

Preferences for forms of land conservation investment in the Ethiopian Highlands: a household plot-level analysis of the roles of poverty, tenure security, and market incentives¹

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Online Appendices

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Appendix A: Multinomial Logit Model (MNLM) estimation of Preference to forms of Investment in Land conservation

Variable		Forms of Investment in Land conservation (Robust standard errors are in parenthesis)						
		Terraces with rocks		Terraces with soil		Digging ditches (DD)	'Kfir' works (KW)	
Traditional (TTR)	Modern (MTR)	Traditional (TTS)	Modern (MTS)					
Poverty-related factors	Cash Income	-.0001 (.0002)	.0004 (.0003)	.0001 (.0002)	-.0001 (.0004)		-.0002 (.0003)	.00002 (.0003)
	Livestock income	.001 (.001)	.001 (.001)	.001 (.001)	.0005 (.001)		.0001 (.0006)	-.0001 (.001)
	Employment income	-.001 (.001)	-.0002 (.001)	-.0003 (.001)	-.001 (.001)		-.001 (.001)	-.00002 (.0001)
	Non-crop income	.0002 (.0004)	.0002 (.0004)	.0002 (.0004)	-.00002 (.0005)		.0002 (.0004)	.0004 (.0004)
	Access to credit	.831 (.433)*	1.091 (.563)*	.448 (.474)	.091 (.673)		1.310 (.511)***	.615 (.652)
	Farm size	.551 (.269)**	.424 (.308)	.575 (.278)**	.179 (.407)		.653 (.280)**	1.031 (.302)***
	Value of livestock	.0001 (.0001)	.0001 (.0001)	.0001 (.0001)	.0001 (.0001)		.0002 (.0001)	-.00001 (.0001)
	Value of live trees	.0001 (.0001)	.0001 (.0001)	.0001 (.0001)	.0001 (.0001)*		.0001 (.0001)	.0001 (.0001)*
	Value of crop produced	.00002 (.0002)	.00002 (.0003)	.0001 (.0002)	.0001 (.0002)		.0001 (.0002)	-.001 (.0003)**
	Male adults per hectare	.010 (.114)	-.111 (.139)	-.136 (.125)	.040 (.160)		-.027 (.150)	.006 (.131)
Human-capital	Female adults per hectare	.087 (.097)	.079 (.127)	.017 (.106)	-.026 (.143)		.020 (.127)	.182 (.106)*
	Dependent ratio	-.231 (.281)	-.019 (.334)	-.772 (.327)**	-.031 (.479)		-.256 (.304)	-.059 (.378)
	Age of household head	-.006 (.011)	.016 (.020)	.003 (.012)	.025 (.018)		-.002 (.013)	.023 (.014)*
	Sex of household head	.318 (.463)	-.069 (.683)	.531 (.519)	.172 (.853)		.072 (.554)	.520 (.565)
	Literacy of head	-.091 (.397)	.666 (.600)	.072 (.406)	-.163 (.633)		-.097 (.402)	-.163 (.490)
	Access to extension	1.389 (.575)**	1.215 (.629)**	1.482 (.606)**	2.470 (.844)***		1.487 (.595)***	1.094 (.803)
	Soil conservation advice	1.390 (.599)**	1.038 (.660)	1.880 (.644)***	1.337 (.813)		1.734 (.622)***	1.768 (.830)
	Household expenditure	-.0004 (.001)	-.001 (.001)*	.0002 (.001)	-.005 (.002)***		-.0004 (.001)	-.001 (.001)
	Cultivate plot in 5 years	.657 (.379)*	.182 (.491)	.745 (.400) *	-.941 (.543)*		-.324 (.397)	.293 (.456)
	Land ownership type	-.524 (.344)	-.939 (.493)**	-.549 (.372)	-.116 (.535)		-.051 (.364)	-.657 (.442)
Risk factors (Tenure security)	Land ownership believe	.776 (.349)**	1.191 (.496)**	.884 (.386)**	1.494 (.577) ***	1.360 (.396)***	.605 (.439)	
Risk factors	Plot-home distance	.082 (.071)	.092 (.082)	-.022 (.083)	.036 (.097)		.047 (.074)	.044 (.084)
	Simpson Index	-3.584 (2.018)*	-3.683 (2.282)*	-5.377 (2.090)**	-5.139 (2.349) **		-5.303 (2.247)**	-5.140 (2.219)**
Market access	Plot age	-.022 (.013)*	-.018 (.022)	-.039 (.015)***	-.026 (.027)		-.056 (.016)***	-.055 (.021)***
	Town-residence distance	-.003 (.005)	-.006 (.008)	-.020 (.006)***	-.014 (.010)		-.012 (.006)*	-.008 (.006)
	Road-residence distance	-.007 (.006)	.004 (.008)	.006 (.006)	.007 (.011)		.003 (.006)	-.001 (.007)
	Market-residence distance	.004 (.005)	.003 (.010)	.003 (.006)	-.007 (.010)		.002 (.006)	.005 (.006)
	Return from investment	-.202 (.371)	-.872 (.500)*	-.758 (.397)*	-.957 (.585)		-.374 (.416)	-.039 (.481)

