TENANCY AND SOIL CONSERVATION IN AUSTRIA: ANALYSING THE CROP CHOICE OF FARMERS

Abstract

Tenancy shares in agriculture are increasing - in Europe as a whole as well as in Austria. At the same time, soil degradation and erosion have increasingly become a concern. Since the early days of the science of economics, researchers have speculated that tenancy discourages farmers from making investments into productivity and soil conservation measures. Empirical evidence for this hypothesis has so far been mixed and is scarce for European countries. This paper investigates the impact of tenure on soil conservation behaviour of Austrian farmers by examining their crop choices. A regression analysis with farm-fixed effects shows that the effect of tenancy status for soil conservation behaviour is very weak or insignificant. However, differences at the level of the farm(er) exist. We speculate that the strong institutions surrounding the rental of agricultural land foster soil conserving behaviour of tenants.

Keywords: Soil conservation, land tenure, land ownership, property rights, crop choice

1 Introduction

As land sales markets are tight in most EU countries and farms nevertheless increase in size over time, tenancy and the land rental market are gaining in importance. The share of rented agricultural land is already high in many EU countries and increasing in most others (CIAIAN ET AL., 2012). In Austria, the share of rented land has more than doubled since the 1960s and is still increasing (HOLZER ET AL., 2013). Rented land now amounts to roughly 30% of the total utilized agricultural area (BMLFUW, 2016) and more than 60% of farmers rent at least part of their land (HOLZER ET AL., 2013). At the same time, soil degradation and erosion have increasingly become a concern. Globally, a third of all land is at least moderately degraded, with Europe having an especially long history of human-induced threats to soil fertility (FAO AND ITPS, 2015). The costs of soil degradation for agricultural production are considerable, with cost estimates ranging from 212 to 620 million £ in the UK alone (as reviewed by GRAVES ET AL., 2015). Agriculture is a key factor in this respect: Farmers experience the immediate impacts of soil degradation first-hand, but also cause soil depletion and exhaustion through their land use.

Agricultural economists have debated the influence of different property rights to land on farmers' behaviour since the early days of the discipline. The general reasoning conceives a trade-off between short-run economic payoffs and long-term investments into soil fertility, with tenants being inclined to focus on the former and in doing so deplete soils. This may be due to time preferences, as expressed in discount rates, as well as the length of a farmer's planning horizon (LEE, 1980). In addition, research in the fields of behavioural studies and socio-psychology has suggested that the endowment effect (KAHNEMAN ET AL., 1991) or feelings of psychological ownership (ARORA ET AL., 2015) may also cause differences between tenants and owners with regard to land use and production decisions.

Institutional theories in particular have shown that many other factors than mere economic rationality enable and constrain behaviour and in doing so foster or counteract desired outcomes: The detailed formal and informal arrangements of tenancy (which is itself a formal institution) as well as surrounding factors, such as conventions and norms, matter greatly for behaviour. Any analysis of behaviour therefore depends on the precise institutional context, impeding the transfer of conclusion across different institutional designs.

An important area of research on the relationship between rights to land and land use behaviour are countries of the Global South. As property rights are frequently not well defined in this context and tenure is often insecure, such studies are of obvious importance. However, the recent developments in Europe described above prompt us to ask similar questions also in the context of the Global North with its very different institutional and legal structures: Does tenure status have any impact on land use behaviour of farmers if tenancy is secure and institutions are strong? Do farmers treat rented plots differently than owned plots under these circumstances?

For this research, we have access to an extensive dataset for Austria, containing plot level information for the year 2012. Using this data, we operationalise the above questions as follows: (1) Do farmers plant different crops on rented and owned plots, especially with respect to wide-row crops that tend to be soil-exhaustive, or soil-enhancing legumes? (2) Is there a difference in the diversity of crops planted over several years between rented and owned fields? We aim at capturing the treatment effect of tenancy status, disentangling it from mechanisms that are at work at the farm or farmer level. Before describing the methods used for this endeavour, we provide a brief summary of the research to date.

Previous research

As reviewed by JOHNSON (1950), the concern for the effects of institutional arrangements for farm productivity and land use is almost as old as the economic discipline itself. Early contributions reaching back to Adam Smith, John Stuart Mill, or Alfred Marshall discuss that sharecropping may be inefficient; most notably if tenancy is insecure. This idea has entered the literature as the well-known “Marshallian inefficiency” and has since produced extensive debates about the theory’s correctness (see e.g. QUIBRIA AND RASHID, 1984 for a discussion). When soil conservation became a research topic in the wake of the ‘dust bowl’ in the US of the 1930s, agricultural economists similarly turned to tenancy and its different shapes as explanations for conservation efforts. SCHICKELE AND HIMMEL (1938) are among the first here to provide empirical evidence that tenancy may indeed discourage soil conservation, emphasising, however, the importance of the relationship between landlord and tenant (e.g., family relations) for land use decisions.

