

Supplemental online material

Investment Crowding-Out: Firm-Level Evidence from Northern Germany

Jerzy Michalek, Pavel Ciaian and d'Artis Kancs

Appendix A1: Specification test results

Estimation of a logit function

After cleaning the data base (by dropping from the set of potential control those agricultural farms which were found to be affected by the AFP) logit function was estimated using 807 observations on bookkeeping farms (Schleswig-Holstein) specialised in milk production, of which 101 were treated farms and 706 programme non-treated farms. The list of variables (40) is provided in **Error!**
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Table A1-1: Results of a logit function estimation

	Coef.	Std. err.	z	P> z	[95% conf. interval]	
Value of fixed assets – buildings	2.02E-06	2.35E-06	0.86	0.39	-2.59E-06	6.63E-06
Operating facilities (value)	-4.51E-06	7.51E-06	-0.6	0.548	-0.0000192	0.0000102
Machinery (value)	-0.0000268	7.17E-06	-3.74	0	-0.0000408	-0.0000127
Cattle (value)	1.97E-06	0.0000146	0.13	0.893	-0.0000267	0.0000306
Inventory stock	0.0000383	0.0000487	0.79	0.432	-0.0000572	0.0001338
Capital stock (value)	-2.54E-07	3.65E-07	-0.69	0.488	-9.70E-07	4.63E-07
Revenues beef/cattle/milk sales	6.66E-06	9.42E-06	0.71	0.48	-0.0000118	0.0000251
Purchased concentrated feed for cattle	0.0000454	0.0000106	4.28	0	0.0000246	0.0000662
Labour costs (total)	0.0001077	0.0004719	0.23	0.819	-0.0008171	0.0010326
Milk yield (per cow)	-0.0000613	0.0002764	-0.22	0.825	-0.000603	0.0004805
Fem. Calves > 0.5 year	0.0186913	0.0178942	1.04	0.296	-0.0163807	0.0537632
Fem. Calves > 0.5 and < 1 year	0.0118835	0.0167657	0.71	0.478	-0.0209766	0.0447436
Fem. Cattle > 1 and < 2 years	-0.0121226	0.0153492	-0.79	0.43	-0.0422064	0.0179613
Breeding Heifer	-0.0060769	0.0137317	-0.44	0.658	-0.0329905	0.0208366
Heifer	-0.0134439	0.0618279	-0.22	0.828	-0.1346243	0.1077365
Milk cows	-0.0613138	0.0338315	-1.81	0.07	-0.1276224	0.0049947
Suckler cows	-0.016113	0.0720671	-0.22	0.823	-0.1573618	0.1251358
Slaughter cows	-0.0048062	0.0287148	-0.17	0.867	-0.0610862	0.0514739
Male calves > 0.5	0.0121035	0.0156262	0.77	0.439	-0.0185234	0.0427303
Male cattle > 0.5 and < 1 year	0.0165394	0.0131412	1.26	0.208	-0.0092169	0.0422956
Male cattle > 1 and < 1.5 years	0.014429	0.013428	1.07	0.283	-0.0118895	0.0407475
Male cattle > 1.5 and < 2 years	0.0051632	0.0197474	0.26	0.794	-0.0335411	0.0438675
Male cattle > 2 years	-0.285279	0.3196748	-0.89	0.372	-0.9118302	0.3412722
Breeding bulls	0.1216614	0.1539543	0.79	0.429	-0.1800836	0.4234063
Pasture area	0.0072186	0.0068231	1.06	0.29	-0.0061544	0.0205916
Agricultural area (total)	0.0050058	0.0079983	0.63	0.531	-0.0106706	0.0206822
Non-family labour	-0.581429	0.4297761	-1.35	0.176	-1.423775	0.2609166
Labour total	0.3884432	0.3904466	0.99	0.32	-0.376818	1.153704
Milk production	7.79E-06	5.58E-06	1.4	0.163	-3.15E-06	0.0000187
Excess milk quota	1.93E-06	3.32E-06	0.58	0.562	-4.59E-06	8.44E-06