Appendix A Continued ...

Variable		Forms of Investment in Land conservation (Robust standard errors are in parenthesis)					
		Terraces with rocks		Terraces with soil		Digging ditches	'Kibir' works (KW)
		Traditional (TIR)	Modern (MIR)	Traditional (TIS)	Modern (MIS)	(DD)	
Physical incentives	Highland	-.040 (.572)	-.746 (.691)	-1.188 (.589)**	-.497 (.943)	.520 (.716)	1.866 (.737)**
	Soil fertility	-.265 (.179)	-.378 (.245)	-.175 (.193)	-.238 (.270)	-.113 (.183)	-.205 (.234)
	Plot slope	-.308 (.418)	-1.087 (.565)*	-.994 (.478)*	-.128 (.977)	-.791 (.486)*	.292 (.580)
	Plot area	.372 (.686)	1.196 (.849)	1.114 (.693)	1.253 (.822)	.263 (.736)	.735 (.771)
	Plot access to irrigation	.030 (.486)	-2.071 (.995)*	.324 (.514)	.145 (.994)	.063 (.664)	.088 (.762)
Major use of plot	Tree plant	.147 (.540)	.616 (.560)	-.620 (.598)	-.241 (.855)	-.453 (.831)	-.110 (.606)
	Grazing	-.777 (.499)	-1.728 (1.226)	-1.044 (.585)*	-1.934 (1.215)	-1.307 (.871)	.335 (.612)
Past land investment intensity		.003 (.005)	.0001 (.006)	.002 (.005)	.002 (.006)	.008 (.006)	.007 (.006)
Village dummies	Amanuel	-3.540 (.640)***	-1.335 (.763)	-2.210 (.600)***	-40.709 (.842)***	1.881 (.683)***	-1.614 (.806)**
	Delias	-.362 (1.044)	.267 (1.566)	1.972 (.970)**	5.490 (1.199)***	4.310 (1.119)***	1.831 (1.285)
	Kebi	.597 (1.054)	-36.722 (1.08)***	1.851 (1.060)*	-35.359 (1.175)***	6.373 (1.116)***	2.685 (1.224)**
	Telma	.576 (1.105)	1.292 (1.442)	2.360 (1.183)**	-35.127 (1.47)***	3.564 (1.266)***	-470 (1.305)
	Yamed	3.691 (1.114)***	7.137 (1.193)***	5.156 (1.130)***	5.824 (1.343)***	2.645 (1.130)*	2.868 (1.093)***
Constant	Wolkie	-.312 (.919)	3.057 (1.250)**	3.689 (.920)***	2.791 (1.502)*	5.896 (.974)***	.523 (.991)
	Sekladibir	.128 (.565)	.351 (1.088)	-1.742 (.930)*	-.747 (1.253)	4.044 (.743)***	-1.158 (1.011)
	Constant	4.601 (1.618)***	1.338 (2.294)	5.642 (1.774)***	1.801 (2.378)	2.245 (1.945)	1.003 (2.059)
Number of observation = 4795		Wald chi2(258) = 91370.92	Prob > chi2 = 0.0000	Log pseudo-likelihood = -5263.7295		Pseudo R2 = 0.3205	

Note:

- Outcome other types of land conservation works (including Grass covers, Contour farming, and Forestation) is the comparison group, and hence estimated coefficients are relative to the state of these form of conservation works.
- Standard errors (shown in parentheses) are adjusted for clustering on household identification.
- *** Significant at 1 percent level. ** Significant at 5 percent level. * Significant at 10 percent level