More recent empirical investigations of the claim that tenancy may lead to soil-depleting behaviour of farmers are limited for countries of the Global North, and almost non-existent for the EU. For countries of the Global South, research is more abundant, but, as briefly mentioned above, circumstances and consequently research questions differ from the European situation: First, most research in this context investigates explicit investments in land quality, such as planting of trees or construction of stone terraces. These are much more profound land use decisions than crop choice or crop rotation. Second, due to the specific institutional situation of countries in the Global South, studies generally focus on (in)security of tenure in varying degrees, rather than a binary divide of ownership vs. tenure (or, for the North American case, a threefold distinction between ownership, share rental, and cash rental). Despite these differences, we can infer from these studies that the association between secure tenure (or ownership) and investment is far from obvious: For example, ABDULAI ET AL. (2011) and LOVO (2016) (using regressions for African data) empirically show that tenure insecurity has a negative effect on soil conservation investments. BRASSELLE ET AL. (2002) find the opposite; and PLACE (2009) concludes in a review that results regarding investments are mixed for Africa, especially when controlling for the household level. It appears therefore that for countries of the Global South there is no clear evidence on a link between tenure and investments.

Research from countries of the Global North is almost exclusively limited to the North American continent, but evidence is again contradictory. For example, LEE AND STEWART (1983) find owners to be less likely to use minimum tillage than tenants, while twenty years later SOULE (2000) finds the opposite. FRASER (2004) investigates crop choice in British Columbia (Canada) and finds that owners plant more soil conserving crops (such as perennials, grain and forage legumes) than tenants. Investigating both minimum tillage and crop choice, VARBLE ET AL. (2016) find that tenants are more likely to use conservation tillage, but less likely to rotate crops. In Europe, MYYRÄ ET AL. (2005) find that Finnish tenants invest less into land improvement measures with a long pay-back period. SKLENICKA ET AL. (2015) investigate the link between tenancy and crop choice in the Czech Republic and conclude that tenants are significantly more likely to plant wide-row crops (prone to soil erosion) than owners, but also more likely to participate in agri-environmental schemes (AES).

Studies examining the unsubsidized adoption of conservation practices in a more general way, or studies modeling the adoption of AES (i.e., subsidized conservation behavior) can also provide some insights about the effects of tenancy. Such research often includes land property rights as one explanatory variable among many. In line with the results just described, WAUTERS AND MATHIJS (2014) review studies on unsubsidized conservation and find mixed results. For research on AES adoption, results to date are ambiguous (LASTRA-BRAVO ET AL., 2015) or find a negative effect of tenancy for AES uptake (WILSON AND HART, 2000).

2 Estimation Strategy and Data

2.1 Operationalising soil use behaviour

As cropland is especially prone to soil erosion and degradation, we specifically investigate land farmed with field crops. We focus on the individual plot as the unit where farmers usually take their land use decisions, such as the choice of a main crop. We use several indicators to operationalise and quantify land-use behaviour, based on what is generally recommended with respect to soil conservation.

Individual crops differ in their capacity to exhaust soils and foster erosion. Wide-row crops tend to increase soil loss through run-off, as the ground remains open for a long period in the beginning of the planting season. Our first indicator, WR, therefore comprises such crops: varieties of corn, potatoes, sunflower, and beets (see also SKENICKA ET AL. (2015) for an application of this indicator). We regard their use as main crop as – on average – soil exhausting. As potato and beet (especially sugar beet) is commonly grown under contract (i.e., very inflexibly) in Austria, we also use corn (CO) alone as a second indicator for soil-exhausting farming, especially if not in combination with mulch-till/no-till farming. Conversely, legumes (varieties of clover, lupin, pea, beans, and vetch) are considered soil enhancing and are, if used as main crops, an indicator (LE) for investments into soil conservation. Further, a number of plot-specific AES have a focus on soil conservation: use of undersown crops or cover crops; tilling in of residuals or straw; and erosion prevention on vulnerable plots. We aggregate participation of a plot in one of these AES to our fourth indicator (AES).

Applying crop rotation systems and alternating main crops can enhance soil quality and prevent nutrient losses. We therefore use crop diversity over five years as an indicator for soil conserving behaviour. To operationalise diversity, we use four different indicators: species richness, the number of years with corn as a main crop, the Herfindahl index, and the Shannon index. To construct these indicators, we first classify all main crops into nine groups (grain, grain legumes, oleiferous fruits, vegetables, fodder crops, hoe crops (potatoes, beets), corn, other cropland, fallow land). Plots that are classified as fallow land for all five years are excluded from this analysis.

Species richness (SR) is a simple count of the different species present in a community. We use it as the count of different main crops on the same plot over the observation period, i.e. ranging from one (the same main crop for all years) to five (five different main crops over the five years). Similarly, the number of years with corn as a main crop (CO5) is a simple count of corn being present or not, ranging from 0 to 5.

The Herfindahl index is a measure of concentration, commonly used in economics for the analysis of competition, and equivalent to the Simpson index in ecology. We calculate the Herfindahl index (HI) as $H = \sum_{k=1}^{N} s_k^2$, where sk is the share of one crop in the period of N = 5 years. It ranges from 0.2 (five different crops in five years) to 1 (the same crop for five years). The Shannon index (or Shannon-Weaver index; SI) is a measure of diversity, i.e. larger if diversity is higher. We calculate it as $-\sum_{k=1}^{N} s_k \ln s_k$. In our sample, the index ranges from zero (same crop for all 5 years) to 1.61 (five different crops).

