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FORLand-Working Paper 28 (2023)

Published by
DFG Research Unit 2569 FORLand, Humboldt-Universität zu Berlin
Unter den Linden 6, D-10099 Berlin
https://www.forland.hu-berlin.de

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Agricultural Land Markets – Efficiency and Regulation

Organic cultivation and farmland prices: Does certification matter?

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March 2023

Abstract

This paper investigates price differentials between organically and conventionally farmed arable land. Organic commodities offer higher prices and environmental benefits such as improved soil constitution, where land buyers gauge these benefits against lower yields at higher risk, switching and higher production cost compared to conventional production. Combining land transaction and cover data from EU's Integrated Administrative Control System between 2005–2019, we test the hypothesis of positive valuation of organic cultivation, also for conventional use after sale. Based on a double robust approach, we find on average no effect but markups for conventional and markdowns for organic use post-sale.

Keywords: Organic agriculture, farmland pricing, Integrated Administrative Control System (IACS), ecosystem services, matching

JEL codes: Q15; Q24; Q51; R30

Acknowledgements

We gratefully acknowledge financial support from the German Research Foundation (DFG) through Research Unit 2569 Agricultural Land Markets - Efficiency and Regulation. We thank Daniel Müller, Jens Kolbe and Tillmann Schmitz for their support. We further thank the Oberer Gutachterausschuss für Grundstückswerte of the Federal State of Brandenburg and the Ministry for Agriculture, Environment and Climate Protection (MLUK) Brandenburg for providing transaction and IACS data, respectively.

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1 Introduction

Consumer preferences for high quality, environmentally friendly products and willingness to pay higher prices underscore the expansion of organic cultivation in the past two decades, from 15 to 75 million hectares, or about 1.6% of the world's total agricultural land (Meemken and Qaim 2018; Willer et al. 2022). Crops grown organically, i.e., without synthetic fertilizers and pest controls, however, generally incur lower yields at higher risks, higher production and labor than conventionally grown products costs (Seufert and Ramankutty 2017; de Ponti, Rijk, and van Ittersum 2012; Knapp and van der Heijden 2018). Also, switching from conventional to organic farming requires substantial investment in reorganizing farm structures and acquiring specific agronomic knowledge, e.g., about crop mix and rotations for plant nutrition and pest control (Genius, Pantzios, and Tzouvelekas 2006). Countries with organic certification processes may further require embargoing conventionally farmed lands before the acreage can be switched to organic cultivation (Musshoff and Hirschauer 2008; Kuminoff and Wossink 2010), i.e., crops cannot be marketed as organic and revenues are thus lower in this period. Germany, our study region, mandates a two-year embargo period (EU Regulation 2018/848 European Parliament 2018). Despite that, organic cultivation can be more profitable given the ongoing consumer trends (Barbieri et al. 2021; Läpple and Kelley 2013).

Plot location and size, and accessibility to local markets and potential customers contribute to achievable commodity prices of both organic and conventional products. A certified organic plot for sale in an organic cluster region may thus be subject to extensive bidding (Schmidtner et al. 2012; Marton and Storm 2021). For instance, environmental benefits from organic cultivation such as increased biodiversity, improved water quality, better soil functioning, and higher carbon stocks in soils could be valued by conventional and organic agricultural buyers (Reganold and Wachter 2016; Mäder et al. 2002; Gattinger et al. 2012; Birkhofer et al. 2008). Both agricultural and non-agricultural investor buyers could view organic farmland as safe havens for storing wealth and hedging against inflation, basing their purchasing decisions on society's increasing demand for organic products (Tietz, Forstner, and Weingarten 2013; Desmarais et al. 2017). Given the overall limited land supply, however, farmland markets are thinly traded and locally specific, where the local market microstructure, i.e., number of agents and their respective information levels as well as search and bargaining cost influence price formation. That is, a cluster region may contain large organic farms with informational and size advantages which offers them exercising market power in the bargaining process (Muthoo 2000; Balmann et al. 2021). Likewise, in an organic cluster region known for strong connectivity between organic farms (Läpple and Cullinan 2012), buyers and sellers may directly negotiate land sales at reduced prices because the search and bargaining costs are low for both sides (Turnbull and van der Vlist 2022; Kostov 2010).

Should potential buyers value the environmental benefits, e.g., soil fertility, from past organic cultivation, and the expected economic benefits, e.g., no conversion cost, of future organic use we hypothesize to observe higher sale prices of organic plots compared to conventional plots. But even if potential buyers value the ecological and societal benefits of organic plots, it remains unclear whether their expectations about future consumer preferences actually translate into net price markups given the hardly predictable local land market microstructure.

Thus, we seek to quantify the net effects of a history of organic farming on farmland transaction prices (treatment effect) and empirically investigate the related time trends for organic and conventional land prices. Combining georeferenced cropland transaction data for the Federal State of Brandenburg between 2005 and 2019 with field-level land cover data from the EU's Integrated Administrative Control System (IACS), we track the cultivation type by field (one transacted plot can consist of some fields or parcels) pre-, at time of, and post-sale. We differentiate three types of organic cultivation status (treatment): always organic, converted to organic, and post-sale converted to conventional, and use "always conventional" (counterfactual) as the reference category.

Comparing sales prices by cultivation status and interpreting price differences causally requires controlling for plot, land market microstructural and other regional characteristics that may affect land prices and the price differential. Therefore, we apply robust double matching. In the first stage, we use kernel matching to find transacted plots that are similar in main price determinants such as size, soil quality, and location, and in the second stage, we use weighted linear regressions on the matched datasets to uncover price differentials attributable to the status of organic cultivation, controlling for differences in local farmland market microstructure. To account for differences between organic cluster regions, we allow the price differentials to vary across "hotspot regions" identified by a hierarchical clustering, and use a rolling window analysis to understand the temporal evolution of price differentials for each cultivation status.

Our survey of the agricultural literature found two recent papers based on pure regression approaches without acknowledging farmland markets as thinly traded: Fuller, Janzen, and Munkhnasan (2021) investigate rental prices in the United States, and Veron (2022) investigates land price formation differences between organic and conventional farms in France. To our knowledge our paper is the first systematic sales price comparison of organic and conventional farmland to use each plot's organic cultivation history, and a double robust matching causally identify the price effects by cultivation type.

The remainder of the paper is organized as follows. Section 2 gives the details of the study region and data. Section 3 discusses the empirical modelling; section 4 presents the results and section 5 discusses the results. Section 6 concludes with policy implications and suggestions for future research.

2 Study region and data description

2.1 Study region

Located in eastern Germany, Brandenburg is an agricultural state with around 44% of its 29,640 km² used for agriculture consisting of 77% cropland and 23% permanent grassland. The agricultural land is characterized by low levels of soil quality (Schmitz and Müller 2020). Average precipiation is low with 580 mm annually between 1991 and 2020 (DWD 2022); nonetheless, only 3.8% of the agricultural land is under irrigation (Destatis 2021b). Soil quality shows substantial spatial variation also at a small scale, and despite clusters of high soil qualities, average soil qualities at county level are similar (see Figure 1a).

Following Germany's reunification in 1990, many collective farms in the east became large cooperative or corporate farms. In 2020, Brandenburg's 5,400 farms operated 242 ha on average, which is almost four times larger than the average German farm (Destatis 2021b). Single farms with an average size of 93 ha account for 68% of the total farms and comprise 26% of the total agricultural area, whereas farms operating as legal entities account for another 18%, have an average size of 703 ha and comprise 55% of the total (Destatis 2021b).

Around 8.5% of Brandenburg's agricultural land was farmed organically in 2006. In 2020, 13% of the farmland and 15% of the farms were under organic cultivation (German average: 9.7%) (Destatis 2021b; BMEL 2021). The strongest organic clusters are in the south and northeast (see Figure 1b); these locations tend to have mediocre soil qualities (Wolff et al. 2021). Conventional farming tends to cluster in areas with high soil qualities (see Figure 1c).

Organic farms are smaller (212 ha) on average than conventional farms (248 ha) and have a higher share of leased land (e.g., for legal entities 78% versus 68%) (Destatis 2021b; LELF 2021). Debt-financed farm growth reduced organic farms' equity ratios from 47% in 2014 to 40% in 2020, they increased their capital stocks from 2.780 €/ha in 2014 to 3250 €/ha in 2020. Nonetheless, conventional farms show higher capital stocks (2020: 5175€/ha) and higher equity ratios (2020: 51,5%).

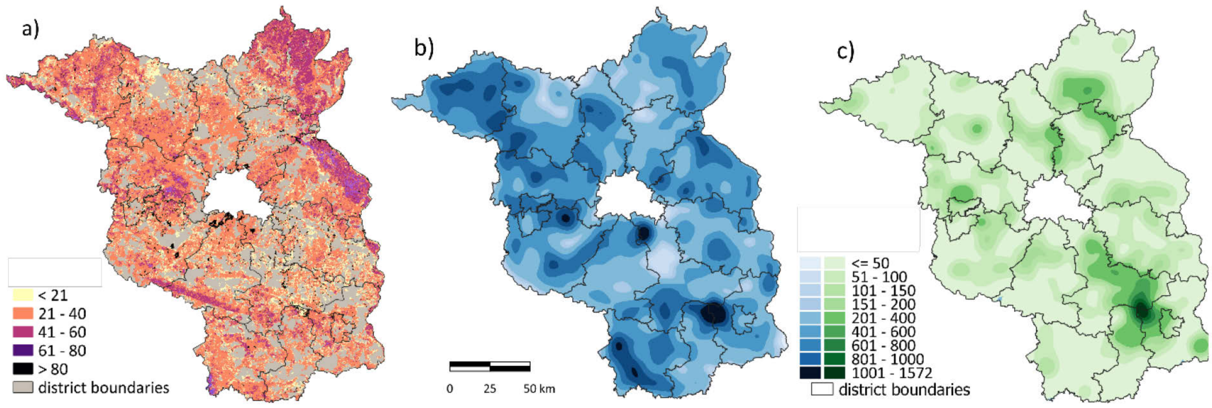

Figure 1: a: Distribution of soil quality of arable lands; b and c: Spatial density of organic (b) and conventional (c) arable land 2018

Source: a: Schmitz and Müller (2020) based on GeoBasis-DE; b and c: heat map based on the data from the Integrated administration and control system 2018 and a quartic kernel with 10 km bandwidth weighted with lot size.

The agricultural land market of Brandenburg has developed dynamically after 2000. Although Brandenburg's average nominal farmland prices increased by 11% annually from 2,470 €/ha in 2005 to 12,685 €/ha in 2020 (+400%), the price levels are still below the German average of 26,000 €/ha (Destatis 2021a). As a major seller, the Bodenverwertungs- und -verwaltungs GmbH (BVVG) privatizes forest and farmland on behalf of Germany's Ministry of Finance. Using first-price sealed-bid auctions with public tenders provides cost-efficient searches of buyers with a high willingness to pay (Seifert, Kahle, and Hüttel 2021); Balmann et al. (2021) reported 57% higher prices on average for BVVG sales in Brandenburg. BVVG transactions account for up to 35% of the transacted acres in Brandenburg annually. Despite privatization, the land market is thin and on average only 1.3% of Brandenburg's agricultural land was traded per year after 2005.

2.2 Farmland transactions data

We use farmland transaction data from Brandenburg's *Oberer Gutachterausschuss* (OGA, committee of land valuation experts) for arable land and grassland from 2005 to 2018. For each transaction we observe the sales price and major plot characteristics, such as size and soil quality measured by an index[1], and sale particulars, e.g., foreclosures. We use each plot's geocoded upper right corner as the latitude-longitude coordinate to link the regional covariates describing the respective region and other data sources to identify the cultivation status as described below.

The initial transaction dataset contains 34,878 observations of arm's-length transactions of arable land. We delete 6,186 observations with missing information on the soil quality index or other main variables (6,186 obs.)[2], land swaps, portfolio transactions, and 2,149 transactions labeled by the OGA as "not useable for price analysis". Following the OGA definition of regular land market activity, we delete 3,335 transactions smaller than 0.25 ha in size used as a minimum threshold for an arms-length transactions. After conducting a statistical outlier detection using the minimum covariance determinant estimator considering transaction price, lot size, and soil quality (Rousseeuw and van Driessen 1999), the resulting land transactions data comprise 22,333 observations.

2.3 Plot-level land use data

We match the transaction data on organic farming practices with plot-level data from the IACS by spatially joining coordinates of plots from the transaction data to the polygons of the IACS fields. The IACS administers annual payments of EU farming subsidies within the Common Agricultural Policy (CAP), thereby registering land management at plot-level for each year for plots larger than 0.3 ha. The annual data consist of a farm identifier, field size, geometry (polygons), crops planted, and the classification into organic or conventional. We assume the classifications imply exclusive use of the respective farming practices. Considering the IACS data as a panel dataset enables us to track the agricultural cultivation modes (always conventional, always organic, organic to conventional, conventional to organic) throughout the observation period.

There is a unique match between a transaction coordinate and an IACS polygon for 95% of the transactions. Because some coordinates of land transactions are located outside IACS polygons, we match transactions located within 50 meters to the nearest IACS polygon and exclude transactions farther away. We also exclude plots, which are no longer used for agricultural, such as for conversions to highways and other infrastructure.

This procedure augments the information of 18,986 transactions with the corresponding farming type information from the IACS. After excluding 1,648 transactions of lots labeled as conventional lots that receive subsidies for landscape conservation because they may include

[1] The soil quality index, which captures the natural yield capacity of arable land and grassland, ensures uniform fiscal valuations of Germany's agricultural land. The index is based on soil structure up to a depth of one meter, terrain, climatic conditions, water availability, and other natural conditions (Schmitz and Müller 2020).

[2] Soil quality data is missing for transactions of lots not intended for future agricultural use, such as public infrastructure investments.

organic farming practices or other farming constraints, the final sample includes 17,338 transactions with information on the cultivation history.

1,536 (9%) of the transacted lots are farmed organically at the point of sale with sales showing spatial clusters (see Appendix Figure 5). 1,162 (7%) of these lots are farmed organically throughout the observation period, whereas 374 (2%) lots are transformed to conventional farming after transactions. 577 (3%) of the transacted lots are farmed conventionally and later transformed to organic farming. 15,225 (88%) transactions belong to the always conventional control group.