Equity capital formation	8.19E-07	1.47E-06	0.56	0.577	-2.06E-06	3.70E-06
Adjusted costs of labour employed	-0.0001288	0.0004732	-0.27	0.786	-0.0010563	0.0007987
Labour productivity (cattle/beef/milk per total labour)	-3.84E-06	0.0000143	-0.27	0.787	-0.0000318	0.0000241
Labour productivity (milk per total labour)	0.0005672	0.0006534	0.87	0.385	-0.0007134	0.0018478
Farm profit	-4.90E-06	8.59E-06	-0.57	0.568	-0.0000217	0.0000119
Adjusted equity capital formation	2.55E-07	2.98E-06	0.09	0.932	-5.58E-06	6.09E-06
Profit per farm (adjusted)	1.37E-06	5.39E-06	0.25	0.8	-9.20E-06	0.0000119
Earnings from self-employment	-0.0005951	0.0013484	-0.44	0.659	-0.0032378	0.0020476
Earnings from non-self-employment	0.0000249	0.000037	0.67	0.5	-0.0000476	0.0000975
Obtained level of support from previous programmes	-1.32E-06	0.0000126	-0.1	0.917	-0.0000261	0.0000234
Constant	-3.443257	2.004407	-1.72	0.086	-7.371823	0.4853098

Note: estimations in this table are based on a sub-sample which excludes programme affected non-treated farms.

In the next step results of a logit function estimation were used to derive for all agricultural farms specialised in milk production their individual probability (propensity scores) of participation in the AFP measure.

Selection of a matching algorithm

As the quality of a given matching algorithm depends strongly on a data set, the selection of a relevant matching technique was carried out using three independent criteria: i) standardised bias (ROSENBAUM and RUBIN, 1985); ii) t-test (ROSENBAUM and RUBIN, 1985); and iii) joint significance and pseudo R² (SIANESI, 2004).

Similar to the cases of other assessments of programme impact we found that the best results were achieved by using an iterative procedure (e.g. linear search) aimed at minimisation of the calculated standardised bias¹ (after matching) and applying $\min[\min]$ as the main selection criterion. In all considered cases (various matching algorithms)² an optimal solution could easily be found due to local/global convexity of the objective function with respect to function parameters under each matching algorithm (e.g. radius magnitude in radius matching; or number of nearest neighbours in nearest neighbour matching). An overview of results obtained using different matching algorithms for the case of re-estimation of effects of the AFP in Schleswig-Holstein is provided in Table A1-2.

Table A1-2: Selection of a matching algorithm

Matching method	Matching parameters	Estimated standardised bias (after matching)
Nearest neighbours	N (8)	4.30
	N (9)	3.90
	N (10)	4.02
Caliper	(0.08)	3.76
	(0.07)	Selected (min) => 3.70

¹ The standardised bias is the difference of the sample means in the treated and non-treated (full or matched) sub-samples as a percentage of the square root of the average of the sample variances in the treated and non-treated groups (ROSENBAUM and RUBIN, 1985).

² This does not apply to local linear weighting function matching which first smoothes out the outcome and then performs nearest neighbour matching. In this case more controls are used to calculate the counterfactual outcome than the nearest neighbour only (LEUVEN and SIANESI, 2009).

	(0.06)	3.95
Kernel normal	bw (0.03)	4.22
	bw (0.04)	3.99
	bw (0.05)	4.13
Kernel biweight		4.65
Kernel epanechnikov	bw (0.11)	3.92
	bw (0.09)	3.76
	bw (0.08)	3.89

The lowest estimated standardised bias (after matching) was found in the case of caliper matching (0.07). This matching algorithm was therefore used in the further work for assessment of the effect of the AFP on direct treated farms³.

The application of the above procedure and common support restrictions resulted in dropping 46 farms (2 treated and 44 non-treated farms) from further analysis, thus selecting *comparable* 761 farms of which: 99 were treated and 662 were non-treated farms (Table A1-3).