2.2 Empirical model and estimation strategy

In order to estimate whether the indicators for soil use just described are related to tenure status we use the following models that build on each other:

$$ind_{ij} = \beta_0 + \beta_1 d_{ij} + \varepsilon_{ij} \tag{1}$$

$$ind_{ij} = \beta_0 + \beta_1 d_{ij} + \beta_2 X_{ij} + \varepsilon_{ij} \tag{2}$$

$$ind_{ij} = b_i + \beta_1 d_{ij} + \varepsilon_{ij} \tag{3}$$

$$ind_{ij} = b_i + \beta_1 d_{ij} + \beta_2 X_{ij} + \varepsilon_{ij} \tag{4}$$

ind_{ij} is the respective soil use indicator on plot j belonging to farm i. d_{ij} is the tenure variable dummy: it can take the values “owned”, “leased” and “unknown”. X_{ij} is a vector of plot-level control variables: the size of the plot (hectares; log), its slope angle (%), a soil-quality indicator (crop yield indicator, scale from 0 – 100), altitude (m above sea), whether the plot is located in an ecologically sensitive area (dummy variable), and the straight-line distance between farm and plot (metres, log). In one CO model we add corn having been planted in the previous year as additional control variable.

β_0 is the constant, and ε_{ij} is the error term. b_i are farm fixed effects that control for all unobserved farm heterogeneity. They result from the demeaning of all variables (“within model”) and are best thought of as dummy variables for each farm – i.e. leading to farm-specific intercepts. This allows us to approximate the treatment effect of tenure status and eliminate farm-level (or larger) effects that influence both ownership and soil use behaviour.

Some of the dependent variables used in the above model specifications are binary (wide-row, corn, legumes, AES), while others are count data (species richness, corn in five years) or may be treated as continuous (Herfindahl and Shannon index). In order to ensure simplicity and transparency in the fixed effects setting, we nevertheless use a ‘standard’ OLS approach (see also LOVO (2016) for a similar approach). For the binary dependent variables, options other than such a linear probability model include fixed effects probit or a random effects logit or probit models. However, the first suffers from the so-called ‘incidental parameters problem’, while the latter assumes the unobserved effects to be random and uncorrelated with the other explanatory variables.

2.3 Data and Study region

Data are taken from the Austrian Integrated Administration and Control System (IACS) database. They contain detailed yearly plot-farm-level information on the plots of all Austrian farms that receive direct payments under the EU’s common agricultural policy (CAP), that is, almost 90% of Austrian farms and 99% of cropland (HOFER AND GMEINER, 2012). The information for each plot includes the main crop, plot and locational characteristics, and the underlying legal property item. Due to the structure of the data and locational differences between farmed plots and legal property items (the legal property items usually consist of multiple plots, and plots are only indirectly assigned to the legal items via larger entities – fields), tenancy status is unclear for around a third of plots. These plots are assigned the tenancy status “unknown”, as are plots with the status “right to use” (as opposed to “leased”). The latter are likely to be owned by close relatives of the farmer and their use often does not entail monetary compensation, so that tenancy effects might be lacking.

To provide some homogeneity, we restrict our analysis to farms in one Austrian region, the Alpenvorland. Situated in the alpine foothills in the North and West of the country, the region exhibits a diverse farming structure with a strong presence of crop production. This ensures that our restriction to cropland still covers a majority of farms. In the Alpenvorland-region, a total 21 900 farms farming 465 000 ha, two-thirds of which are cropland. 17 310 farms farmed at least one plot with field crops in 2012 and are therefore part of our final sample of 196 211 plots.

Table 1 provides summary statistics by tenancy status on the variables used in the empirical model. Most of the control variables are taken directly from the dataset. We approximate ecologically sensitive areas by including a dummy for participation in a corresponding AES. The distance between farm and plots is the Euclidian distance between the geographical coordinates of each, approximating the accessibility of a plot. Observations containing zeros for plot size, metres above sea level or soil quality are treated as missing, as are plots or farms with missing coordinates.

For constructing the diversity indicators, we aggregate main crops per plot over five years. As plots are numbered per farm and indications may change due to renumbering or restructuring, we use only those plots for this second sample that 1) kept the same number and 2) did not change in size (with a 500m² margin of error in one year due to a change in data collection) between 2008 and 2012. This leaves us with a sample of 11 200 farms and 42 000 plots farmed with field crops in the Alpenvorland region for the respective models. Table 2 presents summary information on this dataset.

Table 1: Summary statistics for the variables used in models WR, CO, LE and AES

Variable	total	owned	rented	unknown
No. of plots	196 201	86 520	48 922	60 759
% plots with corn	26.78%	24.64%	29.96%	27.28%
% plots with widerow	30.10%	28.17%	32.72%	30.73%
% plots with legumes	11.43%	12.50%	10.28%	10.85%
% plots with AES soil	0.61%	0.58%	0.59%	0.66%
mean size (ha)	1.61	1.55	1.45	1.83
mean slope angle (%)	6.73	7.06	6.39	6.55
mean soil quality ind. (1-100)	50.09	49.97	50.04	50.29
mean altitude (m)	371.49	378.60	368.06	364.12
% plots in sensitive area	0.41%	0.38%	0.36%	0.49%
mean distance to farm (m)	1 451.64	864.11	2 593.37	1 368.97

Source: own calculations based on IACS data.