2.4 Farmland price determinants

We use variables that describe local farmland markets, farming structures and topographic and climatic conditions to identify the potential price effects from organic farming and reduce omitted-variable bias in hedonic price analyses (Kuminoff, Parmeter, and Pope 2010; Abbott and Klaiber 2011). We capture potential returns from operating the farmland by the soil quality index, water availability, lot size and composition. To account for water availability we use long-run average precipitation from 1981 to 2010 at a 1 km raster[3] (DWD 2022). Since climate change influences yield potential and yield stability (Ortiz-Bobea 2020), we use a soil moisture index to indicate the number of drought months for the three years prior to a transaction.[4] We use the size of the lot to reflect potential economies of scale and an indicator variable for transactions consisting of multiple parcels. Larger lots may offer fixed cost degression to a farmer buyer (Ritter et al. 2020), whereas smaller plots may attract more farmer and other types of potential buyers (Brorsen, Doye, and Neal 2015).

To control for regional land market conditions and capture their potential impact on price formation (Balmann et al. 2021), we consider BVVG's share of transactions at the municipal level for the two years prior to a transaction. To acknowledge the local land market microstructure, we use the municipality's share of utilized agricultural area as an indicator for farmland availability; the municipality's total number transactions in as an indicator for market liquidity (Balmann et al. 2021; Kionka et al. 2021); the number of farms in a 12 km radius around a transaction indicates competition on the buyer side; and a concentration ratio (CR1) calculated as the share of agricultural land operated by the largest farm in a municipality serves as a proxy for market power among buyers (Balmann et al. 2021). We also use variables for lots adjacent to settlements, the Euclidean distance to nearest regional metropolis, to nearest administrative center (BBSR 2019), and to Berlin. To control for the price effects of renewable installations requiring farmland, we use installed kilowatts (kW) of biogas per hectare at the municipal level (Seifert, Kahle, and Hüttel 2021; Balmann et al. 2021). Table 1 lists the summary statistics by type of cultivation (see Appendix Table 4 for the details).

[3] For each transaction we project its location coordinate into this raster in order to assign the local precipitation.

[4] The index, provided by the Helmholtz Centre for Environmental Research, combines precipitation and the water storage capacity of the soils; values below 0.3 indicate abnormally dry conditions (see Zink et al. 2016 for details).

Table 1: Descriptive statistics of model variables by cultivation mode

	Variable	Unit	Always organic (n=1,162)		Organic to conv. (n=374)		Conv. to organic (n=577)		Always conv. (n=15,225)	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
Price	P	€/m²	0.55	0.41	0.54	0.44	0.47	0.38	0.60	0.47
Lot size	$size$	ha	4.89	9.22	5.75	11.48	5.87	11.84	5.79	12.16
Soil quality	$soilq$	index	28.61	8.20	28.13	7.74	29.43	8.42	32.61	9.09
Multiple parcels	$multiple$	[0/1]	0.10	0.30	0.15	0.36	0.14	0.35	0.11	0.31
Adj. to settlement	$settlement$	[0/1]	0.24	0.43	0.28	0.45	0.25	0.43	0.27	0.45
Dist. Berlin	d_Berlin	km	47.37	25.04	56.11	32.38	44.03	23.55	52.86	26.84
Dist. reg. metropolis	d_reg_center	km	33.58	17.76	37.47	19.93	36.58	16.59	40.17	18.35
Dist. admin. center	d_adm_center	Km	12.96	5.44	11.30	5.30	11.50	5.06	11.34	5.50
Drought index	$drought\_index$	count	9.84	3.97	10.19	3.87	9.64	3.40	9.95	3.78
Precipitation	$prec\_30\_yrs$	cm/a	57.07	2.61	57.91	3.46	56.70	3.25	57.00	3.32
Seller BVVG	$seller\_BVVG$	[0/1]	0.20	0.40	0.17	0.38	0.19	0.39	0.18	0.38
Concentration ratio	$CR1$	(0,1]	0.31	0.18	0.25	0.12	0.27	0.14	0.29	0.18
Total sales	$\#transact\_1yr$	count	8.11	6.97	9.90	10.70	10.09	7.73	10.18	10.53
#Farms	$\#farms\_12km$	count	131.61	50.98	108.64	47.33	122.63	48.37	120.46	47.04
Biogas capacities	$biogas\_kW\_ha$	kW/ha	0.10	0.20	0.17	0.32	0.13	0.23	0.15	0.25
Share BVVG	$share\_BVVG$	%	0.20	0.21	0.19	0.22	0.19	0.21	0.19	0.20

3 Empirical modelling

3.1 Effects of interest

To investigate the net price effects of organic cultivation at time of sale, we base our approach on a standard hedonic pricing framework (Nickerson and Zhang 2014). In this framework, a lot's price reflects the implicit prices of its characteristics determined at the point where the buyer's willingness to pay (WTP) equals the seller's willingness to accept (WTA). The observed farmland price P of transaction i is a function of lot characteristics x_i and the lot's cultivation history such that $\ln(P_i) = h(x_i'\beta) + \delta d_i + \varepsilon_i$, where h denotes the hedonic price function, β is a vector of appreciations for the characteristics, d_i is an indicator for the cultivation type history of a lot (treatment), δ is the corresponding net average price effect, i.e. the price differential by cultivation history, and ε captures the deviations in observed prices due to measurement error and noise.

We differentiate three types of organic cultivation status (treatment) and replace d_i by three dummy variables, each representing a distinct treatment group:

- $d_i^{ao} = 1$ for all N^{ao} plots farmed organically in all periods ("always organic": ao)
- $d_i^{co} = 1$ for all N^{co} plots converted from conventional to organic use after the transaction and within our observation window ("conventional to organic": co)
- $d_i^{oc} = 1$ for all N^{oc} plots converted from organic to conventional use after the transaction and within our observation window ("organic to conventional": oc)

3.2 Double robust approach

Estimating the effects of cultivation history depends on whether our hedonic regression model controls for the influence of all other price determinants and that the effects of these variables is the same in all four groups. Figure 1 suggests, however, a strong spatial autocorrelation of organically and conventionally farmed lots and some of the lots more likely are under organic cultivation, i.e., a potential self-selection into the cultivation mode.

To avoid biases introduced by cultivation type and history, we use a double robust two-stage method (Ho et al. 2007): In the first stage we use a matching algorithm to find for each treatment group a control group in the sample of always conventionally cultivated lots with comparable characteristics. In the second stage, we use the matched control group(s) and the treatment groups for the hedonic analysis and estimate a separate weighted regression for each cultivation history.

This two-stage approach ensures that control group plots geographically close and similar with regard to lot size and soil quality to treatment group plots traded in the same time window receive the largest weight in the estimation process. Thereby, we also improve the similarity of treatment and control group regarding price-relevant factors unobserved by us, including, for instance, unobserved environmental and climatic conditions and characteristics of the local market microstructure (cf. Isenhardt, Seifert, and Hüttel 2022).

In stage one, we use kernel matching (Cameron and Trivedi 2008, 875) to determine transaction-specific weights, $w_i \geq 0$, for observations from the control group. For each treatment, we perform six steps:

1. Collect J control group observations from the same observation year, one year prior, or one year after the transaction for each treatment observation i.
2. Calculate the distance in km between treatment observation i and each control group observation j.
3. Calculate the Mahalanobis distance of each control group observation j to treatment observation i using the distance and plots' lot size and soil quality to find a vector of Mahalanobis distances with elements M_{ij}.
4. Determine a bandwidth h using the plug-in estimator of Wand and Jones (1994).
5. Calculate matching weights $w_{ij} = \frac{K\left({M_{ij}}/{h}\right)}{\sum_j K\left({M_{ij}}/{h}\right)}$ using a Gaussian kernel.
6. Repeat steps 1 through 5 for each treatment group observation to obtain a matrix of weights w_{ij} with N^{ao} rows and N^{ac} columns; the final weight of each control group observation j is the sum over its column in the matrix.

In the second stage, we estimate the parameters of the hedonic regression for each treatment indicator $d_i^{ao}, d_i^{co}, d_i^{oc}$ separately with a weighted least squares procedure using the weights for the control group observations obtained in stage one and setting weights $w_i = 1$ for treatment group observations. To illustrate, the weighted least squares estimator for the group "always organic" lots is the solution to

$$\min_{\delta^{ao},\beta} \sum_{i=1}^{N^{ao}+N^{ac}} w_i \cdot [\ln(\mathrm{P_i}) - (h(x_i'\beta) + \delta^{ao} d_i^{ao})]^2 \tag{1}$$

where N^{ao} denotes the number of observations in the "always conventional" control group. δ^{ao} is the average difference in the log price between plots always farmed organically throughout the observation period and the plots always farmed conventionally adjusted for the influence of all other price determinants collected in x_i. Analogously, we derive the parameter estimates δ^{co} and δ^{oc} denoting price differences to "always conventional" lots for lots converted to organic farming and lots converted to conventional farming.

3.3 Empirical specification

We use the log of the nominal price in Euro per square meter as dependent variable and a flexible specification of the hedonic function given by

$$\begin{aligned} h(x_i'\beta) = {} & \beta_0 + \beta_1\sqrt{soilq_i} + \beta_2 soilq_i^2 + \beta_3\sqrt{size_i} + \beta_4 size_i^2 + \beta_5 soilq_i \times size_i \\ & + \beta_6 multiple_i \\ & + \beta_7\, settlement_i + \beta_8\, d\_Berlin_i + \beta_9\, d\_Berlin_i{}^2 + \beta_{10} d\_reg\_center_i \\ & + \beta_{11} d\_adm\_center_i \\ & + \beta_{12} drought\_index_i + \beta_{13} prec\_30\_years_i + \beta_{14} prec\_30\_years_i^2 \\ & + \beta_{15}\, CR1_i + \beta_{16} CR1_i{}^2 + \beta_{17}\, \#transact\_1yr_i + \beta_{18} \#farms\_12km_i \\ & + \beta_{19} biogas\_kW\_ha_i \\ & + \beta_{20}\, seller\_BVVG_i + \beta_{21}\, share\_BVVG_i + \beta_{22}\, share\_BVVG_i^2 \\ & + regional\_FE_i + annual\_FE_i \end{aligned} \tag{2}$$

where the right-hand side variables control for characteristics of the lot (row 1), the location of the lot (row 2), environmental and climatic factors (row 3), and local market conditions (rows 4 and 5); county dummy and year variables for regional and time fixed effects control for further unobserved heterogeneity and the strong price rise in the observation period (row 6). To allow a non-linear relationship between farmland prices and lot size (Ritter et al. 2020) and soil quality (Seifert, Kahle, and Hüttel 2021), both enter the hedonic function in square roots, squared terms, and as their interaction. Likewise, precipitation, the concentration ratio, the share of BVVG transactions, and the distance to Berlin enter as linear and quadratic terms to allow for potential non-linearities. To mitigate potential omitted variable bias due to unobserved regional effects, we add regional fixed effects using 18 dummy variables for Brandenburg's counties; annual fixed effects are included as dummy variables to capture temporal effects. The following variables in the regression equation are multiplied by 10^{-2} to ease the presentation of parameter estimates: the squared terms of lot size and soil quality, their interaction, the distance to

Berlin, regional metropolis and administrative centers, the squared historical precipitation, and the number of farms in a 12 km radius.

3.4 Effect heterogeneity

We observe transactions of "always conventional" lots well distributed over our entire study region, and transactions with different treatments concentrated in some areas. To acknowledge potential influence from regional clusters (Schmidtner et al. 2012), we investigate the potential *spatial heterogeneity* of the effects between spatial clusters of organic farming ("hotspots"). We use cluster analysis to identify hotspots and subsequently estimate an extended specification of our weighted regressions that includes interactions of the treatment indicator with dummy variables indicating the location of a transaction in a hotspot.

We use hierarchical clustering based on geographical distances between all transactions of one treatment type. The clustering uses a single linkage with a cut-off at 6 km such that no other transaction with the same treatment status is located within a 6 km radius around a cluster. For each cluster, we set a minimum size of at least 30 observations. In contrast to other clustering algorithms, such as k-means, this allows to cluster observations without specifying the number of clusters ex ante.

Based on the clustering, we expand the specification of the post-matching regression by interactions of the treatment indicators with dummy variables indicating the location of a transaction in a hotspot. For "always organic" lots, we use dummy variables hs_{ik}^{ao} that equal one if transaction i is located in "ao"-hotspot k and expand the regression equation by

$$\text{(3)} \qquad \dots + \delta^{ao} d_i^{ao} + \sum_k \delta_k^{ao} (d_i^{ao} * hs_{ik}^{ao}),$$

where δ^{ao} is the average log price difference for lots that were always organically farmed compared to always conventional lots, and δ_k^{ao} is the additional markup/markdown for always organically farmed lots in hotspot k. Similarly, we extend the regression specification to estimate hotspot effects δ_l^{co} and δ_m^{oc} for lots switching from conventional to organic and from organic to conventional farming for the respective hotspots l and m, respectively. We estimate all models with weighted least squares using the R function *lm* function under version 4.1.1.

To investigate our conjecture about time trends in potential price markups due to emerging societal trends in organic food consumption, we use a rolling window approach that splits our initial sample of treated observations into overlapping subsamples of four years in length, and analyze the treatment effects for the resulting 11 overlapping slices (2005–2008, 2006–2009, …, 2015–2018). For each slice and for each treatment, we perform kernel matching, considering all control observations from the same period, one year before, and one year after. The weights obtained from kernel matching enter the weighted post-matching regressions with the model specification above. For each treatment, this approach gives the average log price difference to always conventional lots slice for each of the 11 slices.

To test the null hypothesis of no effect of an organic cultivation history, we assume that observed transaction prices are an outcome of a data generating process and rely on the idea of random sampling for statistical inference (Imbens 2021). To indicate estimation uncertainty for statistical testing, we use heteroscedasticity-consistent bootstrapped standard errors using the *vcovBS* function from the sandwich package (Zeileis, Köll, and Graham 2020).

