AJAE Appendix: 'Do Overlapping Land Rights Reduce Agricultural Investment? Evidence from Uganda'

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Table A1: Determinants of Land-Related Investments: SURE Fixed Effects Linear Probability Models

	Tree investment last 5 years	Soil conservation	Manure application
Ownership dummy	0.177***	0.135***	0.055***
	(0.011)	(0.011)	(0.008)
Mailo or freehold dummy	-0.006	-0.043	0.024
	(0.029)	(0.028)	(0.021)
Ownership**Mailo* or freehold	0.151***	0.033*	0.012
	(0.019)	(0.018)	(0.013)
Ownership*Household wealth*10^{-4}	0.025	0.005	-0.024
	(0.024)	(0.023)	(0.017)
Protected occupant: 5-12 years	0.025	0.005	-0.024
	(0.024)	(0.023)	(0.017)
Protected occupant: more than 12 years	0.100***	0.069**	0.007
	(0.030)	(0.029)	(0.021)
Parcel area in acres	0.001	0.000	0.000
	(0.000)	(0.000)	(0.000)
No. of years possessed	0.002***	0.002***	0.002***
	(0.001)	(0.001)	(0.000)
Distance to house	-0.002***	-0.003***	-0.002***
	(0.001)	(0.001)	(0.000)
Good soil quality	-0.020*	0.035***	0.027***
	(0.012)	(0.011)	(0.008)
Poor soil quality	0.027	-0.023	-0.013
	(0.017)	(0.016)	(0.012)
Flat topography	0.003	-0.010	0.050***
	(0.016)	(0.016)	(0.012)
Gently sloped	0.011	0.039***	0.064***
	(0.016)	(0.015)	(0.011)
Irrigated land	-0.073	0.128	-0.064
	(0.083)	(0.079)	(0.059)
Swamp/wetland	-0.055**	0.100***	-0.018
	(0.024)	(0.023)	(0.017)
Constant	-0.000	-0.000	-0.000
	(0.003)	(0.003)	(0.002)
Observations	5448	5448	5448
Number of households	1728	1728	1728
R^2	0.18	0.10	0.07

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: All regressions are estimated with the SURE method (seemingly unrelated regression equation), after within transformation, that corrects for contemporaneous correlation of the error terms.

Table A2. Determinants of Investments in Specific Tree Crops of Owner-cum-Occupants: Fixed Effects Linear Probability Models

	Any tree		Tree investment last 5 years	
	Fruit	**Coffee**	**Fruit**	**Coffee**
Ownership dummy	0.257***	0.146***	0.144***	0.076***
	(0.017)	(0.012)	(0.012)	(0.010)
Mailo or freehold dummy	-0.039	-0.084**	-0.006	-0.038
	(0.048)	(0.034)	(0.033)	(0.027)
Ownership**Mailo* or freehold	0.149***	0.163***	0.141***	0.123***
	(0.028)	(0.026)	(0.024)	(0.021)
Ownership*Household wealth*10^{-4}	0.011	0.009	0.015	0.018*
	(0.011)	(0.010)	(0.010)	(0.009)
Protected occupant: 5-12 years	0.117***	0.013	0.003	0.004
	(0.038)	(0.029)	(0.027)	(0.022)
Protected occupant: more than 12 years	0.143***	0.122***	0.084**	0.052
	(0.046)	(0.039)	(0.036)	(0.032)
Parcel area in acre	0.001**	0.000	0.001*	0.000
	(0.001)	(0.000)	(0.000)	(0.000)
No. of years possessed	0.005***	0.004***	0.002***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Distance to house	-0.003***	-0.003***	-0.002***	-0.001***
	(0.001)	(0.001)	(0.001)	(0.000)
Good soil quality	-0.013	-0.008	-0.028**	0.001
	(0.018)	(0.014)	(0.014)	(0.011)
Poor soil quality	0.032	0.037*	0.018	0.016
	(0.028)	(0.022)	(0.020)	(0.017)
Flat topography	0.081***	0.021	0.018	-0.005
	(0.026)	(0.021)	(0.018)	(0.015)
Gently sloped	0.063**	0.036*	0.015	0.007
	(0.025)	(0.020)	(0.019)	(0.015)
Irrigated land	-0.083	-0.088	-0.122	-0.099
	(0.083)	(0.080)	(0.075)	(0.062)
Swamp/wetland	-0.096**	-0.067***	-0.046*	-0.024
	(0.037)	(0.026)	(0.026)	(0.021)
Constant	0.087***	0.015	0.011	0.007
	(0.026)	(0.020)	(0.018)	(0.014)
Observations	5448	5448	5448	5448
Number of households	1728	1728	1728	1728
R^2	0.22	0.19	0.16	0.11