Table 2: Summary statistics for the variables used in models SR, CO5, HI and SI

Variable	total	owned	rented	unknown
No. of plots	41 806	21 639	12 119	8 048
mean Species Richness	2.29	2.28	2.30	2.28
mean corn count	1.58	1.46	1.76	1.64
mean Herfindahl index	0.56	0.56	0.56	0.55
mean Shannon index	0.70	0.69	0.70	0.70
mean size (ha)	1.26	1.29	1.13	1.37
mean slope angle (%)	6.68	6.98	6.01	6.87
mean soil quality index (1-100)	49.76	49.66	50.40	49.04
mean altitude (m)	353.43	361.62	345.40	343.51
% plots in sensitive area	0.28%	0.21%	0.35%	0.37%
mean distance to farm (m)	1 451.64	864.11	2 593.37	1 368.97

Source: own calculations based on IACS data.

3 Results

We present our results for each of the eight indicators using the four model specifications outlined in section 2.2. We list all models using the abbreviations for the indicators next to the model specification, e.g., CO.2 is the model for corn with the second specification (a linear probability model without farm fixed effects).

Table 3 shows the results for wide-row crops. In model WR.1 (not controlling for farm fixed effects), a positive correlation between the occurrence of wide-row crops and tenure is evident. The probability of a wide-row crop being planted on a plot is 4.6% higher if it is rented than if it is owned: while there is a probability of 28.2% for an owned plot to be planted with wide row crops, this probability is 32.8% for a rented plot. Once control variables are introduced into the model, this difference diminishes to 3.4%, but remains significant (see WR.2). As soon as the farm fixed effects are introduced, however, the significant difference between rented and owned plots disappears. This holds both with and without control variables (WR.3 and WR.4).

Next, table 4 shows the results for one of the wide-row crops in isolation, corn. The results from the first two models (CO.1 and CO.2) again show a significant correlation between tenure and the planting of corn, even when control variables are included. The probability of corn being planted on a plot is 4.1% higher for rented plots than it is for owned plots (CO.2). Including farm fixed effects, this difference diminishes to 1.3% (CO.4, including controls), but remains statistically significant. Here, we estimate an additional model with additional control variables (CO.5): the presence of corn in the previous year (yes/no dummy variable) as well as an interaction term between this variable and the tenure status. The results show that if corn has been planted in 2011, this decreases the probability of corn in 2012. However, this effect differs by 7% between owned and rented plots, with rented plots being less unlikely to be planted with corn twice in a row. We also estimate models CO.4 and CO.5 separately for farms not under the no-till/mulch-till AES, with findings remaining the same (results not shown).

Table 5 presents results for legumes being planted on a plot, as an indicator for an investment into soil enhancement. Models LE.1 and LE.2 show a significant negative correlation between legumes and tenancy, i.e. less % legumes being planted on rented plots. However, including farm fixed effects in LE.3 shows that this effect does not hold at the farm level, and is even reversed (with a difference of 0.7%) once controls are included in LE.4.

Finally, table 6 presents the results for the adoption of soil-related AES at the plot level. It shows no significant differences between rented and owned fields with respect to AES participation, neither in general nor at the farm level (i.e. controlling for farm fixed effects).

Proceeding to the results for the diversity indicators, table 7 presents the results for the species richness indicator. Without farm fixed effects, we see that tenure is (weakly) correlated with higher species richness (models RI.1 and RI.2). However, at the level of the individual farm this relationship is reversed in RI.3, and, once controlling for plot specific characteristics, is rendered insignificant in RI.4.

Next, as the planting of corn was the only indicator of soil use that was significantly influenced by tenure, we investigate the amount of corn planted over five consecutive years in table 8. We see that on average, tenure is associated with more corn being planted on a plot (CO5.1 and CO5.2). However, this correlation disappears (i.e., is rendered insignificant) once we control for farm fixed effects in CO5.3 and CO5.4.

Table 9 and 10 present the results for the Herfindahl and Shannon indices respectively. The results for both indicators are similar: In the simple models without fixed effects rented fields show more diversity (SI.1, SI.2) and less concentration of crops (HI.1, HI.2) than owned fields. However, including the fixed effects reverses these results (HI.3, SI.3) and renders them insignificant once control variables are included (HI.4, SI.4). We can therefore conclude that tenancy status does not have any significant impact on crop diversity.

Table 3: Regression results for wide-row crops.

	Dependent variable: WR			
	(1)	*(2)*	*(3)*	*(4)*
Unknown ownership	0.026*** (0.002)	0.006*** (0.002)	-0.002 (0.003)	-0.011*** (0.003)
Rented	0.046*** (0.003)	0.034*** (0.003)	-0.001 (0.004)	0.006 (0.004)
log(size)		0.058*** (0.001)		0.057*** (0.001)
Slope angle		-0.003*** (0.0002)		-0.004*** (0.0003)
Soil quality indicator		0.001*** (0.0001)		0.002*** (0.0002)
Altitude		-0.0005*** (0.00001)		-0.0005*** (0.0001)
Ecologically sensitive area		-0.254*** (0.003)		-0.224*** (0.015)
log(distance)		0.005*** (0.001)		-0.0003 (0.001)
Constant	0.282*** (0.002)	0.412*** (0.010)		
R2 full model	-	-	0.1694	0.1945
Households	-	-	17309	17309
Observations	196,201	196,201	196,201	196,201
R2	0.002	0.042	0.00000	0.030
Adjusted R2	0.002	0.042	-0.097	-0.064
Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors in parentheses.				