4 Results

4.1 Matching

There is a considerable reduction in the differences between the treated and the control samples for all matching variables. Figure 2 shows that the post-matching differences, which are far below the thresholds of acceptable standardized mean differences between 0.1 and 0.25 for a covariate (Harder, Stuart, and Anthony 2010), indicate a notable balance between the treated and control samples. The average distance between treated and the corresponding weighted control units is 10 km on average and indicates the likely occurrence of transactions of a treated and its matched control units under similar market conditions and market microstructure. For the matched samples, we find small unconditional price differences between the treated and matched control units with markdowns of less than 0.01 EUR/m² for always organic and conventional to organic, and markups of 0.05 EUR/m² for organic to conventional (see Appendix Table 5).

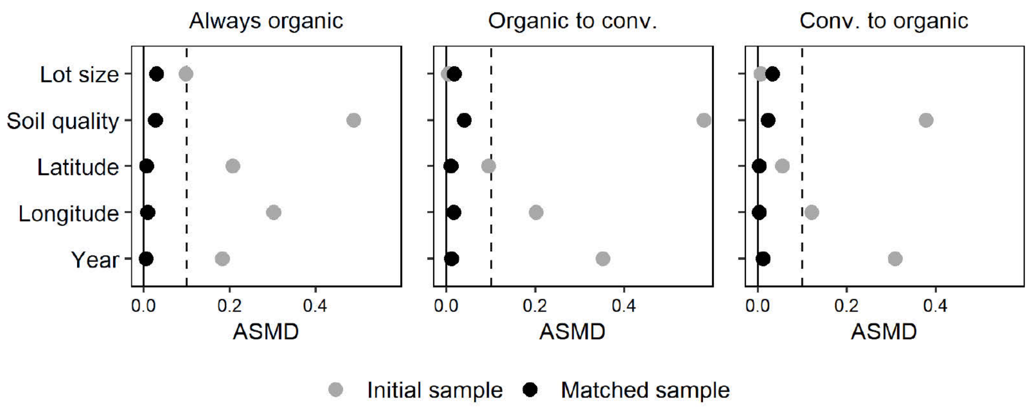

Figure 2: Covariate balance as absolute standardized mean difference (ASMD) before and after matching by treatment

4.2 Regressions

Table 2 summarizes the models' parameter estimates and their respective standard errors for the hedonic and regional control variables of the weighted regressions with weights for the control units obtained by kernel matching (see Appendix Table 6 for the coefficient estimates of the time- and county dummy variables). All models show satisfactory goodness of fit with R^2 greater than 0.7 in all regressions.

Table 2: Coefficient estimates and corresponding confidence intervals of post-matching regressions

	Always organic		Organic to conventional		Conventional to organic	
	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
Intercept	-2.048	[-3.308, -0.788]	-4.879	[-6.152, -3.607]	-4.920	[-6.156, -3.684]
√ Soil quality	0.035	[0.006, 0.065]	0.060	[0.031, 0.088]	0.088	[0.058, 0.119]
√ Lot size	0.044	[0.034, 0.055]	-0.020	[-0.030, -0.010]	-0.004	[-0.014, 0.006]
Lot size² $\times 10^{-2}$	-0.003	[-0.004, -0.002]	-0.007	[-0.008, -0.006]	-0.010	[-0.011, -0.009]
Soil quality² $\times 10^{-2}$	0.014	[0.011, 0.018]	0.004	[0.001, 0.008]	0.004	[-0.0001, 0.007]
Lot size × Soil quality $\times 10^{-2}$	0.008	[0.002, 0.013]	0.040	[0.034, 0.046]	0.039	[0.034, 0.045]
Multiple parcels (1=yes)	-0.039	[-0.059, -0.018]	0.017	[-0.004, 0.037]	-0.032	[-0.052, -0.011]
Adj. to settlement (1=yes)	0.111	[0.098, 0.124]	0.091	[0.076, 0.105]	0.086	[0.072, 0.101]
Dist. Berlin	-0.007	[-0.009, -0.006]	-0.0004	[-0.002, 0.001]	-0.003	[-0.004, -0.002]
Dist. Berlin² $\times 10^{-2}$	0.005	[0.004, 0.006]	-0.002	[-0.003, -0.001]	0.002	[0.001, 0.003]
Dist. reg. metropolis $\times 10^{-2}$	0.039	[-0.014, 0.093]	-0.093	[-0.144, -0.042]	0.096	[0.041, 0.150]
Dist. adm. center $\times 10^{-2}$	0.001	[-0.00001, 0.002]	0.003	[0.002, 0.004]	0.001	[-0.001, 0.002]
Drought index	0.003	[0.001, 0.005]	0.010	[0.008, 0.012]	0.004	[0.002, 0.006]
Precipitation	0.013	[-0.031, 0.057]	0.097	[0.052, 0.142]	0.098	[0.054, 0.142]
Precipitation ² $\times 10^{-2}$	-0.016	[-0.055, 0.022]	-0.084	[-0.123, -0.044]	-0.077	[-0.116, -0.038]
Concentration rate CR1	0.419	[0.286, 0.552]	0.814	[0.679, 0.949]	0.077	[-0.053, 0.206]
Concentration rate CR1²	-0.603	[-0.751, -0.456]	-0.809	[-0.959, -0.660]	-0.132	[-0.275, 0.012]
Total transactions municip.	0.001	[0.0001, 0.001]	0.0001	[-0.0004, 0.001]	0.003	[0.002, 0.003]
#farms 12 km radius $\times 10^{-2}$	-0.006	[-0.023, 0.011]	0.049	[0.032, 0.067]	0.074	[0.056, 0.092]
Biogas kW/ha UAA	-0.021	[-0.048, 0.006]	0.009	[-0.018, 0.037]	-0.049	[-0.076, -0.021]
Seller BVVG	0.428	[0.412, 0.444]	0.448	[0.430, 0.465]	0.436	[0.420, 0.452]
Share BVVG transactions	0.319	[0.239, 0.399]	0.331	[0.248, 0.413]	0.491	[0.410, 0.572]
Share BVVG transactions²	-0.392	[-0.495, -0.288]	-0.538	[-0.641, -0.435]	-0.646	[-0.749, -0.542]
Conv. to organic					-0.041	[-0.075, -0.007]
Organic to conv.			0.079	[0.038, 0.121]		
Always organic	-0.024	[-0.046, -0.001]				
Year dummy	Yes		Yes		Yes	
County dummy	Yes		Yes		Yes	
R^2 weighted	0.685		0.707		0.681	
R^2 unweighted	0.729		0.700		0.709	
Observations	16,387		15,599		15,802	
# Treated units	1,162		374		577	
# Control units	15,225		15,225		15,225	

Notes: 95% CI denotes the 95% confidence interval based on bootstrapped standard errors (1000 bootstrap replications). Estimates and confidence intervals of county and year dummy variables are listed in the appendix, Table 6.

Results show that the price differentials for organic lots depend on a lot's future use. Whereas lots organically farmed throughout the observation period achieve markdowns of 2.4% compared to always conventionally farmed lots (Table 2, column 1), lots converted from organic to conventional after sale achieve markups of 7.9% compared to always conventionally farmed lots (column 2). The average of these effects weighted by the number of transactions of the respective groups is close to zero $(0.001 \approx -0.024 * \frac{1162}{1162+374} + 0.079 * \frac{374}{1162+374})$ indicating overall no differences between lots farmed organically at sale and lots always farmed conventionally.[5] Conventional lots later transformed to organic farming achieve markdowns of 4.1% (column 3). To evaluate statistical significance, we use the corresponding 95% confidence intervals (CI) of the respective estimates: All confidence intervals are one-sided and based on

[5] This is further supported by a post-matching regression based on the matched sample for the treatment "organic at sale" that includes lots of the "always organic" and "organic to conventional" group (see Appendix Table 7).

a t-test, we can reject for all effects the null hypothesis of no effects at least at the 5% significance level. This indicates that buyers intending conventional farming in the future value the history of organic farming of a lot.

4.3 Effect heterogeneity

Figure 3 shows the spatial distributions of the clusters with at least 30 transactions identified by hierarchical clustering. For always organic there are nine clusters with 33 (ID: 9) to 244 (ID:1) transactions; for conventional to organic there are three clusters with 30 to 80 transactions; and for conventional to organic there is one cluster with 32 transactions.

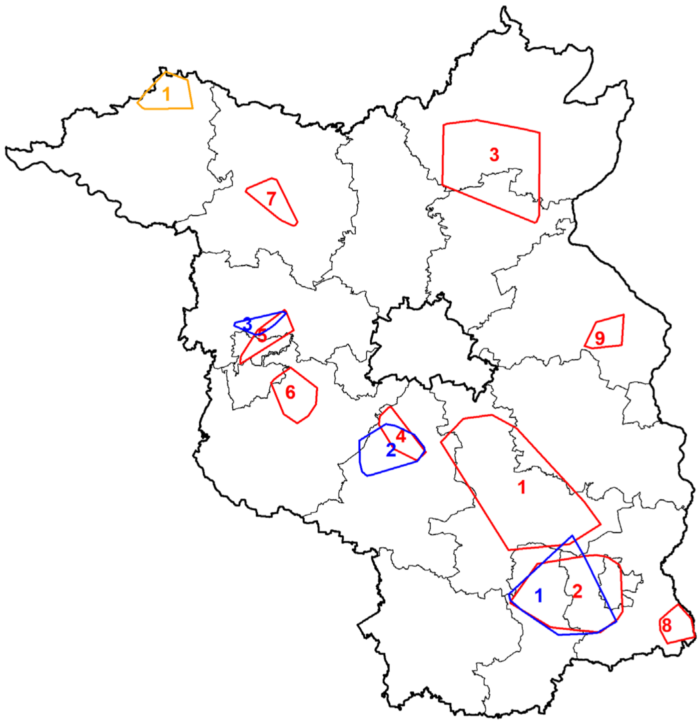

Figure 3: Identified hotspots with more than 30 transactions: always organic (red), conventional to organic (blue), organic to conventional (orange).

Table 3 shows the coefficient estimates from the expanded regression equation. All expanded regressions provide evidence for spatial heterogeneity. Column 1 shows the expanded weighted regression for always organic; it contains dummy variables alw1 to alw9 that indicate that always organic lots are located in one of the nine corresponding hotspot regions. Because there are lots from each treatment group that belong to none of the hotspot regions, we also keep the overall "always organic" dummy variables in the model. The results from the expanded pooled regression can thus be directly compared to the pooled regression results from Table 2, where the interaction dummies of the expanded regression allow to explore spatial heterogeneity in the treatment effects. Analogously, column 2 and 3 show the parameter estimates for lots converted to conventional and to organic, respectively.

Table 3: Coefficient estimates and respective confidence intervals of extended post-matching regressions

	Always organic		Organic to conventional		Conventional to organic	
	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
Intercept	0.209	[-1.073, 1.491]	-4.193	[-5.483, -2.903]	-2.330	[-3.584, -1.076]
√ Soil quality	0.095	[0.066, 0.125]	0.085	[0.056, 0.114]	0.045	[0.015, 0.076]
√ Lot size	0.067	[0.057, 0.077]	0.055	[0.044, 0.066]	0.060	[0.049, 0.070]
Lot size² $\times 10^{-2}$	-0.001	[-0.002, -0.0004]	-0.003	[-0.004, -0.002]	-0.003	[-0.004, -0.002]
Soil quality² $\times 10^{-2}$	0.005	[0.001, 0.009]	0.008	[0.004, 0.012]	0.012	[0.009, 0.016]
Lot size $\times$ Soil quality $\times 10^{-2}$	-0.003	[-0.008, 0.002]	0.002	[-0.004, 0.007]	0.003	[-0.002, 0.009]
Multiple parcels (1=yes)	0.006	[-0.015, 0.026]	-0.080	[-0.101, -0.059]	-0.060	[-0.081, -0.040]
Adj. to settlement (1=yes)	0.153	[0.138, 0.167]	0.080	[0.066, 0.094]	0.136	[0.122, 0.150]
Dist. Berlin	-0.002	[-0.003, -0.001]	-0.001	[-0.003, -0.0003]	-0.003	[-0.004, -0.002]
Dist. Berlin² $\times 10^{-2}$	0.001	[-0.0002, 0.002]	0.0003	[-0.001, 0.001]	0.002	[0.001, 0.003]
Dist. reg. metropolis $\times 10^{-2}$	0.020	[-0.032, 0.073]	0.112	[0.058, 0.165]	0.069	[0.016, 0.122]
Dist. adm. center $\times 10^{-2}$	-0.001	[-0.002, -0.0002]	0.002	[0.001, 0.003]	-0.002	[-0.004, -0.001]
Drought index	0.010	[0.008, 0.012]	0.004	[0.002, 0.006]	0.006	[0.004, 0.009]
Precipitation	-0.088	[-0.134, -0.042]	0.062	[0.016, 0.108]	0.004	[-0.041, 0.049]
Precipitation² $\times 10^{-2}$	0.073	[0.033, 0.113]	-0.056	[-0.096, -0.015]	0.0003	[-0.039, 0.040]
Concentration rate CR1	0.268	[0.138, 0.397]	0.380	[0.251, 0.508]	0.158	[0.026, 0.291]
Concentration rate CR1²	-0.380	[-0.523, -0.237]	-0.541	[-0.678, -0.403]	-0.144	[-0.291, 0.002]
Total transactions municip.	0.0002	[-0.0004, 0.001]	0.002	[0.001, 0.002]	0.001	[0.0003, 0.001]
#farms 12 km radius $\times 10^{-2}$	0.044	[0.026, 0.061]	0.059	[0.041, 0.077]	0.067	[0.049, 0.085]
Biogas kW/ha UAA	0.083	[0.055, 0.110]	0.030	[0.003, 0.056]	0.063	[0.036, 0.090]
Seller BVVG	0.432	[0.415, 0.448]	0.395	[0.379, 0.411]	0.396	[0.380, 0.413]
Share BVVG transactions	0.114	[0.032, 0.195]	0.418	[0.338, 0.497]	0.108	[0.025, 0.192]
Share BVVG transactions²	-0.163	[-0.269, -0.057]	-0.628	[-0.729, -0.527]	-0.247	[-0.356, -0.138]
Cluster: alw1	-0.245	[-0.312, -0.178]				
Cluster: alw2	-0.004	[-0.073, 0.066]				
Cluster: alw3	0.009	[-0.052, 0.070]				
Cluster: alw4	0.107	[-0.029, 0.242]				
Cluster: alw5	-0.025	[-0.144, 0.093]				
Cluster: alw6	0.004	[-0.093, 0.102]				
Cluster: alw7	0.029	[-0.058, 0.116]				
Cluster: alw8	-0.173	[-0.340, -0.006]				
Cluster: alw9	-0.297	[-0.409, -0.185]				
Cluster: otc1			0.207	[0.087, 0.327]		
Cluster: cto1					0.025	[-0.082, 0.133]
Cluster: cto2					-0.356	[-0.446, -0.267]
Cluster: cto3					-0.082	[-0.160, -0.004]
Conv. to organic					0.011	[-0.030, 0.053]
Organic to conv.			-0.019	[-0.063, 0.025]		
Always organic	0.023	[-0.017, 0.062]				
Year dummy	Yes		Yes		Yes	
County dummy	Yes		Yes		Yes	
R^2 weighted	0.734		0.737		0.707	
R^2 unweighted	0.725		0.727		0.729	
Observations	16,387		15,599		15,802	
# Treated units	1,162		374		577	
# Control units	15,225		15,225		15,225	

Notes: 95% CI denotes the 95% confidence interval based on bootstrapped standard errors (1000 bootstrap replications). Estimates and confidence intervals of county and year dummy variables are listed in the appendix, Table 10.