Table A1-3: Overview of the matched sample

Treatment	Common support		Total
	Off support	On support	
Non-treated	44	662	706
Treated	2	99	101
Total	46	761	807

Verification of the balancing property of matched variables

One of the important criteria applied for the assessment of the matching's quality can be the comparison of mean values of relevant covariates in both groups of farms (treated farms vs control group) before and after matching (using the selected matching algorithm). It is expected that application of the selected matching algorithm (here: caliper matching 0.07) will lead to a considerable reduction of original differences in mean values of each individual variable included as a covariate in the logit function, between treated and control farms.

The comparison of mean values for all variables included as covariates in the estimated logit function in both groups of farms before and after matching is presented in Table A1-4. The results show that for almost all variables (except for the variables: number of breeding heifers, non-family labour and earnings from non-self-employment) the selected matching procedure resulted in a significant reduction of differences in variables' means among both groups of farms, i.e. treated farms vs. controls thus making both groups of farms much more comparable. Furthermore, after the implementation of above matching procedure the estimated standardised selection bias could be reduced from 25.6 (before matching) to 3.70 (after matching), i.e. it dropped by 86%. At the same time pseudo R² decreased as expected, i.e. dropped from 0.201 to 0.119 respectively, i.e. by 41%.

³ The caliper matching algorithm (0.07) was also found to perform satisfactory concerning other important Selection criteria, i.e. balancing property and pseudo R² tests.