Table 4: Regression results for corn.

	Dependent variable: CO				
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Unknown ownership	0.026*** (0.002)	0.008*** (0.002)	-0.001 (0.003)	-0.012*** (0.003)	-0.012** (0.005)
Rented	0.053*** (0.003)	0.041*** (0.003)	0.010*** (0.004)	0.013*** (0.004)	-0.011** (0.006)
log(size)		0.067*** (0.001)		0.063*** (0.001)	0.069*** (0.001)
Slope angle		-0.002*** (0.0002)		-0.003*** (0.0003)	-0.004*** (0.0004)
Soil quality indicator		-0.0001 (0.0001)		0.001*** (0.0002)	0.001*** (0.0002)
Altitude		-0.0003*** (0.00001)		-0.0005*** (0.0001)	-0.001*** (0.0001)
Ecologically sensitive area		-0.218*** (0.003)		-0.188*** (0.013)	-0.231*** (0.021)
log(distance)		0.008*** (0.001)		0.005*** (0.001)	0.004** (0.002)
Corn previous year (2011)					-0.178*** (0.006)
Unknown own:Corn 2011					0.002 (0.009)
Rented:Corn 2011					0.073*** (0.010)
Constant	0.246*** (0.001)	0.345*** (0.010)			
R^2 full model	-	-	0.1735	0.2023	0.295
Households	-	-	17309	17309	16388
Observations	196,201	196,201	196,201	196,201	111,455
R^2	0.002	0.045	0.0001	0.035	0.053
Adjusted R^2	0.002	0.045	-0.097	-0.059	-0.110
Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors in parentheses.					

Table 5: Regression results for legumes.

	Dependent variable: LE			
	(1)	*(2)*	*(3)*	*(4)*
Unknown ownership	-0.017*** (0.002)	-0.011*** (0.002)	-0.003 (0.002)	-0.003 (0.002)
Rented	-0.022*** (0.002)	-0.010*** (0.002)	0.001 (0.002)	0.007*** (0.002)
log(size)		0.006*** (0.0005)		0.012*** (0.001)
Slope angle		0.001*** (0.0002)		0.001*** (0.0002)
Soil quality indicator		-0.001*** (0.0001)		-0.001*** (0.0001)
Altitude		0.0002*** (0.00001)		0.00003 (0.00004)
Ecologically sensitive area		0.022* (0.012)		0.025 (0.023)
log(distance)		-0.008*** (0.001)		-0.004*** (0.001)
Constant	0.125*** (0.001)	0.142*** (0.007)		
R^2 full model	-	-	0.2	0.202
Households	-	-	17309	17309
Observations	196,201	196,201	196,201	196,201
R2	0.001	0.007	0.00002	0.002
Adjusted R2	0.001	0.007	-0.097	-0.094
Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors in parentheses.				

Table 6: Regression results for AES participation.

	Dependent variable: AES			
	(1)	*(2)*	*(3)*	*(4)*
Unknown ownership	0.001** (0.0004)	-0.0001 (0.0004)	0.0003 (0.0005)	-0.00000 (0.001)
Rented	0.0001 (0.0004)	-0.001* (0.0005)	0.0004 (0.001)	-0.00001 (0.001)
log(size)		0.001*** (0.0001)		0.001*** (0.0001)
Slope angle		0.0003*** (0.00004)		-0.0002** (0.0001)
Soil quality indicator		-0.0002*** (0.00002)		-0.0001** (0.00003)
Altitude		-0.00005*** (0.00000)		-0.00002 (0.00002)
Ecologically sensitive area		-0.008*** (0.0003)		-0.010*** (0.003)
log(distance)		0.001*** (0.0002)		0.0005 (0.0004)
Constant	0.006*** (0.0003)	0.030*** (0.002)		
R^2 full model	-	-	0.3914	0.392
Households	-	-	17309	17309
Observations	196,201	196,201	196,201	196,201
R^2	0.00002	0.004	0.00000	0.001
Adjusted R^2	0.00001	0.004	-0.097	-0.096
Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors in parentheses.				

Table 7: Regression results for species richness.

	Dependent variable: SR			
	(1)	*(2)*	*(3)*	*(4)*
Unknown ownership	-0.004 (0.009)	-0.028*** (0.009)	-0.015 (0.010)	-0.024** (0.010)
Rented	0.016** (0.008)	0.016* (0.009)	-0.044*** (0.010)	-0.016 (0.010)
log(size)		0.164*** (0.004)		0.127*** (0.005)
Slope angle		-0.004*** (0.001)		-0.006*** (0.001)
Soil quality indicator		0.003*** (0.0003)		0.002*** (0.0004)
Altitude		-0.001*** (0.00004)		0.0002 (0.0002)
Ecologically sensitive area		-0.435*** (0.054)		-0.531*** (0.083)
log(distance)		-0.004 (0.003)		-0.013*** (0.004)
Constant	2.281*** (0.005)	2.623*** (0.034)		
R2 full model	-	-	0.5706	0.5919
Households	-	-	11236	11236
Observations	41,806	41,806	41,806	41,806
R^2	0.0001	0.076	0.001	0.050
Adjusted R^2	0.0001	0.076	-0.367	-0.299
Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors in parentheses.				