Notes: Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Table A3. Determinants of Land-related Investments Controlling for Length of Occupation on All Owned and Usufruct Parcels: Fixed Effects Linear Probability Models

	Any tree	Tree investment last 5 years	Soil conservation	Manure application
Ownership dummy, γ_T	0.317***	0.160***	0.128***	0.047***
	(0.017)	(0.013)	(0.013)	(0.010)
Mailo or freehold dummy	-0.067	-0.029	-0.048	0.008
	(0.047)	(0.033)	(0.037)	(0.028)
Ownership**Mailo* or freehold, γ_D	0.096***	0.140***	0.030	0.022
	(0.029)	(0.026)	(0.024)	(0.019)
Ownership*Household wealth*10^{-4}	0.008	0.013	-0.005	0.015
	(0.011)	(0.011)	(0.012)	(0.009)
Protected occupant: 5-12 years, γ^2_L	0.108***	0.018	0.005	-0.027
	(0.040)	(0.031)	(0.031)	(0.022)
Protected occupant: 12 years and above, γ^1_L	0.203***	0.087**	0.068**	0.008
	(0.047)	(0.040)	(0.034)	(0.029)
Parcel area in acres	0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
No. of years possessed	0.006***	0.003***	0.003***	0.002***
	(0.001)	(0.001)	(0.001)	(0.000)
Distance to house	-0.004***	-0.003***	-0.004***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Good soil quality	-0.018	-0.026**	0.037***	0.028***
	(0.015)	(0.013)	(0.011)	(0.009)
Poor soil quality	0.048**	0.035*	-0.034*	-0.025*
	(0.022)	(0.018)	(0.017)	(0.014)
Flat topography	0.025	0.010	0.000	0.049***
	(0.021)	(0.016)	(0.017)	(0.014)
Gently sloped	0.029	0.018	0.031*	0.047***
	(0.021)	(0.017)	(0.017)	(0.014)
Irrigated land	-0.119	-0.089	0.028	-0.045
	(0.103)	(0.101)	(0.117)	(0.096)
Swamp/wetland	-0.171***	-0.071***	0.057*	-0.013
	(0.032)	(0.023)	(0.029)	(0.018)
Constant	0.201***	0.025	0.077***	-0.037**
	(0.024)	(0.018)	(0.019)	(0.015)
Observations	12924	12924	12924	12924
Number of households	5532	5532	5532	5532
R^2	0.17	0.10	0.06	0.04
F-tests for equality of coefficients				
$\gamma_T = \gamma^2_L$	28.04***	20.97***	15.59***	12.42***
$\gamma_T = \gamma^1_L$	5.75**	3.25*	3.04*	1.85

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table A4. Intensity of Labor Input Use and Yield on Owned and Usufruct Land of Mixed Owners: Household Fixed Effects Estimates