Table A1-4: Balancing property tests

Variable-Name	Sample	Treated	Control	% bias	% reduction bias	t-test	
						t	p> t
Long-term assets – buildings	Unmatched	78645	64423	26.4		2.33	0.020
	Matched	77665	77949	-0.5	98	-0.03	0.974
Operating facilities (value)	Unmatched	17355	16524	4.4		0.40	0.691
	Matched	17400	17474	-0.4	91.1	-0.03	0.977
Machinery (value)	Unmatched	28285	32066	-16.3		-1.44	0.150
	Matched	28410	28297	0.5	97	0.04	0.970
Cattle (value)	Unmatched	1.10E+05	93309	43.7		4.27	0.000
	Matched	1.10E+05	1.10E+05	4.8	89	0.33	0.744
Inventory stock	Unmatched	174.12	93.661	4.3		0.39	0.700
	Matched	177.64	115.81	3.3	23.2	0.21	0.834
Capital stock (value)	Unmatched	6.80E+05	6.60E+05	5.9		0.55	0.584
	Matched	6.80E+05	6.70E+05	2.8	52.3	0.20	0.844
Revenues beef/cattle/milk sales	Unmatched	2.30E+05	1.70E+05	63.7		6.39	0.000
	Matched	2.20E+05	2.20E+05	6.3	90.1	0.42	0.675
Purchased concentrated feed for cattle	Unmatched	-29362	-26278	-16		-1.70	0.090
	Matched	-29955	-30484	2.7	82.9	0.18	0.856
Labour costs (total)	Unmatched	-6808.1	-5562.6	-14.9		-1.39	0.164
	Matched	-6815.2	-6229.6	-7	53	-0.51	0.613
Milk yield (per cow)	Unmatched	7351.9	6572	64		5.67	0.000
	Matched	7340.2	7283.7	4.6	92.8	0.33	0.744
Fem. Calves > 0.5 year	Unmatched	17.089	13.544	35.7		3.38	0.001
	Matched	16.929	16.114	8.2	77	0.53	0.594
Fem. Calves > 0.5 and < 1 year	Unmatched	21.911	19.007	25.4		2.35	0.019
	Matched	21.788	21.116	5.9	76.9	0.42	0.678
Fem. Cattle > 1 and < 2 years	Unmatched	35.119	30.305	32.9		3.04	0.002
	Matched	35.03	33.67	9.3	71.7	0.65	0.519
Breeding Heifer	Unmatched	19.218	19.221	0		-0.00	0.998
	Matched	19.222	19.545	-2.6	-10189.4	-0.17	0.863
Heifer	Unmatched	0.18812	0.30028	-6.4		-0.48	0.631
	Matched	0.19192	0.15312	2.2	65.4	0.20	0.841
Milk cows	Unmatched	71.861	61.584	38.6		3.63	0.000
	Matched	71.404	70.437	3.6	90.6	0.25	0.806
Suckler cows	Unmatched	0.13861	0.25212	-6.8		-0.53	0.599
	Matched	0.14141	0.12746	0.8	87.7	0.07	0.941
Slaughter cows	Unmatched	2.4158	1.5312	20.9		2.00	0.045
	Matched	2.4646	2.2616	4.8	77	0.30	0.764
Male calves > 0.5	Unmatched	14.762	10.374	41.7		3.78	0.000
	Matched	14.525	14.631	-1	97.6	-0.06	0.952
Male cattle > 0.5 and < 1 year	Unmatched	19.465	13.006	44.7		4.20	0.000
	Matched	19.364	20.036	-4.7	89.6	-0.27	0.789
Male cattle > 1 and < 1.5 years	Unmatched	16.04	9.7578	43.3		4.20	0.000
	Matched	15.818	15.918	-0.7	98.4	-0.04	0.969
Male cattle > 1.5 and < 2 years	Unmatched	4.6337	2.6785	26.3		2.68	0.008
	Matched	4.5556	4.4296	1.7	93.6	0.10	0.923
Male cattle > 2 years	Unmatched	0.05941	0.2762	-15.4		-1.10	0.270
	Matched	0.0404	0.04363	-0.2	98.5	-0.08	0.936
Breeding bulls	Unmatched	0.63366	0.61331	2.4		0.24	0.814
	Matched	0.60606	0.60544	0.1	96.9	0.01	0.996
Pasture area (ha)	Unmatched	48.231	39.04	36.1		3.78	0.000
	Matched	47.908	45.685	8.7	75.8	0.59	0.554
Agricultural area (total) (ha)	Unmatched	94.335	83.954	26.9		2.69	0.007
	Matched	93.834	92.596	3.2	88.1	0.23	0.819
Non-family labour	Unmatched	0.17337	0.18493	-2.5		-0.24	0.810
	Matched	0.17586	0.14761	6.2	-144.3	0.47	0.637
Labour total	Unmatched	1.7463	1.7426	0.5		0.05	0.961
	Matched	1.7523	1.7325	2.7	-429.2	0.19	0.850
Milk production	Unmatched	5.30E+05	4.10E+05	59		5.83	0.000
	Matched	5.30E+05	5.10E+05	5.9	90.1	0.39	0.697
Excess milk quota	Unmatched	22801	15735	20.8		1.93	0.054
	Matched	23064	20533	7.4	64.2	0.48	0.634
Equity capital formation	Unmatched	1.60E+05	1.30E+05	23.5		2.08	0.038
	Matched	1.60E+05	1.50E+05	5.4	77.1	0.40	0.691
Adjusted costs of labour employed	Unmatched	-5374.4	-4303	-13.2		-1.24	0.216
	Matched	-5387.1	-4827.3	-6.9	47.8	-0.50	0.618
Labour productivity (cattle/beef / milk per total labour)	Unmatched	1.40E+05	1.10E+05	69.6		6.80	0.000
	Matched	1.40E+05	1.40E+05	0.5	99.2	0.03	0.977
Labour productivity (milk per total labour)	Unmatched	3303	2487.6	64.8		6.21	0.000
	Matched	3266.7	3255.9	0.9	98.7	0.05	0.961
Farm profit	Unmatched	54629	40518	48.8		4.65	0.000
	Matched	54634	52293	8.1	83.4	0.53	0.594
Adjusted equity capital formation	Unmatched	4818	2168.3	5.6		0.42	0.674
	Matched	4847.6	6284	-3	45.8	-0.24	0.808
Profit per farm (adjusted)	Unmatched	35728	23889	35.3		2.97	0.003
	Matched	35855	34159	5.1	85.7	0.36	0.722
Earnings from self-employment	Unmatched	9.8107	93.767	-10.2		-0.73	0.467
	Matched	10.009	11.991	-0.2	97.6	-0.18	0.858
Earnings from non-self-employment	Unmatched	466.01	534.24	-2.3		-0.20	0.845
	Matched	475	389.37	2.9	-25.5	0.22	0.827
Obtained level of support from previous programmes	Unmatched	9340	8685.3	5.8		0.55	0.583
	Matched	9206.3	8954.3	2.2	61.5	0.16	0.871

Note: estimations in this table are based on a sub-sample which excludes programme affected non-treated farms.