Table 8: Regression results for corn count.

	Dependent variable: CO5			
	(1)	*(2)*	*(3)*	*(4)*
Unknown ownership	0.177*** (0.017)	0.109*** (0.016)	-0.015 (0.018)	-0.040** (0.018)
Rented	0.298*** (0.015)	0.190*** (0.016)	-0.009 (0.018)	-0.022 (0.018)
log(size)		0.212*** (0.006)		0.197*** (0.008)
Slope angle		-0.022*** (0.001)		-0.017*** (0.002)
Soil quality indicator		0.006*** (0.001)		0.005*** (0.001)
Altitude		-0.002*** (0.0001)		-0.003*** (0.0004)
Ecologically sensitive area		-1.293*** (0.051)		-0.975*** (0.171)
log(distance)		0.076*** (0.006)		0.033*** (0.009)
Constant	1.464*** (0.009)	1.569*** (0.063)		
Observations	41,806	41,806	41,806	41,806
Households	-	-	11236	11236
R^2	0.010	0.086	0.00003	0.061
Adjusted R^2	0.010	0.086	-0.368	-0.285
R^2 full model	-	-	0.6267	0.6494

Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors in parentheses.

Table 9: Regression results for Herfindahl index.

	Dependent variable: HI			
	(1)	*(2)*	*(3)*	*(4)*
Unknown ownership	-0.004 (0.003)	0.003 (0.002)	0.002 (0.003)	0.005* (0.003)
Rented	-0.003 (0.002)	-0.006*** (0.002)	0.010*** (0.003)	0.0003 (0.003)
log(size)		-0.056*** (0.001)		-0.045*** (0.001)
Slope angle		0.001*** (0.0002)		0.002*** (0.0003)
Soil quality indicator		-0.001*** (0.0001)		-0.001*** (0.0001)
Altitude		0.0003*** (0.00001)		-0.0001** (0.0001)
Ecologically sensitive area		0.141*** (0.019)		0.181*** (0.026)
log(distance)		0.002*** (0.001)		0.004*** (0.001)
Constant	0.559*** (0.001)	0.451*** (0.009)		
R2 full model	-	-	0.5677	0.6011
Households	-	-	11236	11236
Observations	41,806	41,806	41,806	41,806
R^2	0.0001	0.099	0.001	0.078
Adjusted R^2	0.00003	0.099	-0.367	-0.261
Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors in parentheses.				

Table 10: Regression results for Shannon index.

	Dependent variable: SI			
	(1)	*(2)*	*(3)*	*(4)*
Unknown ownership	0.003 (0.004)	-0.009** (0.004)	-0.005 (0.005)	-0.010** (0.005)
Rented	0.007* (0.004)	0.010** (0.004)	-0.019*** (0.005)	-0.004 (0.005)
log(size)		0.089*** (0.002)		0.071*** (0.002)
Slope angle		-0.002*** (0.0003)		-0.003*** (0.0005)
Soil quality indicator		0.001*** (0.0002)		0.001*** (0.0002)
Altitude		-0.001*** (0.00002)		0.0002** (0.0001)
Ecologically sensitive area		-0.231*** (0.029)		-0.290*** (0.042)
log(distance)		-0.003** (0.002)		-0.006*** (0.002)
Constant	0.694*** (0.002)	0.871*** (0.016)		
R2 full model	-	-	0.5746	0.6038
Households	-	-	11236	11236
Observations	41,806	41,806	41,806	41,806
R2	0.0001	0.093	0.001	0.069
Adjusted R2	0.00003	0.093	-0.367	-0.273
Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors in parentheses.				

4 Discussion and Conclusion

In summary, our results show few statistical significant effects of tenure on soil use behaviour once controlling for the farm level. Even in the three models where we find a statistically significant effect of tenure, real-world importance is small and results are not always as expected: The probability of corn being planted on a plot is only 1.3% higher if a plot is rented rather than owned. However, the probability of legumes being planted on a rented plot is also 0.7% higher than on an owned plot, an effect that we expected to be the opposite. Moreover, the results for corn show that while renters are more likely than owners to plant corn twice in a row, there is no effect of tenancy for the amount of corn planted in a period of five years.

Two potential explanations lend themselves to clarifying these contradictions. First, the higher probability of legumes on a rented plot could capture an effect present on newly rented plots, previously farmed by their owner: these plots may not be in good condition, as owners may have been elderly and about to quit farming, or not interested in farming and hence neglecting these plots before finally renting them out. Such fields then require special attention from their new tenant, such as the planting of legumes. Second, the surprising finding that the amount of corn planted on a plot over five years is not significantly related to tenure while the same effect is present in a single year could be due to the fact that plots that have changed tenant during this period are not part of our dataset for this model. This means that plots with a very short rental period and plots whose rental period ended between 2008 and 2012 are not captured by the five-year indicator. The one-year effect may therefore indicate that there is a tenure effect for corn only in short-term contracts or in the last year of tenure.