Regarding the "always organic" effect, several of the hotspot-dummy variables show sizeable and statistically significant negative effects (alw1, alw8 and alw9). The corresponding clusters 1, 8 and 9 contain 244, 33 and 36 observations, respectively, where clusters 1 and 8 are areas with high shares of organic farming. In fact, for "always organic" lots in cluster 1 and 8, on average 43% and 22% of the surrounding farmland in a 12 km radius is operated organically, in contrast to only 9% for organically operated lots not assigned to clusters.

Regarding the "organic to conventional" effect, we find a strong and statistically significant effect for the single hotspot cluster (otc1). The effect size is considerably larger than the "organic to conventional" effects reported in Table 2, suggesting that the hotspot cluster stands out. We note that transactions in this cluster have a median size of 8.2 ha, and are thus nearly three times larger than average transactions of this treatment group and "always conventional" transactions.

There is also considerable spatial heterogeneity for conventional to organic indicated by the substantial cluster-specific deviations from the modest negative effect in Table 2. The dummy variable for all conventional to organic transactions is statistically insignificant, whereas cto2 and cto3 show large negative and statistically significant effects. There are no effects for always organic alw4 and alw5, which partly overlap with cto2 and cto3.

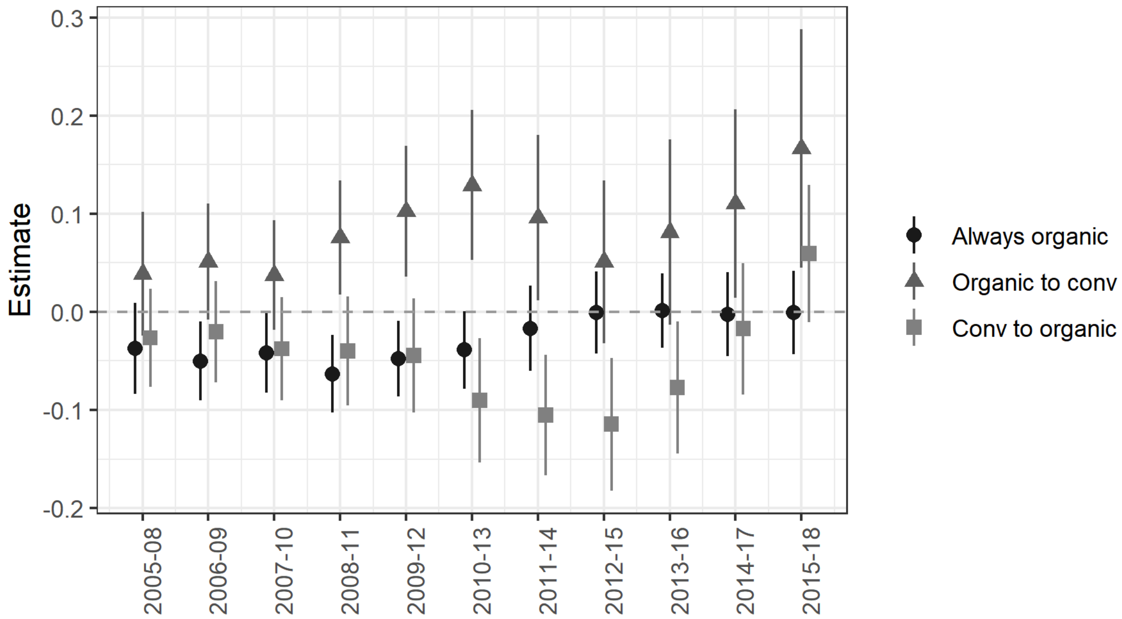

Figure 4: Coefficient estimates of treatment indicators for 4-year rolling window with 95% confidence intervals based on bootstrapped standard errors (1000 bootstrap replications)

Splitting our initial sample of treated observations into overlapping subsamples of four years in length produces treatment effects for the resulting eleven overlapping slices. Regression results for the hedonic function are generally in line with the pooled regressions in Table 2 (see Appendix Table 11–13 for detailed regression results). The treatment effects by slice indicate that always organic achieves statistically significant price markdowns between 4% and 6% for the six slices before 2011, whereas treatment effects are statistically insignificant after 2011 (Figure 4). In contrast, organic lots converted to conventional farmland show a markup compared to always conventional lots in all slices. The markups exceed 10% in the middle and at the end of the observation period of the ongoing price boom.

Conventional to organic shows a statistically significant markdown after 2010, but the trend reverses after 2012 resulting in a markup in the last slice. The number of observations in the later years is, however, comparably small for lots switching cultivation modes; e.g., there are 43 transactions of lots switching from organic to conventional farming in the 2015–2018 slice.

5 Discussion

Farmland values may be inflated by price determinants, such as local market conditions related to bargaining power in thinly traded farmland markets, climatic conditions, buyer/investor behavior, and consumer preference for organic products. For our study region of Brandenburg, the longitudinal aspect of our data allows us to estimate the net price effects of organic cultivation at time of sale of always organically cultivated plots, converted to organic and conventional post-sale, respectively, compared to a benchmark of always conventionally cropped plots. We use a double robust matching approach with a rich regression specification to causally link the estimated price effects of private and public farmland sales throughout the observation period to the cultivation type.

We find a positive relationship between soil quality, water availability and prices (e.g., Lehn and Bahrs 2018), but the positive coefficient for the drought index indicates higher prices with higher drought sensitivity possibly resulting from increased prices over the observation period due to the positive correlation of the drought index and the observation year. A nonlinear price-size relationship (e.g., Seifert, Kahle, and Hüttel 2021; Ritter et al. 2020) with price markdowns for large plots may indicate borrowing constraints (Brorsen, Doye, and Neal 2015). Specifications indicating a markdown of 3% or 4% for transactions involving multiple parcels may reflect a lack of economies of scale compared to transactions of the same size involving one parcel. Higher prices for lots close to settlement areas may indicate a potential price markup for the option value of future land development (Brorsen, Doye, and Neal 2015). In line with Balmann et al. (2021), our parameter estimates indicate lower prices for lots located farther from Berlin, whereas the price effects of the distances to the next regional metropolis and the closest administrative centers are small and partly not robust across the specifications. Our results emphasize the role of the market microstructure and land market activity for land prices (Seifert, Kahle, and Hüttel 2021; Balmann et al. 2021; Kionka et al. 2021). We find a price markup of more than 40% for lots sold by BVVG, a professional seller. Likewise, prices increase with the number of transactions in the past year reflecting market activity and the number of farms in a 12 km radius (potential competitors). Parameter estimates for the concentration ratio CR1 suggest an inverse U-shaped relationship.

We find no statistically significant average price difference between plots classified as organic at time of sale or conventional throughout the observation period, which is in line with Veron (2022) for France, but not with Fuller, Janzen, and Munkhnasan (2021), who find markups on land rental rates that should be capitalized into values. Accounting for the plots' cultivation type history, we find statistically significant price differentials with average markdowns for always organic (2.4%, 0.014 EUR/m²) and post-sale converted plots from conventional to organic (4.1%, 0.025 EUR/m²) throughout the observation period, but markups for post-sale converted from organic to conventional (7.9%, 0.048 EUR/m²). These markups were highest towards the end of the observation period covering the ongoing price boom, even exceeding 10%.

Identifying geographical clusters of the treatment group plots demonstrates the effects of cluster-specific price differentials. For the group “converted organic to conventional”, we find price markups in one region, but the transactions have a median size of 8.2 ha, i.e., nearly four times as large as other transactions in this treatment group in other clusters and “always conventional” transactions. We attribute the results to selectivity issues. For always organic clusters 1 and 8, 43% and 22% of the surrounding farmland in a 12 km radius is organic, but only 8% to 9% for cluster 9 and always organic lots not assigned to any of the clusters. Cluster 1 shows markdowns for always organic of 0.148 EUR/m², cluster 8 of 0.104 EUR/m²and cluster 9 about 0.179 EUR/m² compared to always conventional. This suggests that the competition between organic farms might not necessarily result in higher prices as search and bargaining cost savings may offer benefits for sellers and buyers.

6 Concluding Remarks

In this paper proposed to quantify the net effects of a history of organic farming on farmland transaction prices (treatment effect) as potential buyers should value the environmental benefits, e.g., soil fertility, from past organic cultivation, and the expected economic benefits, e.g., no conversion cost, of future organic use. On average we find no price differentials but markups for conventional and markdowns for organic plots post-sale. The results underline the importance of acknowledging the local land market structure, and related competition effects that may inflate identifying or outweigh positive valuations.

Organic farming—proposed as part of the solution to mitigate environmental harm from farming systems and to contribute to the sustainability transformation of agriculture (Eyhorn et al. 2019). Yet, in particular land-intense organic farming rests on the availability of fertile land, facing an increased competition over the past decades. Related price surges have sparked intense debates about intensification of farmland market regulation, thereby favoring sustainable farming systems. Given the lacking definition of sustainable farming, typically organic farms are in favor of such regulations. For instance, the German privatization agency will no longer sell the land by competitive tender mechanisms, instead the land will be leased to organic farms. However, regulations define organic mostly in terms of inputs, i.e. natural or synthetic, where sustainable best practices are often not covered (Seufert, Ramankutty, and Mayerhofer 2017). Often perceived as the more sustainable system, our results show that competition effects and potential market power exercising appear irrespective of the cultivation type.

Our findings therefore offer the following policy implications: instead of favoring certain cultivation types in factor markets, rather regionally integrated sustainable systems should be supported that offer, for instance, value co-creation in a region. Further, farmland market functioning should be supported and information on price formation should be provided that offers all market agents forming expectations about future returns by cultivation type and competition in the land market. For instance, available information about the past cultivation type could serve as an orientation for an improved assessment of true soil functioning and carbon sequestration as essential pillars for future returns. Also, expanding the recommendation of other investigations of land market functioning, information on the number of competitors and the volume of transacted type of land in a region can contribute to market transparency and foster market functioning (Curtiss et al. 2021; Balmann et al. 2021; Bigelow, Ifft, and Kuethe 2020).

Our paper has the following limitations: while combining non-parametric matching with a rich specification of the parametric second-stage regression is doubly robust, functional misspecifications and unobserved heterogeneity can introduce bias. While the results of our research are based on comprehensive organic and conventional land use data, detailed buyer and seller information, and buyers' competition is lacking as these are not collected. After a sales transaction in the last years of the observation period, a switch in farm mode may introduce potential bias in the rolling window analysis. Also, the period covers some policy changes in the EU's Common Agricultural Policy and other related national environmental policies with impact on expectation formation of potential sellers and buyers about future returns of one or the other type of cultivation (Salhofer and Feichtinger 2020; Graubner 2018), and thus their bidding behavior (e.g., Gunnelin and Söderberg 2003; Hüttel et al. 2015). A detailed investigation of these impacts is left for future research.

7 References

Abbott, J.K., and H.A. Klaiber. 2011. "An embarrassment of riches: Confronting omitted variable bias and multiscale capitalization in hedonic price models." *The Review of Economics and Statistics* 93 (4): 1331–42. Accessed May 25, 2020.

Balmann, A., M. Graubner, D. Müller, S. Hüttel, S. Seifert, M. Odening, J. Plogmann, and M. Ritter. 2021. "Market Power in Agricultural Land Markets: Concepts and Empirical Challenges." *German Journal of Agricultural Economics* 70 (4): 213–35. doi:10.30430/gjae.2021.0117.

Barbieri, P., S. Pellerin, V. Seufert, L. Smith, N. Ramankutty, and T. Nesme. 2021. "Global option space for organic agriculture is delimited by nitrogen availability." *Nat Food* 2 (5): 363–72. doi:10.1038/s43016-021-00276-y.

BBSR. 2019. "Laufende Stadtbeobachtung - Raumabgrenzungen: Großstadtregionen." https://www.bbsr.bund.de/BBSR/DE/Raumbeobachtung/Raumabgrenzungen/deutschland/regionen/Grossstadtregionen/stadtregionen_node.html.

Bigelow, D.P., J. Ifft, and T.H. Kuethe. 2020. "Following the Market? Hedonic Farmland Valuation Using Sales Prices versus Self-reported Values." *Land Economics* 96 (3): 418–40. doi:10.3368/le.96.3.418.

Birkhofer, K., T.M. Bezemer, J. Bloem, M. Bonkowski, S. Christensen, D. Dubois, F. Ekelund et al. 2008. "Long-term organic farming fosters below and aboveground biota: Implications for soil quality, biological control and productivity." *Soil Biology and Biochemistry* 40 (9): 2297–2308. doi:10.1016/j.soilbio.2008.05.007.

BMEL. 2021. "Ökologischer Landbau in Deutschland.".

Brorsen, B.W., D. Doye, and K.B. Neal. 2015. "Agricultural Land and the Small Parcel Size Premium Puzzle." *Land Economics* 91 (3): 572–85. https://muse.jhu.edu/article/586390. Accessed March 12, 2018.