Appendix B: Wald tests that a covariate^a has no effect throughout the alternatives

Independent variables			Wald statistics, $\chi^2(6)$	P-value
Poverty-related factors	Cash Income	Livestock income	10.937	0.090*
		Employment income	7.289	0.295
		Non-crop income	2.266	0.894
		Cash crop income	1.647	0.949
		Access to credit	11.690	0.069*
	Non-liquid asset	Farm size	17.368	0.008***
		Value of livestock	15.301	0.018**
		Value of live trees	6.604	0.359
		Value of crop produced	6.981	0.323
		Male adults per hectare	6.962	0.324
		Female adults per hectare	7.229	0.300
	Human-capital	Dependent ratio	11.533	0.073*
		Age of household head	9.654	0.140
		Sex of household head	2.552	0.863
		Literacy of head	2.668	0.849
		Access to extension	9.758	0.135
		Soil conservation advise	12.289	0.056*
Household expenditure		12.554	0.051*	
Risk factors (Tenure security)	Cultivate plot in 5 years		31.148	0.000***
	Land ownership type		9.807	0.133
	Land ownership believe		14.475	0.025**
	Plot-home distance		6.309	0.389
	Simpson Index		10.337	0.09*
	Plot age		17.575	0.007***
Market access	Town-residence distance		19.493	0.003***
	Road-residence distance		12.368	0.054*
	Market-residence distance		2.761	0.838
	Return from investment		12.135	0.059*
Physical incentives	Highland		45.164	0.000***
	Soil fertility		4.229	0.646
	Plot slope		12.022	0.061*
	Plot area		9.212	0.162
	Plot access to irrigation		7.943	0.242
	Major use of plot	Tree plan	8.569	0.199
		Grazing	10.267	0.114
Past land investment intensity			26.585	0.000***
Village dummies	Amanuel		3209.117	0.000***
	Delias		64.683	0.000***
	Kebi		7594.162	0.000***
	Telma		1704.659	0.000***
	Yamed		75.871	0.000***
	Wolkie		109.686	0.000***
	Sekladebir		65.088	0.000***
^a Null hypothesis. Ho: All coefficients associated with given variable(s) are 0.				

^a Null hypothesis, H_0 : All coefficients associated with given variable(s) are 0.

Note: ***significant at 0 percent level, **significant at 5 percent level, *significant at 10 percent level.

Appendix C: Wald test for multiple independence variables

	Wald statistics, χ^2	Degrees of freedom	P-value
Poverty-related factors	156.766	108	0.002***
Land tenure security	85.636	36	0.000***
Market access	49.418	24	0.002***
Physical incentives	102.173	42	0.000***

Note: ***significant at 0 percent level, **significant at 5 percent level, *significant at 10 percent level.

Appendix D: Wald test for pairs of preferences is indistinguishable with respect of the covariates