However, the question remains of why we do not find any effect of tenure for the other indicators, against our expectations. It is important to note that without controlling for the farm level, differences are significant and as expected for most variables (except diversity indicators). It must therefore be factors at the level of the farm or farmer that influence tenure and soil use behaviour at the same time and that are more pronounced than the pure tenancy effect. Two other observations support this point: First, one disadvantage of fixed effects regression is that farms that own or rent all of their cropland (i.e., show no variation in tenancy status) have no influence on results, as it is impossible to ascribe effects to either the farm(er) or other variables. These farms could hence be responsible for the overall correlation between tenure and land use, but are not reflected in the final results. Taking a brief look at these farms shows differences between our indicators that are indeed as expected (more corn and wide row crops for tenants, more legumes and higher AES participation for owners). This suggests a correlation between soil-depleting land use and larger tenancy shares at the farm level. Second, we can take a brief look at rental shares of farms participating in the no-till/mulch-till AES, which is signed for an entire farm (making a farm fixed effects analysis unfeasible). The difference in the share of rented cropland between participants and non-participants is 13%: Non-users rent on average 40.2% of their cropland while users rent 53.5%. Farmers that rent a larger share of their cropland therefore seem to be inclined to prevent soil erosion when subsidized via AES. While these two findings are only very brief comparisons without a proper statistical analysis, they are nevertheless additional indicators that farm(er) specificities rather than mere ownership status cause differences in land use – at least in the Austrian context.

We can therefore conclude here that while tenancy may play a small role in determining farmers' land use behaviour, research into farmer types or attitudes is presumably more promising. Several farm-level factors could qualify as causing differences in land use, including size, part-time vs. full-time farming, or rather traditional peasant farming vs. larger-scale and industrialised farming.

A second explanation for the lack of a tenure effect in our findings may be the specific Austrian situation. While general economic theory predicts that tenants may be short-term oriented and prioritise immediate economic profit over long-term thinking and sustainability concerns, institutional theories have taught us that behaviour, norms, and even perceptions – and therefore outcomes – depend on institutions, both formal and informal. It may therefore be that in Austria, the formal and informal institutions surrounding farming and the rental of agricultural land are of a kind that fosters sustainable soil use behaviour. Formal institutions concerning the land market are quite strict compared to other countries. While there is no binding minimum contract length, the legally fixed 'reference duration' may, for example, foster long rental periods and thus provide stability for tenants. The fact that there is no difference in AES participation between owners and tenants supports the assumption that rental contracts are at least longer than five years, as AES contracts are usually signed for this period. In addition, land sales transactions for agricultural land require that any new buyer has to ensure 'proper agricultural management' of the land. Land owners may then require the same of their tenants, preventing excessive exploitation of soils.

Next to these formal institutions, informal institutions like norms, customs and self-identities also determine behaviour, as they prescribe what is expected and appropriate in a given situation. It may well be that in Austria's small-scale and relatively traditional agricultural setting, social control and self-identities define what it means to be ‘a good farmer’, no matter whether plots are rented or owned. Especially the small and scattered fields that are common in many regions in Austria (due to, e.g., inheritance laws and lack of farmland consolidation) imply that neighbours – and landowners – are often close by and can observe farming conduct. This social control can then prevent short-term orientation and soil exploitation, and support the retaining of traditions such as crop rotation patterns by establishing a threat of social exclusion and/or not getting a rental contract renewed in the future.

In addition, a farmer’s self-identity (equally susceptible to social influences) may determine her behaviour stronger than the tenancy status of a single plot. Farmers may orient themselves towards their own understanding of how to be a ‘good farmer’ and then apply the resulting behavioural rules similarly towards all their plots. This would mean that farmers seek a certain balance between short-term and long-term thinking or between economic and conservational goals for all fields, applying similar crop rotation and farming systems independent of tenancy status.

The latter theory again leads us back to farmer types and related approaches, and may explain why there are differences at the farm level, even if the legal framework (i.e., the formal institutions) are the same for all tenants. Differences in self-identities and social norms may determine both soil use behaviour as well as the inclination to rent (e.g., because of expansion). Additional research in this areas seems definitely needed.

In summary, we can conclude that institutions surrounding agricultural land markets and land use in Austria are of such a kind that tenancy alone does not seem to have any negative impact on soil use behaviour. This conclusion can have important consequences for policy considerations. With rising rental shares in the EU, concerns have been raised over sustainability in soil use. We put forward that rental is per se not a reason to be worried if proper institutions are in place, such as long rental periods and/or informal institutions supporting sustainable soil use. As such, sustainability concerns are then not an argument supporting a “land to the tiller” position, often present in agricultural land laws. While there may be other legitimate reasons for such a position, we have shown that the Austrian rental market seems to be able to provide enough security to foster long-term thinking of tenants.

Nevertheless, it may be important to prevent unsustainable soil use behaviour at the farm or farmer level. We have not investigated this idea in detail, but have provided some indications that AES (such as support for mulch-till/no-till farming) may be an opportunity of doing so. More research in this direction should examine e.g., which farmers exhibit sustainable soil use behaviour no matter what or may even be ‘crowded out’ by the offer of receiving money for doing the same; or which types of farmers need to be incentivised in order to care about their soil.