	Parcel level		Household level
	Total labor	**Family labor**	**Crop output per acre**
Ownership dummy	0.023	0.039	-0.052
	(0.034)	(0.034)	(0.077)
Mailo or freehold	-0.007	-0.015	0.295*
	(0.080)	(0.080)	(0.178)
Ownership**Mailo* or freehold	-0.061	-0.081	-0.160
	(0.050)	(0.051)	(0.103)
Distance to house	-0.009***	-0.010***	-0.015*
	(0.003)	(0.003)	(0.008)
No. of years possessed	0.001	0.001	0.007**
	(0.002)	(0.002)	(0.003)
Good soil quality	-0.002	-0.003	0.097
	(0.034)	(0.035)	(0.084)
Poor soil quality	-0.099*	-0.091*	-0.103
	(0.051)	(0.051)	(0.125)
Flat topography	-0.007	-0.004	0.094
	(0.045)	(0.045)	(0.107)
Gently Slope	-0.032	-0.029	0.008
	(0.044)	(0.044)	(0.110)
Irrigated land	-0.297	-0.338	0.810
	(0.287)	(0.289)	(0.730)
Swamp/wetland	0.273***	0.273***	0.542***
	(0.073)	(0.073)	(0.176)
Vegetables	0.441***	0.436***	0.568***
	(0.090)	(0.091)	(0.206)
Roots	0.291***	0.307***	0.339***
	(0.028)	(0.028)	(0.068)
Fruits	-0.039	-0.034	0.364*
	(0.121)	(0.122)	(0.193)
Banana	-0.466***	-0.447***	0.330***
	(0.040)	(0.040)	(0.088)
Coffee	-0.265***	-0.268***	-0.021
	(0.063)	(0.063)	(0.103)
Other cash crops	-0.056	-0.036	0.058
	(0.062)	(0.062)	(0.139)
Season dummy	-0.350***	-0.344***	
	(0.021)	(0.021)	
Constant	4.356***	4.294***	3.884***
	(0.055)	(0.055)	(0.106)
Observations	6628	6628	2150
Number of households	1310	1310	1075
R^2	0.12	0.12	0.08

Notes: Absolute value of standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Unit of observation is a parcel (under crop) in a given season for the labor use regressions. A sub-sample of households who cultivate different types of crops on their owned and occupied parcels is used for the yield regression. The reference category for crop composition is cereals and pulses, the dominant crops on occupied plots.

As discussed in the main text, land tenure should no longer have a systematic effect on the level of output or input use once investments in trees or permanent crops and other observable characteristics are accounted for. To test whether this is the case, let Y_{hi} be either the value of output or the amount of total or family labor days per acre in an output or input regressions and estimate an equation to compare outputs and key inputs between owned and occupied parcels cultivated by the same household as

(A1) $$Y_{hi} = \gamma_T D_{hi} + \boldsymbol{\beta}'\boldsymbol{X}_{hi} + \gamma_M M_{hi} + \gamma_D M_{hi} * D_{hi} + \varphi'\boldsymbol{K}_{hi} + \alpha_h + \varepsilon_{hi},$$

where $\boldsymbol{K}_{ht}$ is a vector of crop dummies and all remaining variables—with the exception of a season dummy that is added to capture climatic and other time-varying variables not specific to a given parcel—are as defined above. Although γ_T=0 is a sufficient condition for our model to be fully specified, ability to reject it for either output or input regressions would suggest systematic differences between owned and occupied parcels not accounted for in our framework, thus casting doubt at the reliability of the results.

A complicating factor in estimating (A1) for output is that, due to widespread intercropping, data on output could be collected by crop only, unlike information on inputs and crops grown which is available at plot or parcel level, respectively. Thus, while we can estimate (A1) for labor input at the parcel level, the output equation can only be estimated at the household level. In this case, we drop households who grow the same crop on parcels with different tenure status have to be dropped to prevent errors from apportioning outputs to parcels of different tenure status so that our sample contains owner-cum-occupants who cultivated different types of crops on at least one of their owned and occupied parcels. The fact that we do not find statistically significant differences in levels of consumption and assets, as well as demographic characteristics between households who have all their parcels included and those who have at least one parcel dropped increases our confidence in doing so. Furthermore, estimating (A1) for the whole sample under the assumption of equal yield on parcels of different tenure but the same crop, with results very similar to those reported in table A4.