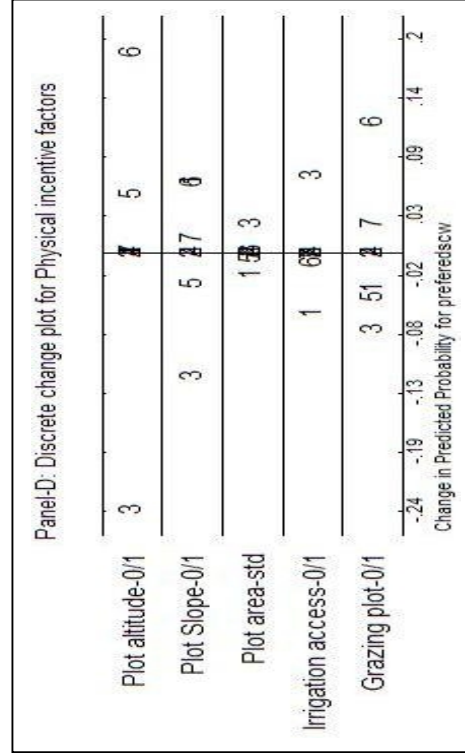
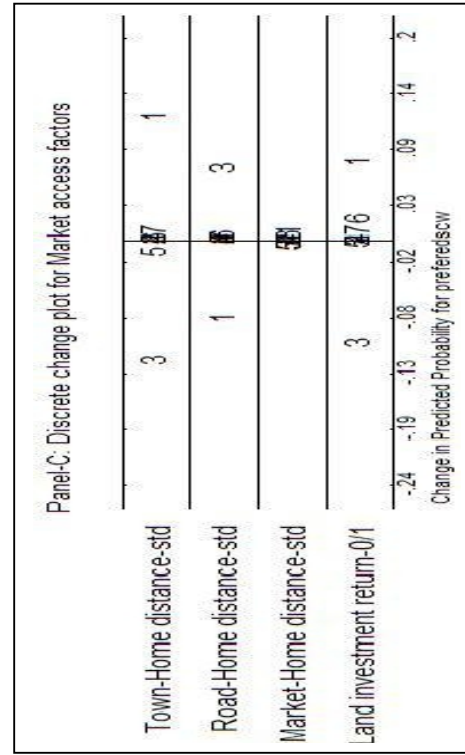
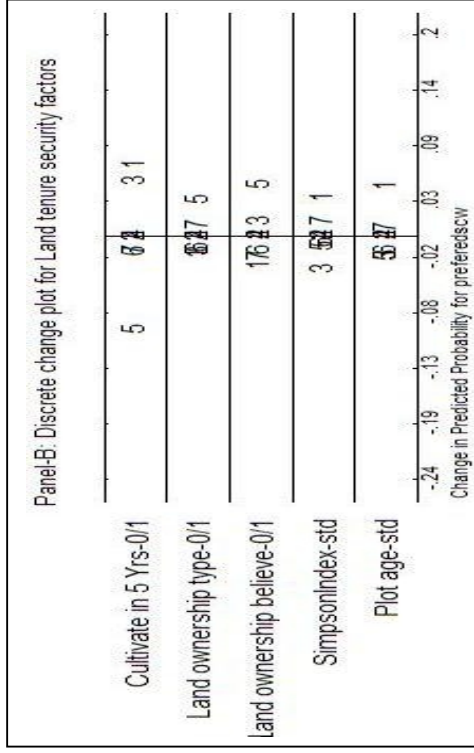
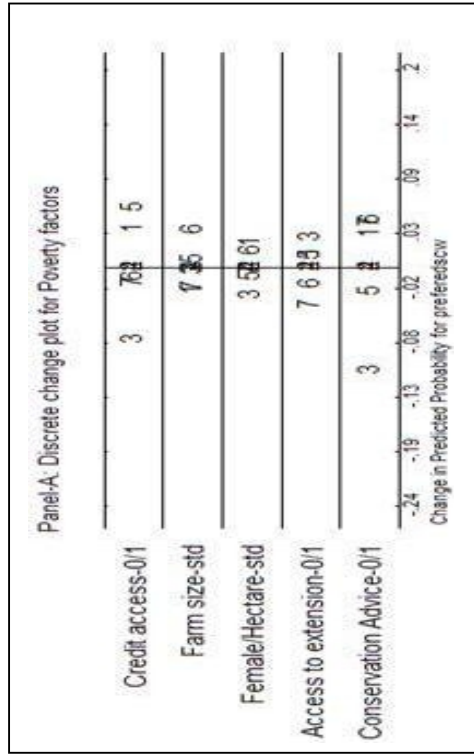
		MTR	TTS	MTS	DD	KW	OTHERS
TTR^a	$\chi^2(43)$ P-value	10392.37 (0.000)	238.70 (0.000)	17672.53 (0.000)	265.67 (0.000)	150.06 (0.000)	125.41 (0.000)
MTR	$\chi^2(43)$ P-value		15824.58 (0.000)	9470.15 (0.000)	21311.94 (0.000)	9728.92 (0.000)	2844.54 (0.000)
TTS	$\chi^2(43)$ P-value			20492.94 (0.000)	176.17 (0.000)	170.53 (0.000)	158.46 (0.000)
MTS	$\chi^2(43)$ P-value				18147.83 (0.000)	13235.36 (0.000)	11695.85 (0.000)
DD	$\chi^2(43)$ P-value					175.07 (0.000)	156.07 (0.000)
KW	$\chi^2(43)$ P-value						135.78 (0.000)

^a TTR represents traditional terraces - with rocks, MTR is modern terraces - with rocks, TTS is traditional terraces-with soil, MTS is modern terraces-with soil, DD is digging ditches, KW is 'Kitir works', and OTHERS is others types of practices (including Grass covers, Contour farming, and Forestation).

