regard to farm types gives us a more diverging picture of those developments. Therefore, whereas investing dairy cattle farms and to some extent pig farms need a considerable amount of time to realise the final effects of farm growth, investing poultry farms reach maximum effect after only two years of investment. Similar developments of the effects can be seen in the intensity in husbandry, with the highest effects for pig and poultry farms. This fact emphasises that growth on dairy and cattle farms is highly depending on the availability of land, in contrast to pig and poultry farms. The latter farm types are also those groups where supported investment activities show the highest effects with regard to not exiting husbandry. This is in contrast to dairy and cattle farms, where this effect is only small and is noticeably time delayed. The indication here is of rather long-term effects of an (supported) investment on dairy and cattle farms in contrast to poultry farms. Next to a slow increase in intensity effects in husbandry, it is dairy and cattle farms which use the supported farm-investment activities to enter organic farming.

These results give some incentive for new investment support programmes as well as for further application of programme-evaluation approaches. In this work we would like to stress that in particular the application of approaches like the conditional DiD Estimator might lead to biased results, as such methods usually do not consider a dynamic view on the results. The conclusion of our work, therefore, is that looking at only one point after the treatment might be disturbing, as the effects change quite fast over the time. The estimation of effects, particularly, might require different models with adequate time horizons for different farm types. However, the methodology used is well suited to the analysis of investment support programmes, since pre- and post-treatment data is obtainable. Furthermore, it helps to develop a data basis on which policy makers can readjust and enhance agri-political programs. Due to its simplicity, the *matching* analysis allows the opening of an integrative process, where researchers and policymakers can jointly reflect on causal exposures and develop new ideas for existing data limitations.

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Annex

Table A1: Means of matching variables (Z) for participating and control farms after matching

	Participating farms	Control farms
Number of farms	3555	3555
Mountain Farm Cadaster	80.49 (92.55)	80.16 (92.04)
Mountain farm zone 0 (%)	44 (5)	44 (5)
Mountain farm zone 1 (%)	17 (38)	17 (38)
Mountain farm zone 2 (%)	15 (36)	15 (36)
Mountain farm zone 3 (%)	20 (4)	20 (4)
Mountain farm zone 4 (%)	4 (18)	4 (18)
Federal state: Burgenland (%)	4 (19)	4 (19)
Federal state: Carinthia (%)	7 (25)	7 (25)
Federal state: Lower Austria (%)	26 (44)	26 (44)
Federal state: Upper Austria (%)	28 (45)	28 (45)
Federal state: Salzburg (%)	9 (28)	9 (28)
Federal state: Styria (%)	16 (37)	16 (37)
Federal state: Tyrol (%)	9 (29)	9 (29)
Federal state: Vorarlberg (%)	1 (11)	1 (11)
Total livestock units	22.38 (16.14)	22.06 (16.11)
Farm type: Dairy (%)	25 (43)	25 (43)
Farm type: Cattle (%)	43 (5)	43 (5)
Farm type: Pig (%)	13 (33)	13 (33)
Farm type: Poultry (%)	1 (1)	1 (1)
Farm type: Sheep and goat (%)	1 (11)	1 (11)
Farm type: Mixed (%)	7 (25)	7 (25)
Farm type: No husbandry (%)	10 (3)	10 (3)
Intensity in husbandry (LU/ha) [1)]	1.37 (0.48)	1.38 (0.48)
Diversity in husbandry [1)]	0.08 (0.13)	0.08 (0.13)
Fruit area (ha)	0.03 (0.45)	0.03 (0.45)
Wine area (ha)	0.36 (1.63)	0.35 (1.63)
Share of arable land (%)	42 (37)	42 (37)
Diversity on arable land (Pt.) [2)]	0.61 (0.2)	0.61 (0.21)
Intensity on arable land (Pt.) [2)]	2.01 (0.5)	2.00 (0.51)
Alpine farming (%)	7 (26)	7 (26)
Organic farming (%)	17 (37)	17 (37)
Agri-enviro 00-06 (%)	88 (32)	88 (32)
Agri-enviro 07-11 (%)	72 (45)	72 (45)

Notes: [1)] Estimation is done only for farms with continuous husbandry (n=2688 pairs); [2)] Estimation is done only for farms with continuous arable land (n=2269 pairs); Number in parentheses show standard deviations; Source: Own calculations

Table A2: Definition for all variables used in the model

	Variable name	Description of variable	Levels
T:	Treatment	Farm investment support in Austria participation in 2002-4	yes/no
Z:	Mountain Farm Cadaster	The Mountain Farm Cadaster (MFC) is a system for the individual assessment of the handicaps which a mountain farm. The management handicaps of mountain farms in Austria are assessed by the internal and external transport situation as well as climate and soil.	0 -570
	Mountain Farm Zone	According to the MFC, farms are assigned in five different mountain farm zones.	0, 1, 2, 3, 4
	State	Austria is divided in nine states.	Carinthia, Burgenland, Lower Austria, Upper Austria, Salzburg, Styria, Tyrol, Vorarlberg and the City of Vienna.
	Total livestock units	Total sum of all livestock, measured in livestock unit (LU)	continuous
	Farm type for livestock husbandry	Farms are assigned to farm types regarding their above average level of animal type (livestock units).	no animal husbandry, dairy farm, cattle farm, pig farm, poultry farm, sheep and goat farm, mixed farm
	Intensity in husbandry	Livestock per hectare UAA	continuous
	diversification in animal husbandry	A diversification index based on the Herfindahl measure is used.	0 - 1
	Fruit area	Total area of fruit production (hectares)	continuous
	Wine area	Total area of fruit production (hectares)	continuous
	Share of arable land	Hectare arable land per hectare UAA	0 - 1
	Diversity on arable land	A diversification index based on the Herfindahl measure is used.	0 - 1
	Intensity on arable land	Arable crops are assigned to a certain level of intensity. A weighted average is computed for each farm.	0 - 3
	Alpine farming	Farm has an alp	yes/no
	Organic farming	Farm is organic	yes/no
	Agri-enviro 00-06	Participation in agri-environmental scheme 2000-06 (except organic farming)	yes/no
	Agri-enviro 07-11	Participation in agri-environmental measure UBAG 2007-11	yes/no
Y:	Total livestock units	Total sum of all livestock, measured in livestock unit (LU)	continuous
	UAA	Utilized agricultural Area (hectares)	continuous
	Arable land	Total arable land (hectares)	continuous
	Grassland	Total grassland (hectares)	continuous
	Intensity in husbandry	Livestock per hectare UAA	continuous
	Intensity on arable land	Arable crops are assigned to a certain level of intensity (0,1,2,3). A weighted average is computed for each farm.	0 - 3
	Intensity on grassland	Share of extensive grassland on total grassland	0 - 1
	Entering organic farming	Farm is not organic in the year 2000 but in 2011.	yes/no
	Exiting organic farming	Farm is organic in the year 2000 but not in 2011.	yes/no
	Diversity in husbandry	A diversification index based on the Herfindahl measure is used	0 - 1
	Diversity on arable land	A diversification index based on the Herfindahl measure is used	0 - 1