Appendix A2: Specification test results of the crowding-out effect

Given the previously calculated individual propensity scores for treated farms and control group, and after imposing restrictions on the common support region, a new relevant matching technique was selected (a truncated data base consisted of 244 observations of which 83 observations were on treated farms and 161 on non-treated farms), according to three independent criteria: i) standardised bias (ROSENBAUM and RUBIN, 1985); ii) t-test (ROSENBAUM and RUBIN, 1985); and iii) joint significance and pseudo R² (SIANESI, 2004). As a result, a kernel (normal kernel, b.w. 0.08) was found to be the “best” matching technique and was selected for calculation of the crowding-out effect effects of the AFP.

The comparison of mean values for all variables included as covariates in the estimated logit function in both groups of farms before and after matching is presented in Table A2-1. The results show that for almost all variables (except for the number of breeding heifers and total labour) the selected matching procedure resulted in a significant reduction of differences in variables’ means among both groups of farms, i.e. treated farms *versus* controls thus making both groups of farms much more comparable.

Table A2-1: Balancing property tests (crowding-out effect)

Variable-Name	Sample	Treated	Control	% bias	% reduction bias	t-test	
						t	p> t
Long-term assets – buildings	Unmatched	80059	51608	57.2		4.26	0.000
	Matched	77609	56705	42	26.5	2.51	0.013
Operating facilities (value)	Unmatched	16750	17352	-3.5		-0.25	0.800
	Matched	16952	17281	-1.9	45.3	-0.12	0.906
Machinery (value)	Unmatched	27561	35370	-36.9		-2.61	0.010
	Matched	27622	32227	-21.8	41	-1.34	0.182
Cattle (value)	Unmatched	1.10E+05	1.00E+05	23.1		1.74	0.083
	Matched	1.10E+05	1.10E+05	-7.8	66.1	-0.47	0.638
Inventory stock	Unmatched	211.8	0	15.5		1.40	0.164
	Matched	225.4	0	16.5	-6.4	1.00	0.320
Capital stock (value)	Unmatched	6.70E+05	6.20E+05	14		1.01	0.316
	Matched	6.60E+05	6.40E+05	4.4	68.6	0.28	0.782
Revenues beef/cattle/milk sales	Unmatched	2.20E+05	1.90E+05	37		2.81	0.005
	Matched	2.20E+05	2.20E+05	-6.3	83	-0.39	0.700
Purchased concentrated feed for cattle	Unmatched	-29142	-28927	-1.1		-0.09	0.931
	Matched	-30490	-31376	4.6	-313.5	0.29	0.776
Labour costs (total)	Unmatched	-6428.1	-5904.8	-6		-0.42	0.672
	Matched	-6232.8	-6232.2	0	99.9	-0.00	1.000
Milk yield (per cow)	Unmatched	7330.4	6846.9	38.4		2.77	0.006
	Matched	7244.4	7231.2	1.1	97.3	0.07	0.945
Fem. Calves > 0.5 year	Unmatched	17.181	14.012	31.2		2.33	0.021
	Matched	16.59	17.002	-4.1	87	-0.22	0.824
Fem. Calves > 0.5 and < 1 year	Unmatched	21.855	20.205	14.1		1.05	0.293
	Matched	21.372	21.056	2.7	80.9	0.17	0.867
Fem. Cattle > 1 and < 2 years	Unmatched	35.096	32.168	19.5		1.44	0.152
	Matched	34.385	33.672	4.7	75.7	0.30	0.767
Breeding Heifer	Unmatched	19.06	20.919	-14.2		-1.06	0.289
	Matched	19.205	21.536	-17.9	-25.4	-1.06	0.289
Heifer	Unmatched	0.22892	0.13043	12.1		0.94	0.347
	Matched	0.24359	0.07922	20.2	-66.9	1.31	0.193
Milk cows	Unmatched	71.096	64.745	23.6		1.76	0.079
	Matched	69.859	70.878	-3.8	84	-0.23	0.820
Suckler cows	Unmatched	0.16867	0.39752	-9.5		-0.63	0.529
	Matched	0.17949	0.2351	-2.3	75.7	-0.17	0.865
Slaughter cows	Unmatched	2.3253	1.4472	21.4		1.63	0.104