Cameron, A.C., and P.K. Trivedi. 2008. *Microeconometrics: Methods and Applications.* 7. print. Cambridge: Cambridge Univ. Press.

Curtiss, J., L. Jelínek, T. Medonos, M. Hruška, and S. Hüttel. 2021. "Investors' impact on Czech farmland prices: a microstructural analysis." *Eur Rev Agric Econ* 48 (1): 97–157. doi:10.1093/erae/jbaa029.

de Ponti, T., B. Rijk, and M.K. van Ittersum. 2012. "The crop yield gap between organic and conventional agriculture." *Agricultural Systems* 108: 1–9.

Desmarais, A.A., D. Qualman, A. Magnan, and N. Wiebe. 2017. "Investor Ownership or Social Investment? Changing Farmland Ownership in Saskatchewan, Canada." *Agriculture and Human Values* 34 (1): 149–66. doi:10.1007/s10460-016-9704-5.

Destatis. 2021a. "Kaufwerte für landwirtschaftliche Grundstücke 2020." Land und Forstwirtschaft, Fischerei Fachserie 3 Reihe 2.4.

———. 2021b. "Land- und Forstwirtschaft, Fischerei: Landwirtschaftszählung." https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Landwirtschaft-Forstwirtschaft-Fischerei/Landwirtschaftliche-Betriebe/Publikationen/Downloads-Landwirtschaftliche-Betriebe/eigentums-pachtverhaeltnisse-2030216209004.pdf?__blob=publicationFile.

DWD. 2022. "Multi-annual grids of precipitation height over Germany." Unpublished manuscript, last modified April 07, 2020. https://opendata.dwd.de/climate_environment/CDC/grids_germany/multi_annual/precipitation/.
Eyhorn, F., A. Muller, J.P. Reganold, E. Frison, H.R. Herren, L. Luttikholt, A. Mueller et al. 2019. "Sustainability in global agriculture driven by organic farming." *Nat Sustain* 2 (4): 253–55. doi:10.1038/s41893-019-0266-6.
Fuller, K.B., J.P. Janzen, and B. Munkhnasan. 2021. "Farmland Rental Rates: Does Organic Certification Matter?" *Land Economics* 97 (1): 80–106. doi:10.3368/wple.97.1.030119-0032R2.
Gattinger, A., A. Muller, M. Haeni, C. Skinner, A. Fliessbach, N. Buchmann, P. Mäder et al. 2012. "Enhanced Top Soil Carbon Stocks Under Organic Farming." *PNAS* 109 (44): 18226–31. doi:10.1073/pnas.1209429109.
Genius, M., C.J. Pantzios, and V. Tzouvelekas. 2006. "Information Acquisition and Adoption of Organic Farming Practices." *Journal of Agricultural and Resource Economics* 31 (1): 93–113. http://www.jstor.org/stable/40987308.
Graubner, M. 2018. "Lost in space? The effect of direct payments on land rental prices." *European Review of Agricultural Economics* 45 (2): 143–71. doi:10.1093/erae/jbx027.
Gunnelin, Å., and B. Söderberg. 2003. "Term Structures in the Office Rental Market in Stockholm." *J Real Estate Finan Econ* 26 (2/3): 241–65. doi:10.1023/A:1022934926474.
Harder, V.S., E.A. Stuart, and J.C. Anthony. 2010. "Propensity Score Techniques and the Assessment of Measured Covariate Balance to Test Causal Associations in Psychological Research." *Psychological methods* 15 (3): 234–49. doi:10.1037/a0019623.
Ho, D.E., K. Imai, G. King, and E.A. Stuart. 2007. "Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference." *Polit. anal.* 15 (3): 199–236. doi:10.1093/pan/mpl013.
Hüttel, S., M. Ritter, V. Esaulov, and M. Odening. 2015. "Is there a Term Structure in Land Lease Rates?" *European Review of Agricultural Economics* 43 (1): 165–87. doi:10.1093/erae/jbv010.
Imbens, G.W. 2021. "Statistical Significance, p -Values, and the Reporting of Uncertainty." *Journal of Economic Perspectives* 35 (3): 157–74. doi:10.1257/jep.35.3.157.
Isenhardt, L., S. Seifert, and S. Hüttel. 2022. "Tenant Favoritism and Right of First Refusals in Farmland Auctions: Competition and Price Effects." *Land Economics*, no. forthcoming: 080721-0091R1. doi:10.3368/le.080721-0091R1.
Kionka, M., M. Odening, J. Plogmann, and M. Ritter. 2021. "Measuring liquidity in agricultural land markets." *Agricultural Finance Review* ahead-of-print (ahead-of-print). doi:10.1108/AFR-03-2021-0037.
Knapp, S., and M.G.A. van der Heijden. 2018. "A Global Meta-Analysis of Yield Stability in Organic and Conservation Agriculture." *Nature communications* 9 (1): 3632. doi:10.1038/s41467-018-05956-1.
Kostov, P. 2010. "Do Buyers' Characteristics and Personal Relationships Affect Agricultural Land Prices?" *00237639* 86 (1): 48–65. http://www.jstor.org/stable/27759717.
Kuminoff, N.V., C.F. Parmeter, and J.C. Pope. 2010. "Which hedonic models can we trust to recover the marginal willingness to pay for environmental amenities?" *Journal of Environmental Economics and Management* 60 (3): 145–60. doi:10.1016/j.jeem.2010.06.001.
Kuminoff, N.V., and A. Wossink. 2010. "Why Isn't More US Farmland Organic?" *Journal of Agricultural Economics* 61 (2): 240–58. doi:10.1111/j.1477-9552.2009.00235.x.
Läpple, D., and J. Cullinan. 2012. "The development and geographic distribution of organic farming in Ireland." *Irish Geography* 45 (1): 67–85. doi:10.1080/00750778.2012.698585.
Läpple, D., and H. Kelley. 2013. "Understanding the uptake of organic farming: Accounting for heterogeneities among Irish farmers." *Ecological Economics* 88:11–19. doi:10.1016/j.ecolecon.2012.12.025.
Lehn, F., and E. Bahrs. 2018. "Analysis of factors influencing standard farmland values with regard to stronger interventions in the German farmland market." *Land Use Policy* 73:138–46. doi:10.1016/j.landusepol.2018.01.020.
LELF. 2021. "Wirtschaftsergebnisse landwirtschaftlicher Unternehmen Brandenburgs: Wirtschaftsjahr 2019/2020." Wirtschaftsergebnisse landwirtschaftlicher Unternehmen Brandenburgs.
Mäder, P., A. Fliessbach, D. Dubois, L. Gunst, P. Fried, and U. Niggli. 2002. "Soil Fertility and Biodiversity in Organic Farming." *Science (New York, N.Y.)* 296 (5573): 1694–97. doi:10.1126/science.1071148.
Marton, T.A., and H. Storm. 2021. "The case of organic dairy conversion in Norway: Assessment of multivariate neighbourhood effects." *Q Open* 1 (1). doi:10.1093/qopen/qoab009.
Meemken, E.-M., and M. Qaim. 2018. "Organic Agriculture, Food Security, and the Environment." *Annu. Rev. Resour. Econ.* 10 (1): 39–63. doi:10.1146/annurev-resource-100517-023252.

Musshoff, O., and N. Hirschauer. 2008. “Adoption of organic farming in Germany and Austria: an integrative dynamic investment perspective.” *Agricultural Economics* 39 (1): 135–45. doi:10.1111/j.1574-0862.2008.00321.x.
Muthoo, A. 2000. “A Non-Technical Introduction to Bargaining Theory.” *World Economics* 1 (2): 145–66. https://warwick.ac.uk/fac/soc/economics/staff/amuthoo/bargaining/simpbarg.pdf.
Nickerson, C.J., and W. Zhang. 2014. “Modeling the Determinants of Farmland Values in the United States.” In *The Oxford Handbook of Land Economics*, edited by J. M. Duke and J. Wu, 111–38. New York: Oxford University Press.
Ortiz-Bobea, A. 2020. “The Role of Nonfarm Influences in Ricardian Estimates of Climate Change Impacts on US Agriculture.” *Am J Agric Econ* 102 (3): 934–59. doi:10.1093/ajae/aaz047.
Reganold, J.P., and J.M. Wachter. 2016. “Organic agriculture in the twenty-first century.” *Nature Plants* 2:15221. doi:10.1038/nplants.2015.221.
Regulation (EU) 2018/848 on organic production and labelling of organic products. European Parliament. L 150/1. Official Journal of the European Union. 2018.
Ritter, M., S. Hüttel, M. Odening, and S. Seifert. 2020. “Revisiting the relationship between land price and parcel size in agriculture.” *Land Use Policy* 97:104771. doi:10.1016/j.landusepol.2020.104771.
Rousseeuw, P.J., and K. van Driessen. 1999. “A fast algorithm for the minimum covariance determinant estimator.” *Technometrics* 41 (3): 212–23.
Salhofer, K., and P. Feichtinger. 2020. “Regional differences in the capitalisation of first and second pillar payments of the CAP into land rental prices.” *Eur Rev Agric Econ.* doi:10.1093/erae/jbaa028.
Schmidtner, E., C. Lippert, B. Engler, A.M. Häring, J. Aurbacher, and S. Dabbert. 2012. “Spatial distribution of organic farming in Germany: does neighbourhood matter?” *Eur Rev Agric Econ* 39 (4): 661–83. doi:10.1093/erae/jbr047.
Schmitz, T., and D. Müller. 2020. “Digitale Karte der Bodenwertzahlen für Brandenburg.” FORLand Technical Reports 1, Humboldt University Berlin.
Seifert, S., C. Kahle, and S. Hüttel. 2021. “Price Dispersion in Farmland Markets: What Is the Role of Asymmetric Information?” *American Journal of Agricultural Economics*, no. 103: 1545–68. doi:10.1111/ajae.12153.
Seufert, V., and N. Ramankutty. 2017. “Many Shades of Gray-the Context-Dependent Performance of Organic Agriculture.” *Science advances* 3 (3): e1602638. doi:10.1126/sciadv.1602638.
Seufert, V., N. Ramankutty, and T. Mayerhofer. 2017. “What is this thing called organic? – How organic farming is codified in regulations.” *Food Policy* 68:10–20. doi:10.1016/j.foodpol.2016.12.009.
Tietz, A., B. Forstner, and P. Weingarten. 2013. “Non-Agricultural and Supra-Regional Investors on the German Agricultural Land Market: An Empirical Analysis of their Significance and Impacts.” *German Journal of Agricultural Economics* 62 (2): 86–98.
Turnbull, G.K., and A.J. van der Vlist. 2022. “Bargaining power and segmented markets: Evidence from rental and owner-occupied housing.” *Real Estate Economics.* doi:10.1111/1540-6229.12380.
Veron, E. 2022. “Comparative Analysis of Revenue and Land Prices Between Organic and Conventional Farming.” Conference Paper for the 96th Annual Conference, 2022.
Wand, M.P., and M. Jones. 1994. “Multivariate plug-in bandwidth selection.” *Computational Statistics* 9 (97-116).
Willer, H., J. Trávníček, C. Meier, and B. Schlatter, eds. 2022. *The World of Organic Agriculture: Statistics and Emerging Trends 2022.* Frick, Switzerland: Research Institute of Organic Agriculture FiBL and IFOAM – Organics International.
Wolff, S., S. Hüttel, C. Nendel, and T. Lakes. 2021. “Agricultural Landscapes in Brandenburg, Germany: An Analysis of Characteristics and Spatial Patterns.” *Int J Environ Res* 15 (3): 487–507. doi:10.1007/s41742-021-00328-y.
Zeileis, A., S. Köll, and N. Graham. 2020. “Various Versatile Variances: An Object-Oriented Implementation of Clustered Covariances in R.” *J. Stat. Soft.* 95 (1). doi:10.18637/jss.v095.i01.
Zink, M., L. Samaniego, R. Kumar, S. Thober, J. Mai, D. Schäfer, and A. Marx. 2016. “The German drought monitor.” *Environ. Res. Lett.* 11 (7): 74002. doi:10.1088/1748-9326/11/7/074002.

8 Appendix

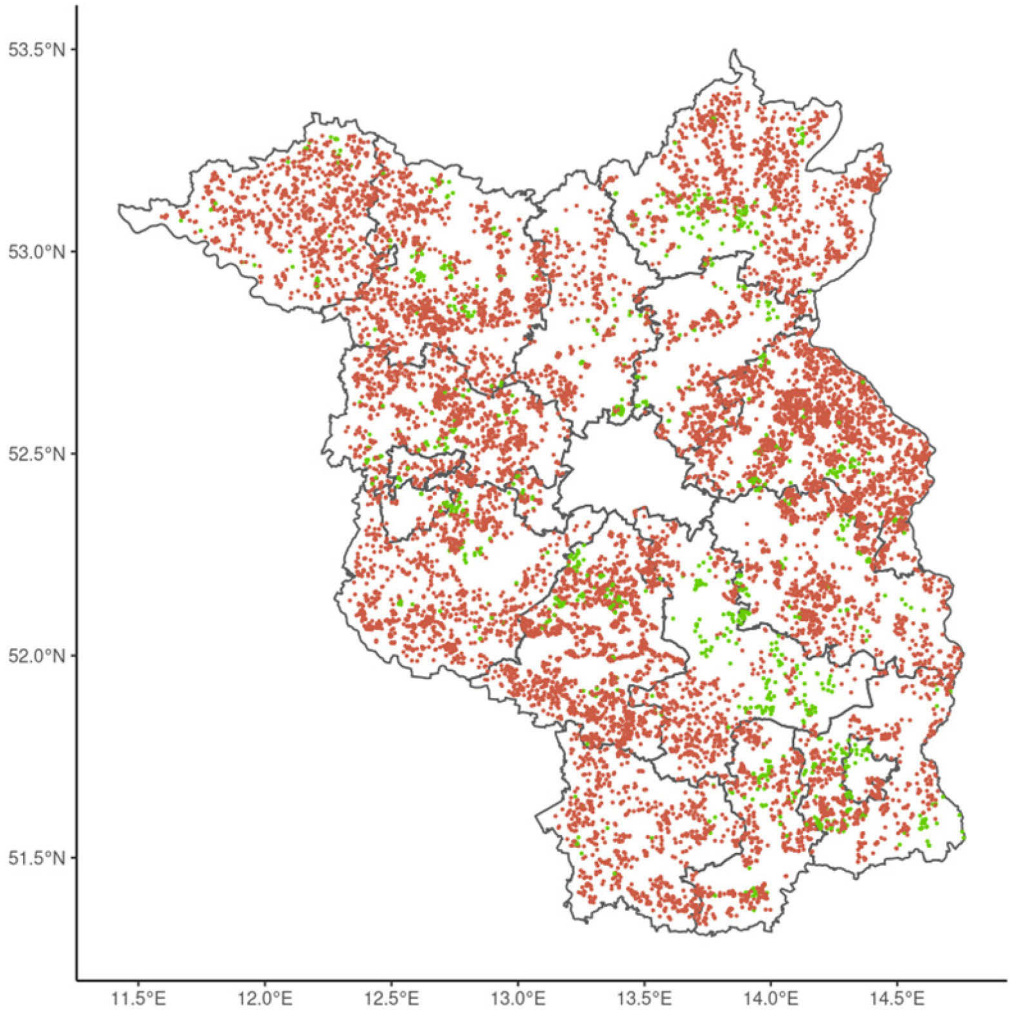

Figure 5: Location of land transactions by farming type at time of sale: conventional (red); organic (green)