For us, it remains to conclude with the words of SCHICKELE AND HIMMEL (1938, p. 368), written 80 years ago but still accurate today: “*A categorical statement—such as: Tenancy inevitably leads to soil exploitation—is utterly untenable and betrays a serious misconception of the problem.*”

Bibliography

ABDULAI, A., OWUSU, V., GOETZ, R., 2011. Land tenure differences and investment in land improvement measures: Theoretical and empirical analyses. J. Dev. Econ. 96, 66–78.

ARORA, P., BERT, F., PODESTA, G., KRANTZ, D.H., 2015. Ownership effect in the wild: Influence of land ownership on agribusiness goals and decisions in the Argentine Pampas. J. Behav. Exp. Econ. 58, 162–170.

BMLFUW, 2016. Grüner Bericht 2016: Bericht über die Situation der Österreichischen Land- und Forstwirtschaft im Jahr 2016. Wien.

BRASSELLE, A.-S., GASPART, F., PLATTEAU, J.-P., 2002. Land tenure security and investment incentives: puzzling evidence from Burkina Faso. J. Dev. Econ. 67, 373–418.

CIAIAN, P., KANCS, A., SWINNEN, J., HERCK, K. VAN, 2012. Key Issues and Developments in Farmland Rental Markets in EU Member States and Candidate Countries 32, 30.

FAO, ITPS, 2015. The Status of the World's Soil Resources - Main Report. Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils, Rome, Italy.

FRASER, E.D.G., 2004. Land tenure and agricultural management: Soil conservation on rented and owned fields in southwest British Columbia. Agric. Human Values 21, 73–79.

GRAVES, A.R., MORRIS, J., DEEKS, L.K., RICKSON, R.J., KIBBLEWHITE, M.G., HARRIS, J.A., FAREWELL, T.S., TRUCKLE, I., 2015. The total costs of soil degradation in England and Wales. Ecol. Econ. 119, 399–413.

HOFER, O., GMEINER, P., 2012. Vergleich der Agrarstrukturerhebung 2010 mit den INVEKOS-Daten 2010 [WWW Document]. URL https://gruenerbericht.at/cm4/jdownload/send/20-spezielle-studien/513-vergleich-agrarstrukturerhebung-invekos-2010 (accessed 8.3.17).

HOLZER, G., JILCH, M., WILFINGER, H., 2013. Pachten und Verpachten in Österreich, 4. überarb. ed. NWV Neuer Wissenschaftlicher Verlag, Wien.

JOHNSON, G.D., 1950. Resource Allocation under Share Contracts. J. Polit. Econ. 58, 111–123.

KAHNEMAN, D., KNETSCH, J.L., THALER, R.H., 1991. Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias. J. Econ. Perspect. 5, 193–206.

LASTRA-BRAVO, X.B., HUBBARD, C., GARROD, G., TOLÓN-BECERRA, A., 2015. What drives farmers' participation in EU agri-environmental schemes?: Results from a qualitative meta-analysis. Environ. Sci. Policy 54, 1–9.

LEE, L.K., 1980. Landownership Conservation. Am. J. Agric. Econ. 62, 1070–1076.

LEE, L.K., STEWART, W.H., 1983. Landownership and the Adoption of Minimum Tillage. Am. J. Agric. Econ. 65, 256–264.

LOVO, S., 2016. Tenure Insecurity and Investment in Soil Conservation. Evidence from Malawi. World Dev. 78, 219–229.

MYYRÄ, S., KETOJA, E., YLI-HALLA, M., PIETOLA, K., 2005. Land improvements under land tenure insecurity: the case of pH and phosphate in Finland. Land Econ. 81, 557–569.

PLACE, F., 2009. Land Tenure and Agricultural Productivity in Africa: A Comparative Analysis of the Economics Literature and Recent Policy Strategies and Reforms. World Dev. 37, 1326–1336.

QUIBRIA, M.G., RASHID, S., 1984. The Puzzle of Sharecropping: A Survey of Theories. World Dev. 12, 103–114.

SCHICKELE, R., HIMMEL, J.P., 1938. Socio-Economic Phases of Soil Conservation in the Tarkio Creek Area, Iowa Agricultural Experiment Station Bulletin 241. Ames, Iowa.

SKLENICKA, P., MOLNAROVA, K.J., SALEK, M., SIMOVA, P., VLASAK, J., SEKAC, P., JANOVSKA, V., 2015. Owner or tenant: Who adopts better soil conservation practices? Land use policy 47, 253–261.

SOULE, M.J., TEGENE, A., WIEBE, K.D., 2000. Land Tenure and the Adoption of Conservation Practices. Source Am. J. Agric. Econ. 82, 993–1005.

VARBLE, S., SECCHI, S., DRUSCHKE, C.G., 2016. An Examination of Growing Trends in Land Tenure and Conservation Practice Adoption: Results from a Farmer Survey in Iowa. Environ. Manage. 57, 318–330.

WAUTERS, E., MATHIJS, E., 2014. The adoption of farm level soil conservation practices in developed countries: a meta-analytic review. Int. J. Agric. Resour. Gov. Ecol. 10, 78.

WILSON, G.A., HART, K., 2000. Financial imperative or conservation concern? EU farmers' motivations for participation in voluntary agri-environmental schemes. Environ. Plan. A 32, 2161–2185.