	Matched	2.2179	2.2264	-0.2	99	-0.01	0.990
Male calves > 0.5	Unmatched	14.735	11.708	26.8		1.91	0.058
	Matched	14.218	15.16	-8.3	68.9	-0.43	0.667
Male cattle > 0.5 and < 1 year	Unmatched	19.542	13.969	38.1		2.78	0.006
	Matched	19.359	18.654	4.8	87.3	0.25	0.805
Male cattle > 1 and < 1.5 years	Unmatched	16.06	11.143	30.4		2.19	0.029
	Matched	15.821	16.31	-3	90	-0.14	0.887
Male cattle > 1.5 and < 2 years	Unmatched	4.506	3.1615	18.3		1.35	0.177
	Matched	4.3974	4.686	-3.9	78.5	-0.22	0.826
Male cattle > 2 years	Unmatched	0.06024	0.34161	-14.1		-0.91	0.365
	Matched	0.03846	0.04948	-0.6	96.1	-0.26	0.798
Breeding bulls	Unmatched	0.61446	0.58385	3.7		0.28	0.779
	Matched	0.58974	0.57852	1.3	63.3	0.08	0.933
Pasture area (ha)	Unmatched	49.093	40.81	29.9		2.28	0.023
	Matched	48.201	44.891	11.9	60	0.75	0.456
Agricultural area (total) (ha)	Unmatched	93.311	89.865	9.2		0.69	0.490
	Matched	91.975	94.859	-7.7	16.3	-0.50	0.617
Non-family labour	Unmatched	0.15614	0.20634	-11.2		-0.79	0.429
	Matched	0.13923	0.18349	-9.9	11.8	-0.70	0.484
Labour total	Unmatched	1.6827	1.7401	-8.3		-0.62	0.539
	Matched	1.6683	1.785	-16.9	-103.1	-1.04	0.299
Milk production	Unmatched	5.20E+05	4.50E+05	36.4		2.75	0.006
	Matched	5.10E+05	5.10E+05	-2.5	93.3	-0.15	0.879
Excess milk quota	Unmatched	23110	18986	10.7		0.75	0.453
	Matched	21233	21270	-0.1	99.1	-0.01	0.995
Equity capital formation	Unmatched	1.60E+05	1.50E+05	7		0.49	0.627
	Matched	1.50E+05	1.40E+05	8.3	-18.3	0.71	0.479
Adjusted costs of labour employed	Unmatched	-5010.7	-4587.9	-5		-0.35	0.725
	Matched	-4834.9	-4826.6	-0.1	98	-0.01	0.995
Labour productivity (cattle/beef / milk per total labour)	Unmatched	1.40E+05	1.20E+05	49		3.77	0.000
	Matched	1.40E+05	1.30E+05	11.8	76.4	0.69	0.492
Labour productivity (milk per total labour)	Unmatched	3339.9	2746.1	47.6		3.56	0.000
	Matched	3269.4	3113.7	12.5	73.8	0.72	0.473
Farm profit	Unmatched	53271	44302	28.9		2.10	0.037
	Matched	50921	51098	-0.6	98	-0.04	0.971
Adjusted equity capital formation	Unmatched	5701.7	11245	-7.3		-0.48	0.632
	Matched	6079.4	5885	0.3	96.5	0.04	0.972
Profit per farm (adjusted)	Unmatched	34517	25450	28.9		2.07	0.040
	Matched	32722	32037	2.2	92.4	0.14	0.889
Earnings from self-employment	Unmatched	11.938	14.915	-3.1		-0.23	0.820
	Matched	12.704	11.316	1.5	53.4	0.10	0.919
Earnings from non-self-employment	Unmatched	540.52	758.7	-5.9		-0.41	0.683
	Matched	574.63	535.55	1.1	82.1	0.07	0.942
Obtained level of support from previous programmes	Unmatched	9207.8	8598	5.4		0.41	0.685
	Matched	9007.9	8587.9	3.7	31.1	0.23	0.817