Table 4: Descriptive statistics by treatment status

	Always conventional $(n = 15{,}225)$					**Always organic** $(n = 1{,}162)$				
	Mean	Median	SD	Q1	Q99	Mean	Median	SD	Q1	Q99
Price	0.60	0.45	0.47	0.11	2.31	0.55	0.42	0.41	0.11	2.02
Lot size	5.79	2.46	12.16	0.26	55.58	4.89	1.81	9.22	0.26	47.68
Soil quality	32.61	31.00	9.09	15.00	55.00	28.61	28.00	8.20	13.00	50.00
Multiple parcels	0.11	0.00	0.31	0.00	1.00	0.10	0.00	0.30	0.00	1.00
Adj. to settlement	0.27	0.00	0.45	0.00	1.00	0.24	0.00	0.43	0.00	1.00
Dist. Berlin	52.86	49.61	26.84	4.71	111.25	47.37	45.29	25.04	7.07	107.40
Dist. reg. metropolis	40.17	38.54	18.35	6.32	81.01	33.58	30.91	17.76	4.89	69.15
Dist. admin. center	11.34	10.94	5.50	1.53	25.04	12.96	12.87	5.44	2.21	24.28
Drought index	9.95	10.00	3.78	3.00	22.00	9.84	9.00	3.97	3.00	21.00
Precipitation	57.00	56.90	3.32	48.77	64.80	57.07	56.68	2.61	52.13	65.03
Seller BVVG	0.18	0.00	0.38	0.00	1.00	0.20	0.00	0.40	0.00	1.00
Concentration ratio	0.29	0.24	0.18	0.08	0.87	0.31	0.25	0.18	0.10	0.83
Total sales	10.18	8.00	10.53	1.00	45.00	8.11	6.00	6.97	1.00	34.00
#Farms	120.46	127.00	47.04	3.00	225.00	131.61	131.00	50.98	0.00	268.00
Biogas capacities	0.15	0.04	0.25	0.00	1.13	0.10	0.00	0.20	0.00	0.95
Share BVVG	0.19	0.13	0.20	0.00	0.88	0.20	0.14	0.21	0.00	0.89

	Organic to conventional $(n = 374)$					**Conventional to organic** $(n = 577)$				
	Mean	Median	SD	Q1	Q99	Mean	Median	SD	Q1	Q99
Price	0.54	0.39	0.44	0.11	2.33	0.47	0.33	0.38	0.10	1.91
Lot size	5.75	2.40	11.48	0.27	54.10	5.87	2.41	11.84	0.28	46.48
Soil quality	28.13	27.00	7.74	12.00	52.81	29.43	28.00	8.42	13.76	51.00
Multiple parcels	0.15	0.00	0.36	0.00	1.00	0.14	0.00	0.35	0.00	1.00
Adj. to settlement	0.28	0.00	0.45	0.00	1.00	0.25	0.00	0.43	0.00	1.00
Dist. Berlin	56.11	51.89	32.38	1.68	112.32	44.03	39.68	23.55	7.33	108.15
Dist. reg. metropolis	37.47	32.82	19.93	4.78	77.76	36.58	32.68	16.59	8.31	74.50
Dist. admin. center	11.30	10.91	5.30	1.93	23.82	11.50	11.30	5.06	2.87	24.68
Drought index	10.19	10.00	3.87	4.00	23.27	9.64	10.00	3.40	4.00	21.24
Precipitation	57.91	57.54	3.46	50.56	66.61	56.70	56.41	3.25	48.20	64.15
Seller BVVG	0.17	0.00	0.38	0.00	1.00	0.19	0.00	0.39	0.00	1.00
Concentration ratio	0.25	0.21	0.12	0.09	0.61	0.27	0.23	0.14	0.10	0.75
Total sales	9.90	8.00	10.70	1.00	43.00	10.09	8.00	7.73	1.00	34.00
#Farms	108.64	113.50	47.33	12.73	237.81	122.63	127.00	48.37	0.00	257.72
Biogas capacities	0.17	0.02	0.32	0.00	1.77	0.13	0.03	0.23	0.00	0.96
Share BVVG	0.19	0.14	0.22	0.00	1.00	0.19	0.13	0.21	0.00	0.81

	Organic at sale $(n = 1,536)$					**Conventional at sale** $(n = 15,802)$				
	Mean	Median	SD	Q1	Q99	Mean	Median	SD	Q1	Q99
Price	0.55	0.41	0.42	0.11	2.09	0.60	0.45	0.47	0.11	2.30
Lot size	5.10	1.96	9.82	0.26	49.43	5.79	2.45	12.15	0.27	55.49
Soil quality	28.49	28.00	8.09	13.00	50.65	32.49	31.00	9.09	15.00	55.00
Multiple parcels	0.11	0.00	0.32	0.00	1.00	0.11	0.00	0.31	0.00	1.00
Adj. to settlement	0.25	0.00	0.43	0.00	1.00	0.27	0.00	0.45	0.00	1.00
Dist. Berlin	49.50	48.31	27.26	2.18	110.47	52.53	49.20	26.78	4.77	111.22
Dist. reg. metropolis	34.53	31.43	18.38	4.84	72.19	40.04	38.34	18.30	6.37	80.95
Dist. admin. center	12.56	12.24	5.45	2.09	24.27	11.34	10.94	5.49	1.55	25.04
Drought index	9.93	9.00	3.94	3.00	21.00	9.94	10.00	3.77	3.00	22.00
Precipitation	57.27	56.84	2.86	51.68	65.48	56.99	56.89	3.32	48.76	64.78
Seller BVVG	0.19	0.00	0.39	0.00	1.00	0.18	0.00	0.38	0.00	1.00
Concentration ratio	0.29	0.24	0.17	0.10	0.81	0.29	0.24	0.17	0.08	0.87
Total sales	8.54	7.00	8.07	1.00	34.00	10.18	8.00	10.44	1.00	45.00
#Farms	126.02	127.00	51.06	1.05	262.60	120.54	127.00	47.09	3.00	229.99
Biogas capacities	0.12	0.00	0.23	0.00	1.00	0.15	0.04	0.25	0.00	1.12
Share BVVG	0.19	0.14	0.21	0.00	0.91	0.19	0.13	0.20	0.00	0.88

Table 5: Absolute ($P_t - \sum_c w_c P_c$) and relative ($P_t / \sum_c w_c P_c - 1$) price differences between treated and matched control units

	Absolute price differences (EUR/m²)				Relative price differences (%)			
	1%	Median	Mean	99%	1%	Median	Mean	99%
Always organic	-0.580	-0.023	-0.006	0.782	-68.2	-5.0	1.6	141.8
Organic to conv.	-0.438	0.001	0.051	1.272	-68.0	0.4	10.8	185.1
Conv. to organic	-0.566	-0.021	-0.007	0.815	-72.2	-7.0	0.9	230.7

Table 6: Coefficient estimates and respective standard errors of time dummy and county dummy variables of the post-matching regression

	Always organic		Organic to conventional		Conventional to organic	
	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
Year: 2006	-0.014	[-0.055, 0.026]	-0.058	[-0.097, -0.019]	-0.115	[-0.154, -0.075]
Year: 2007	0.026	[-0.014, 0.066]	-0.098	[-0.138, -0.059]	-0.005	[-0.045, 0.035]
Year: 2008	0.159	[0.120, 0.199]	0.079	[0.041, 0.117]	0.121	[0.083, 0.160]
Year: 2009	0.345	[0.305, 0.385]	0.178	[0.141, 0.216]	0.265	[0.226, 0.305]
Year: 2010	0.453	[0.412, 0.494]	0.301	[0.262, 0.340]	0.253	[0.213, 0.292]
Year: 2011	0.632	[0.590, 0.673]	0.570	[0.529, 0.611]	0.541	[0.500, 0.582]
Year: 2012	0.738	[0.698, 0.778]	0.696	[0.655, 0.737]	0.664	[0.623, 0.705]
Year: 2013	0.899	[0.857, 0.940]	0.870	[0.828, 0.913]	0.799	[0.758, 0.840]
Year: 2014	0.984	[0.942, 1.026]	1.008	[0.966, 1.051]	0.961	[0.919, 1.003]
Year: 2015	1.102	[1.059, 1.146]	1.132	[1.089, 1.175]	1.111	[1.070, 1.152]
Year: 2016	1.212	[1.169, 1.256]	1.112	[1.068, 1.155]	1.186	[1.141, 1.230]
Year: 2017	1.224	[1.178, 1.269]	1.148	[1.104, 1.191]	1.199	[1.154, 1.245]
Year: 2018	1.320	[1.276, 1.365]	1.291	[1.247, 1.335]	1.332	[1.289, 1.376]
County: CB	-0.226	[-0.333, -0.119]	-0.519	[-0.640, -0.399]	-0.508	[-0.631, -0.385]
County: FF	-0.184	[-0.286, -0.081]	-0.415	[-0.525, -0.305]	-0.515	[-0.629, -0.385]
County: P	0.207	[0.094, 0.321]	-0.299	[-0.420, -0.177]	0.013	[-0.109, 0.136]
County: BAR	0.028	[-0.060, 0.115]	0.076	[-0.019, 0.171]	-0.313	[-0.415, -0.211]
County: LDS	-0.266	[-0.353, -0.179]	-0.334	[-0.430, -0.237]	-0.413	[-0.516, -0.310]
County: EE	-0.230	[-0.323, -0.138]	-0.171	[-0.269, -0.072]	-0.646	[-0.752, -0.540]
County: HVL	0.053	[-0.033, 0.138]	0.073	[-0.019, 0.166]	-0.224	[-0.322, -0.125]
County: MOL	0.038	[-0.047, 0.123]	0.151	[0.059, 0.242]	-0.189	[-0.286, -0.092]
County: OHV	-0.086	[-0.178, 0.007]	0.022	[-0.074, 0.119]	-0.552	[-0.658, -0.445]
County: OSL	-0.233	[-0.324, -0.143]	-0.220	[-0.320, -0.119]	-0.557	[-0.663, -0.452]
County: LOS	-0.219	[-0.304, -0.133]	-0.270	[-0.362, -0.177]	-0.498	[-0.596, -0.399]
County: OPR	0.208	[0.119, 0.296]	0.200	[0.105, 0.294]	-0.253	[-0.354, -0.152]
County: PM	-0.061	[-0.145, 0.022]	-0.190	[-0.283, -0.098]	-0.377	[-0.475, -0.279]
County: PR	0.219	[0.122, 0.315]	0.419	[0.316, 0.522]	-0.232	[-0.344, -0.120]
County: SPN	-0.213	[-0.298, -0.127]	-0.295	[-0.392, -0.199]	-0.547	[-0.648, -0.445]
County: TF	-0.299	[-0.386, -0.213]	-0.247	[-0.342, -0.153]	-0.575	[-0.674, -0.476]
County: UM	0.393	[0.304, 0.482]	0.261	[0.166, 0.356]	-0.011	[-0.113, 0.091]
R^2 weighted	0.685		0.707		0.681	
R^2 unweighted	0.729		0.700		0.709	
Observations	16,387		15,599		15,802	
# Treated units	1162		374		577	

Notes: 95% CI denotes the 95% confidence interval based on bootstrapped standard errors (1000 bootstrap replications).

Table 7: Coefficient estimates and corresponding confidence intervals of post-matching regression using transactions organic at sale as treated observations

	Organic at sale	
	Coef.	95% CI
Intercept	-2.827	[-4.055, -1.599]
√ Soil quality	0.053	[0.025, 0.080]
√ Lot size	0.035	[0.025, 0.045]
Lot size² $\times 10^{-2}$	-0.004	[-0.005, -0.003]
Soil quality² $\times 10^{-2}$	0.011	[0.008, 0.015]
Lot size × Soil quality $\times 10^{-2}$	0.013	[0.007, 0.018]
Multiple parcels (1=yes)	-0.028	[-0.049, -0.008]
Adj. to settlement (1=yes)	0.108	[0.094, 0.122]
Dist. Berlin	-0.006	[-0.007, -0.005]
Dist. Berlin² $\times 10^{-2}$	0.003	[0.002, 0.004]
Dist. reg. metropolis $\times 10^{-2}$	-0.017	[-0.070, 0.035]
Dist. adm. center $\times 10^{-2}$	0.001	[0.0001, 0.002]
Drought index	0.006	[0.004, 0.008]
Precipitation	0.033	[-0.010, 0.077]
Precipitation ² $\times 10^{-2}$	-0.032	[-0.070, 0.007]
Concentration rate CR1	0.575	[0.447, 0.703]
Concentration rate CR1²	-0.727	[-0.869, -0.584]
Total transactions municip.	0.0002	[-0.0004, 0.001]
#farms 12 km radius $\times 10^{-2}$	0.002	[-0.015, 0.019]
Biogas kW/ha UAA	0.004	[-0.022, 0.030]
Seller BVVG	0.427	[0.412, 0.443]
Share BVVG transactions	0.322	[0.247, 0.398]
Share BVVG transactions²	-0.42	[-0.517, -0.323]
Organic at sale	0.006	[-0.014, 0.026]
Year dummy	Yes	
County dummy	Yes	
R^2 weighted	0.683	
R^2 unweighted	0.729	
Observations	17,338	
# Treated units	1,536	
# Control units	15,802	

Notes: 95% CI denotes the 95% confidence interval based on bootstrapped standard errors (1000 bootstrap replications).

Table 8: Absolute and relative price differences by treatment and by county, standard error of the mean in parentheses (bold indicates estimates statistically significant at the 10% level based on two-sided t-tests)

	Always organic		Organic to conv.		Conv. to organic	
County	Abs. Diff. (EUR/m²)	Rel. Diff. (%)	Abs. Diff. (EUR/m²)	Rel. Diff. (%)	Abs. Diff. (EUR/ m²)	Rel. Diff. (%)
Brandenburg a.d. Havel [BB]	0.059 (0.079)	0.076 (0.098)	0.018 (0.055)	0.021 (0.102)	0.557 (0.681)	0.825 (0.897)
Cottbus [CB]	0.021 (0.022)	0.074 (0.056)	0.042 (0.173)	0.043 (0.387)	NA	NA
Frankfurt (Oder) [FF]	-0.105 (0.121)	-0.11 (0.182)	NA	NA	NA	NA
Potsdam [P]	**0.169** **(0.083)**	**0.364** **(0.148)**	**-0.103** **(0.037)**	**-0.243** **(0.077)**	0.038 (0.033)	0.117 (0.085)
Barnim [BAR]	**-0.063** **(0.033)**	**-0.108** **(0.044)**	0.041 (0.041)	0.12 (0.084)	0.022 (0.047)	-0.034 (0.077)
Dahme-Spreewald [LDS]	-0.017 (0.013)	-0.008 (0.032)	0.015 (0.038)	0.033 (0.127)	0.081 (0.061)	0.278 (0.169)
Elbe-Elster [EE]	**-0.052** **(0.029)**	**-0.113** **(0.063)**	0.068 (0.052)	0.142 (0.127)	0.007 (0.04)	0.029 (0.133)
Havelland [HVL]	-0.04 (0.029)	-0.046 (0.053)	**0.187** **(0.084)**	**0.357** **(0.206)**	-0.009 (0.031)	0.041 (0.055)
Märkisch-Oderland [MOL]	-0.048 (0.03)	-0.046 (0.038)	0.046 (0.044)	0.061 (0.064)	0.036 (0.043)	0.045 (0.055)
Oberhavel [OHV]	-0.063 (0.042)	-0.084 (0.141)	**0.218** **(0.117)**	0.191 (0.128)	**-0.065** **(0.023)**	**-0.179** **(0.058)**
Oberspreewald-Lausitz [OSL]	0.027 (0.022)	**0.107** **(0.055)**	**0.070** **(0.025)**	**0.224** **(0.078)**	-0.008 (0.024)	0.001 (0.08)
Oder-Spree [LOS]	-0.021 (0.019)	-0.016 (0.041)	0.002 (0.068)	0.064 (0.119)	0.015 (0.029)	0.116 (0.077)
Ostprignitz-Ruppin [OPR]	-0.028 (0.027)	0.026 (0.046)	**0.067** **(0.036)**	**0.141** **(0.06)**	-0.024 (0.048)	0.026 (0.076)
Potsdam-Mittelmark [PM]	-0.014 (0.036)	0.003 (0.057)	-0.028 (0.032)	-0.04 (0.096)	-0.002 (0.027)	0.066 (0.071)
Prignitz [PR]	**0.143** **(0.07)**	**0.201** **(0.096)**	0.001 (0.04)	0.008 (0.055)	0.073 (0.065)	0.15 (0.128)
Spree-Neiße [SPN]	0.019 (0.015)	**0.066** **(0.037)**	-0.004 (0.026)	0.062 (0.099)	-0.02 (0.043)	-0.033 (0.147)
Teltow-Fläming [TF]	0.015 (0.025)	0.077 (0.057)	0.026 (0.037)	0.133 (0.101)	**-0.06** **(0.015)**	**-0.124** **(0.043)**
Uckermark [UM]	0.016 (0.032)	0.015 (0.034)	0.015 (0.04)	0.068 (0.067)	-0.028 (0.035)	-0.01 (0.047)

Notes: Counties names with official abbreviations in square brackets. Bold indicates a statistically significant mean at the 10% level based on two-sided t-tests

Table 9: Selected descriptive statistics by cluster (median values)

Group	Cluster	Soil quality	Lot Size	Distance Berlin	#Farms 1 km	%Organic 12 km
Always conv.	other	31.00	2.46	49.61	127.0	5.70
Always organic	alw1	23.00	1.62	31.10	114.0	43.30
	alw2	30.00	1.41	73.32	166.0	29.40
	alw3	33.00	5.40	54.01	127.0	29.30
	alw4	24.00	1.75	17.60	123.5	13.10
	alw5	32.00	0.87	36.82	137.0	10.00
	alw6	30.50	1.44	26.91	158.5	10.50
	alw7	26.00	4.37	57.15	124.0	18.00
	alw8	29.00	1.69	101.41	57.0	21.60
	alw9	29.50	4.88	37.80	157.5	9.50
	other	27.00	1.85	36.38	125.0	9.00
Organic to conv.	otc1	28.00	8.16	106.68	114.5	10.30
	other	27.00	2.19	49.56	113.5	12.40
Conv. to organic	cto1	31.00	1.70	70.86	151.0	19.90
	cto2	24.50	2.18	22.20	109.5	7.80
	cto3	34.00	4.35	38.43	138.0	12.90
	other	29.00	2.53	42.54	127.0	8.50

Table 10: Coefficient estimates and respective standard errors of time dummy and county dummy variables of the extended post-matching regression

	Always organic		Organic to conventional		Conventional to organic	
	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
Year: 2006	-0.028	[-0.065, 0.010]	0.025	[-0.015, 0.065]	-0.010	[-0.049, 0.029]
Year: 2007	0.029	[-0.008, 0.067]	0.058	[0.015, 0.101]	0.031	[-0.009, 0.071]
Year: 2008	0.189	[0.151, 0.227]	0.286	[0.245, 0.328]	0.212	[0.173, 0.252]
Year: 2009	0.355	[0.317, 0.392]	0.405	[0.365, 0.446]	0.346	[0.307, 0.384]
Year: 2010	0.481	[0.444, 0.518]	0.488	[0.447, 0.530]	0.504	[0.463, 0.545]
Year: 2011	0.686	[0.647, 0.726]	0.626	[0.584, 0.669]	0.663	[0.623, 0.704]
Year: 2012	0.774	[0.735, 0.814]	0.795	[0.753, 0.836]	0.725	[0.683, 0.766]
Year: 2013	0.958	[0.919, 0.997]	0.995	[0.953, 1.037]	0.927	[0.885, 0.968]
Year: 2014	1.104	[1.064, 1.145]	1.134	[1.091, 1.176]	1.087	[1.046, 1.128]
Year: 2015	1.215	[1.176, 1.255]	1.220	[1.177, 1.263]	1.155	[1.113, 1.196]
Year: 2016	1.249	[1.208, 1.291]	1.259	[1.213, 1.304]	1.163	[1.120, 1.206]
Year: 2017	1.228	[1.186, 1.269]	1.373	[1.326, 1.420]	1.272	[1.226, 1.319]
Year: 2018	1.320	[1.278, 1.362]	1.421	[1.374, 1.467]	1.374	[1.330, 1.419]
County: CB	-0.232	[-0.343, -0.120]	-0.204	[-0.327, -0.081]	-0.267	[-0.396, -0.138]
County: FF	-0.061	[-0.169, 0.047]	-0.117	[-0.232, -0.002]	-0.142	[-0.264, -0.020)
County: P	0.311	[0.187, 0.436]	0.279	[0.156, 0.402]	0.257	[0.128, 0.386]
County: BAR	0.117	[0.020, 0.214]	-0.007	[-0.104, 0.090]	0.023	[-0.087, 0.132]
County: LDS	-0.131	[-0.229, -0.033]	-0.236	[-0.335, -0.138]	-0.142	[-0.251, -0.033]
County: EE	-0.089	[-0.189, 0.011]	-0.300	[-0.401, -0.199]	-0.351	[-0.461, -0.242]
County: HVL	0.061	[-0.031, 0.153]	0.031	[-0.062, 0.123]	0.0005	[-0.105, 0.106]
County: MOL	0.092	[0.001, 0.183]	0.152	[0.060, 0.245]	0.091	[-0.012, 0.194]
County: OHV	-0.011	[-0.109, 0.087]	-0.060	[-0.158, 0.038]	-0.099	[-0.209, 0.012]
County: OSL	-0.446	[-0.547, -0.345]	-0.237	[-0.338, -0.136]	-0.480	[-0.589, -0.371]
County: LOS	-0.203	[-0.295, -0.110]	-0.089	[-0.182, 0.004]	-0.298	[-0.403, -0.194]
County: OPR	0.247	[0.153, 0.341]	0.110	[0.015, 0.205]	0.153	[0.047, 0.258]
County: PM	-0.016	[-0.107, 0.075]	-0.064	[-0.154, 0.026]	-0.113	[-0.215, -0.010]
County: PR	0.245	[0.138, 0.351]	0.144	[0.039, 0.250]	0.007	[-0.108, 0.122]
County: SPN	-0.259	[-0.358, -0.159]	-0.243	[-0.340, -0.146]	-0.299	[-0.408, -0.189]
County: TF	-0.148	[-0.241, -0.054]	-0.170	[-0.262, -0.079]	-0.228	[-0.333, -0.124]
County: UM	0.476	[0.379, 0.572]	0.416	[0.320, 0.512]	0.382	[0.274, 0.489]
R^2 weighted	0.734		0.737		0.707	
R^2 unweighted	0.725		0.727		0.729	
Observations	16,387		15,599		15,802	
# Treated units	1162		374		577	

Notes: 95% CI denotes the 95% confidence interval based on bootstrapped standard errors (1000 bootstrap replications).

Table 11: Parameter estimates of rolling window regressions for always organic regressions, bootstrapped standard errors standard errors in parentheses

	2005-08	2006-09	2007-10	2008-11	2009-12	2010-13	2011-14	2012-15	2013-16	2014-17	2015-18
Intercept	2.898	1.489	-3.209	-4.831	-4.258	-1.772	-1.143	0.002	0.635	1.913	-0.123
	(1.021)	(1.018)	(0.965)	(0.932)	(0.923)	(1.009)	(0.961)	(1.177)	(1.075)	(1.111)	(1.189)
√Soil quality	-0.023	-0.059	0.035	-0.013	0.009	0.088	0.127	0.110	0.132	0.106	0.093
	(0.023)	(0.021)	(0.021)	(0.022)	(0.021)	(0.022)	(0.025)	(0.024)	(0.023)	(0.024)	(0.026)
√Lot size	-0.002	-0.004	0.012	-0.006	0.010	0.036	0.057	0.065	0.048	0.049	0.051
	(0.009)	(0.008)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.009)
Lot size²	0.0001	-0.00001	-0.00000	-0.0002	-0.0003	-0.0002	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Soil quality²	0.0002	0.0003	0.0001	0.0002	0.0001	0.00005	0.00003	0.00005	0.00002	0.0001	0.0001
	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)
Lot size × Soil quality	0.00003	0.0001	0.0001	0.001	0.0005	0.0004	0.0001	0.0001	0.0002	0.0001	0.0002
	(0.00004)	(0.00004)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00004)	(0.00004)	(0.00004)
Multiple parcels	-0.006	-0.002	0.001	-0.039	-0.058	-0.072	-0.104	-0.097	-0.065	-0.087	-0.142
	(0.015)	(0.013)	(0.013)	(0.014)	(0.014)	(0.015)	(0.017)	(0.018)	(0.023)	(0.029)	(0.034)
Adj. to settlement	0.095	0.067	0.059	0.094	0.133	0.190	0.195	0.163	0.098	0.082	0.044
	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.011)	(0.010)	(0.011)	(0.012)
Dist. Berlin	-0.008	-0.007	-0.006	-0.007	-0.007	-0.006	-0.003	-0.003	-0.004	-0.008	-0.009
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Dist. Berlin²	0.0001	0.00005	0.00003	0.00004	0.00002	0.00002	-0.00000	0.00000	0.00003	0.0001	0.0001
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Dist. reg. metropolis	-0.002	-0.001	0.001	0.001	0.002	0.001	-0.0003	-0.001	-0.001	0.002	0.003
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0005)
Dist. adm. center	0.001	-0.002	-0.002	0.002	0.002	0.0005	0.001	0.001	0.002	0.003	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Drought index	-0.0002	-0.002	-0.009	-0.008	-0.006	0.004	0.008	0.012	0.013	0.006	0.0002

	2005-08	2006-09	2007-10	2008-11	2009-12	2010-13	2011-14	2012-15	2013-16	2014-17	2015-18
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Precipitation	-0.123	-0.073	0.053	0.110	0.086	-0.010	-0.029	-0.052	-0.070	-0.101	-0.018
	(0.036)	(0.036)	(0.034)	(0.033)	(0.032)	(0.036)	(0.034)	(0.042)	(0.038)	(0.039)	(0.042)
Precipitation ²	0.001	0.0004	-0.0005	-0.001	-0.001	0.0001	0.0002	0.0003	0.001	0.001	0.0001
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0003)	(0.0003)	(0.0004)
Concentration rate CR1	0.179	0.213	0.232	0.132	0.354	0.381	0.576	0.852	0.462	0.610	0.429
	(0.097)	(0.091)	(0.090)	(0.090)	(0.093)	(0.095)	(0.104)	(0.109)	(0.110)	(0.102)	(0.118)
Concentration rate CR1²	-0.220	-0.299	-0.249	-0.173	-0.448	-0.500	-0.769	-1.107	-0.844	-0.986	-0.759
	(0.105)	(0.099)	(0.097)	(0.099)	(0.100)	(0.103)	(0.112)	(0.118)	(0.120)	(0.114)	(0.135)
Total transactions	-0.003	-0.002	0.0004	0.001	0.004	0.008	0.009	0.008	0.005	0.002	-0.003
	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0003)	(0.0004)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
#farms 12 km radius	-0.0002	-0.00003	0.001	0.001	0.001	0.0002	-0.0003	-0.001	-0.0004	-0.0003	-0.0002
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Biogas kW/ha UAA	-0.004	0.021	0.061	0.129	0.114	0.046	-0.013	-0.055	-0.111	-0.077	-0.095
	(0.033)	(0.027)	(0.022)	(0.020)	(0.019)	(0.020)	(0.019)	(0.018)	(0.018)	(0.019)	(0.020)
Seller BVVG	0.436	0.502	0.562	0.585	0.575	0.504	0.455	0.404	0.347	0.320	0.301
	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.014)	(0.013)	(0.014)	(0.014)	(0.015)
Share BVVG	0.007	-0.030	0.303	0.327	0.220	0.305	0.092	0.086	0.175	0.249	0.475
	(0.057)	(0.054)	(0.058)	(0.059)	(0.065)	(0.067)	(0.067)	(0.067)	(0.068)	(0.075)	(0.081)
Share BVVG²	-0.051	-0.080	-0.545	-0.534	-0.279	-0.343	-0.089	-0.058	-0.115	-0.113	-0.401
	(0.070)	(0.068)	(0.075)	(0.075)	(0.081)	(0.082)	(0.086)	(0.093)	(0.096)	(0.108)	(0.122)
Always organic	-0.038	-0.050	-0.042	-0.063	-0.048	-0.039	-0.017	-0.001	0.001	-0.002	-0.001
	(0.022)	(0.022)	(0.020)	(0.019)	(0.021)	(0.021)	(0.022)	(0.021)	(0.021)	(0.021)	(0.021)
NTreated	246	307	340	366	363	374	370	399	403	393	372
NControl	5,576	6,783	7,368	7,589	7,588	7,175	6,949	6,625	6,421	6,159	4,930
R2 weighted	0.505	0.507	0.53	0.57	0.593	0.592	0.576	0.63	0.614	0.608	0.621

Table 12: Parameter estimates of rolling window regressions for "conventional to organic" regressions, bootstrapped standard errors standard errors in parentheses

	2005-08	2006-09	2007-10	2008-11	2009-12	2010-13	2011-14	2012-15	2013-16	2014-17	2015-18
Intercept	4.433	2.012	-4.981	-5.378	-8.283	-8.712	-7.359	-12.117	-10.927	-7.503	-17.013
	(0.981)	(1.025)	(0.944)	(0.980)	(0.948)	(1.003)	(1.060)	(1.044)	(0.966)	(1.080)	(1.148)
√Soil quality	-0.008	-0.062	0.082	0.022	0.321	0.340	0.226	0.397	0.187	0.496	0.453
	(0.024)	(0.023)	(0.022)	(0.022)	(0.022)	(0.022)	(0.025)	(0.025)	(0.024)	(0.024)	(0.026)
√Lot size	-0.122	-0.055	-0.040	-0.036	-0.025	0.001	0.037	-0.018	-0.113	-0.069	-0.002
	(0.009)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
Lot size²	-0.0004	0.00002	-0.00001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0004	-0.001	0.0003	0.001
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Soil quality²	0.0001	0.0002	0.0001	0.0002	-0.0003	-0.0003	-0.0002	-0.0005	-0.0003	-0.001	-0.001
	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)
Lot size × Soil quality	0.001	0.0003	0.0003	0.0004	0.0003	0.0004	0.0003	0.001	0.002	0.001	0.0004
	(0.00005)	(0.00004)	(0.00004)	(0.00003)	(0.00004)	(0.00003)	(0.00003)	(0.00003)	(0.00004)	(0.00004)	(0.00004)
Multiple parcels	0.056	0.042	-0.007	0.017	-0.022	-0.035	-0.093	-0.158	-0.016	-0.567	-0.900
	(0.014)	(0.014)	(0.013)	(0.013)	(0.014)	(0.016)	(0.018)	(0.019)	(0.024)	(0.029)	(0.037)
Adj. to settlement	0.120	0.114	0.115	0.100	0.110	0.139	0.095	0.077	-0.012	0.027	0.023
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)	(0.011)	(0.010)	(0.012)
Dist. Berlin	-0.012	-0.008	-0.005	-0.003	-0.001	0.0003	0.002	0.004	0.007	0.007	0.006
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Dist. Berlin²	0.0001	0.00003	-0.00000	-0.00000	-0.00001	-0.00003	-0.00003	-0.00003	-0.0001	-0.00004	-0.00004
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Dist. reg. metropolis	0.004	0.002	-0.002	-0.001	-0.003	-0.004	-0.0001	0.001	-0.001	-0.002	-0.006
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0005)
Dist. adm. center	0.004	0.001	0.005	0.002	-0.0005	-0.0005	0.005	0.008	0.009	0.008	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Drought index	-0.008	0.007	0.018	0.024	0.027	0.020	0.018	0.025	0.024	0.018	0.025

	2005-08	2006-09	2007-10	2008-11	2009-12	2010-13	2011-14	2012-15	2013-16	2014-17	2015-18
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Precipitation	-0.200	-0.122	0.085	0.101	0.171	0.183	0.153	0.289	0.292	0.142	0.487
	(0.036)	(0.037)	(0.034)	(0.035)	(0.034)	(0.036)	(0.037)	(0.037)	(0.034)	(0.038)	(0.040)
Precipitation²	0.002	0.001	-0.001	-0.001	-0.002	-0.002	-0.001	-0.002	-0.002	-0.001	-0.004
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Concentration rate CR1	0.087	0.280	0.118	0.373	0.238	0.609	1.258	1.791	1.596	1.366	1.526
	(0.103)	(0.097)	(0.092)	(0.091)	(0.091)	(0.102)	(0.113)	(0.112)	(0.110)	(0.124)	(0.123)
Concentration rate CR1²	-0.231	-0.230	-0.092	-0.229	-0.033	-0.578	-1.198	-1.826	-1.502	-1.030	-1.267
	(0.108)	(0.105)	(0.100)	(0.094)	(0.095)	(0.109)	(0.120)	(0.120)	(0.120)	(0.136)	(0.138)
Total transactions.	-0.007	-0.001	-0.001	0.001	0.002	0.009	0.011	0.010	0.010	0.004	0.004
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
#farms 12 km radius	0.0005	0.001	0.001	0.001	0.001	0.0003	0.0001	-0.0002	0.001	0.002	0.002
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Biogas kW/ha UAA	0.072	0.003	-0.028	-0.019	-0.027	-0.054	0.108	-0.006	0.020	0.139	0.160
	(0.031)	(0.025)	(0.021)	(0.020)	(0.019)	(0.019)	(0.018)	(0.018)	(0.019)	(0.020)	(0.020)
Seller BVVG	0.374	0.409	0.476	0.488	0.511	0.484	0.447	0.441	0.409	0.408	0.377
	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.013)	(0.014)	(0.015)	(0.014)	(0.015)	(0.016)
Share BVVG	0.068	0.040	0.155	0.307	0.492	0.417	0.325	-0.067	-0.581	0.461	0.424
	(0.057)	(0.053)	(0.056)	(0.061)	(0.064)	(0.070)	(0.070)	(0.075)	(0.076)	(0.071)	(0.086)
Share BVVG²	-0.299	-0.150	-0.261	-0.492	-0.822	-0.503	-0.337	0.251	1.184	-0.459	-0.684
	(0.069)	(0.068)	(0.071)	(0.079)	(0.084)	(0.090)	(0.093)	(0.105)	(0.106)	(0.101)	(0.128)
Conventional to organic	0.039	0.051	0.037	0.076	0.102	0.129	0.096	0.051	0.081	0.110	0.167
	(0.033)	(0.031)	(0.028)	(0.031)	(0.034)	(0.040)	(0.041)	(0.043)	(0.046)	(0.049)	(0.060)
Treated	132	146	165	161	140	140	119	101	86	65	43
Control	5,579	6,784	7,368	7,588	7,587	7,175	6,950	6,628	6,425	6,164	4,934
R2 weighted	0.493	0.514	0.542	0.55	0.616	0.62	0.592	0.618	0.64	0.658	0.67

Table 13: Parameter estimates of rolling window regressions for "organic to conventional" regressions, bootstrapped standard errors standard errors in parentheses

	2005-08	2006-09	2007-10	2008-11	2009-12	2010-13	2011-14	2012-15	2013-16	2014-17	2015-18
Intercept	0.089	-0.602	-3.505	-7.202	-10.396	-9.028	-4.319	-4.788	2.874	1353	-0.993
	(1.057)	(0.957)	(0.933)	(0.995)	(0.937)	(0.994)	(1.083)	(1.017)	(1.073)	(1.056)	(1.222)
√Soil quality	0.008	-0.035	0.061	0.042	0.081	0.105	0.198	0.145	-0.024	-0.017	-0.294
	(0.025)	(0.022)	(0.021)	(0.022)	(0.023)	(0.020)	(0.023)	(0.025)	(0.023)	(0.023)	(0.026)
√Lot size	-0.121	-0.137	-0.079	-0.062	-0.009	0.033	-0.010	0.057	0.075	0.068	0.090
	(0.009)	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
Lot size²	-0.0002	-0.0003	-0.0002	-0.0002	-0.0001	-0.0001	-0.001	-0.0003	-0.0002	-0.00002	-0.00002
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00000)	(0.00001)	(0.00001)	(0.00001)
Soil quality²	0.0001	0.0001	0.00001	0.0001	0.0001	0.00003	-0.0001	-0.00001	0.0002	0.0003	0.001
	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)
Lot size × Soil quality	0.001	0.001	0.001	0.001	0.0005	0.0004	0.001	0.0004	0.0001	-0.0001	-0.0001
	(0.00005)	(0.00004)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00004)	(0.00004)	(0.00004)
Multiple parcels	-0.054	-0.065	-0.093	-0.061	0.011	0.020	-0.002	0.008	-0.117	-0.121	-0.122
	(0.015)	(0.013)	(0.013)	(0.012)	(0.013)	(0.016)	(0.017)	(0.020)	(0.025)	(0.029)	(0.036)
Adj. to settlement	0.154	0.144	0.060	0.107	0.114	0.126	0.066	0.036	0.048	0.011	0.046
	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)	(0.012)
Dist. Berlin	-0.005	-0.005	-0.003	0.001	-0.001	0.001	-0.004	-0.001	-0.006	-0.006	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Dist. Berlin²	0.00004	0.00005	0.00003	-0.00003	0.00000	-0.00003	0.00002	0.00001	0.0001	0.00005	-0.00001
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Dist. reg. metropolis	0.0002	-0.001	-0.002	-0.001	0.001	0.002	0.004	0.003	0.007	0.005	0.004
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0005)
Dist. adm. center	0.001	-0.001	0.002	0.003	0.003	0.003	0.006	-0.0004	0.001	0.002	-0.005
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Drought index	-0.014	-0.019	-0.011	0.006	0.014	0.028	0.013	0.007	0.002	0.004	-0.012

	2005-08	2006-09	2007-10	2008-11	2009-12	2010-13	2011-14	2012-15	2013-16	2014-17	2015-18
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Precipitation	-0.051	-0.035	0.048	0.172	0.287	0.228	0.047	0.097	-0.138	-0.079	0.051
	(0.038)	(0.034)	(0.033)	(0.036)	(0.033)	(0.035)	(0.038)	(0.036)	(0.038)	(0.037)	(0.042)
Precipitation²	0.001	0.0004	-0.0004	-0.001	-0.003	-0.002	-0.0003	-0.001	0.001	0.001	-0.0003
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)
Concentration rate CR1	0.480	0.693	0.715	0.045	0.176	0.211	0.240	0.294	0.056	-0.076	0.156
	(0.101)	(0.093)	(0.090)	(0.095)	(0.092)	(0.101)	(0.106)	(0.112)	(0.108)	(0.110)	(0.130)
Concentration rate CR1²	-0.440	-0.662	-0.666	-0.017	-0.325	-0.335	-0.355	-0.321	-0.090	-0.005	-0.564
	(0.108)	(0.102)	(0.099)	(0.100)	(0.099)	(0.109)	(0.115)	(0.121)	(0.121)	(0.124)	(0.145)
Total transactions	0.002	0.004	0.006	0.007	0.004	0.007	0.006	0.006	0.005	0.004	0.0004
	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
#farms 12 km radius	0.001	0.001	0.001	0.0001	-0.0002	-0.0004	-0.00005	0.001	0.001	0.001	0.001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Biogas kW/ha UAA	0.072	0.103	0.033	0.020	0.063	-0.079	-0.069	-0.081	-0.072	-0.061	-0.009
	(0.030)	(0.027)	(0.022)	(0.020)	(0.022)	(0.020)	(0.018)	(0.019)	(0.018)	(0.019)	(0.019)
Seller BVVG	0.391	0.468	0.555	0.598	0.589	0.577	0.479	0.404	0.318	0.261	0.264
	(0.012)	(0.011)	(0.010)	(0.010)	(0.011)	(0.013)	(0.013)	(0.015)	(0.014)	(0.014)	(0.016)
Share BVVG	0.194	0.236	0.443	0.571	0.529	0.686	0.499	0.521	0.477	0.282	0.017
	(0.058)	(0.057)	(0.057)	(0.062)	(0.063)	(0.067)	(0.074)	(0.075)	(0.076)	(0.074)	(0.083)
Share BVVG²	-0.329	-0.392	-0.691	-0.781	-0.816	-1.127	-0.772	-0.721	-0.597	0.098	0.708
	(0.070)	(0.071)	(0.074)	(0.081)	(0.083)	(0.090)	(0.101)	(0.107)	(0.110)	(0.105)	(0.120)
Organic to conventional	-0.026	-0.020	-0.038	-0.040	-0.044	-0.090	-0.105	-0.115	-0.077	-0.017	0.059
	(0.024)	(0.025)	(0.025)	(0.029)	(0.032)	(0.033)	(0.033)	(0.033)	(0.034)	(0.035)	(0.037)
Treated	206	226	234	232	204	196	195	178	158	125	81
Control	5,576	6,783	7,366	7,587	7,587	7,174	6,950	6,628	6,425	6,162	4,932
R2 weighted	0.495	0.562	0.584	0.565	0.557	0.529	0.539	0.595	0.619	0.685	0.712