Appendix E: Distribution of the predicted probabilities of outcome of the dependent variable

	<i>Probability of Outcome</i>						
	TTR	MTR	TTS	MTS	DD	KW	Others
Mean	0.39	0.06	0.20	0.03	0.19	0.06	0.07
Standard deviation	0.27	0.09	0.16	0.09	0.24	0.08	0.13
Minimum	0.004	~ 0.00	0.001	~ 0.00	0.0001	~ 0.00	~0.00
Maximum	0.98	0.76	0.88	0.94	0.96	0.66	0.95
Range	0.976	0.76	0.879	0.94	0.96	0.66	0.95

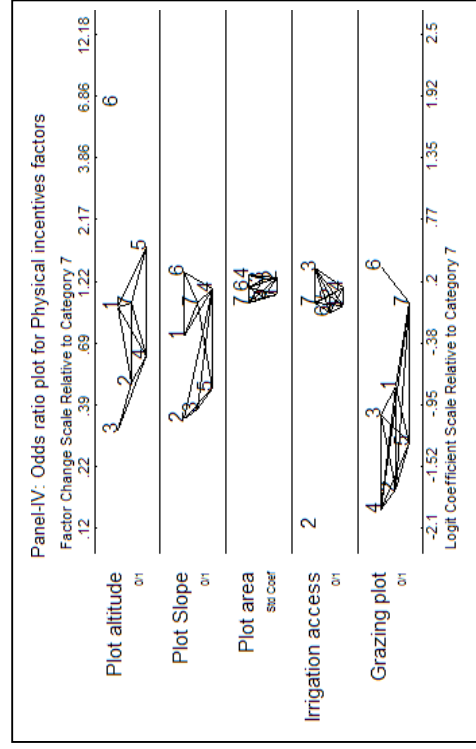
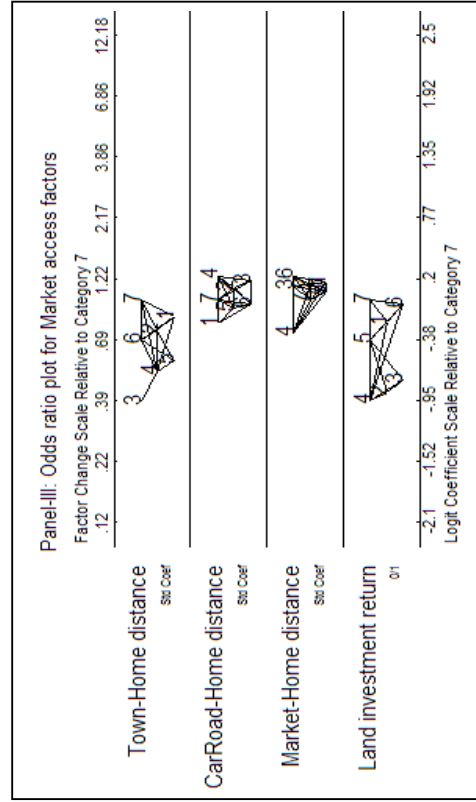
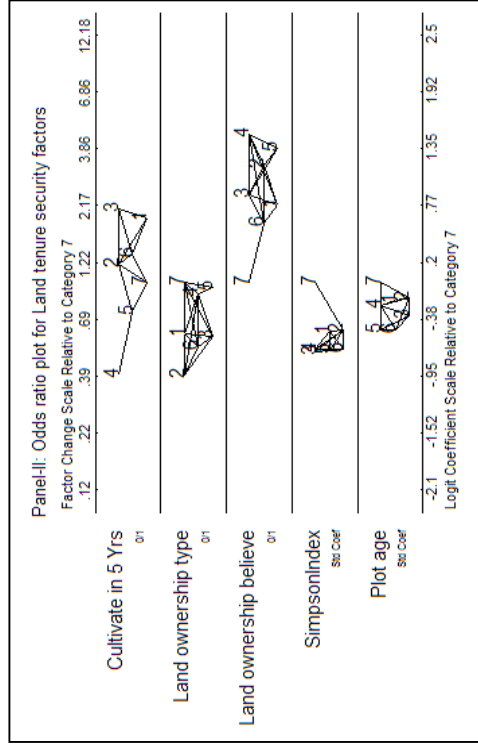
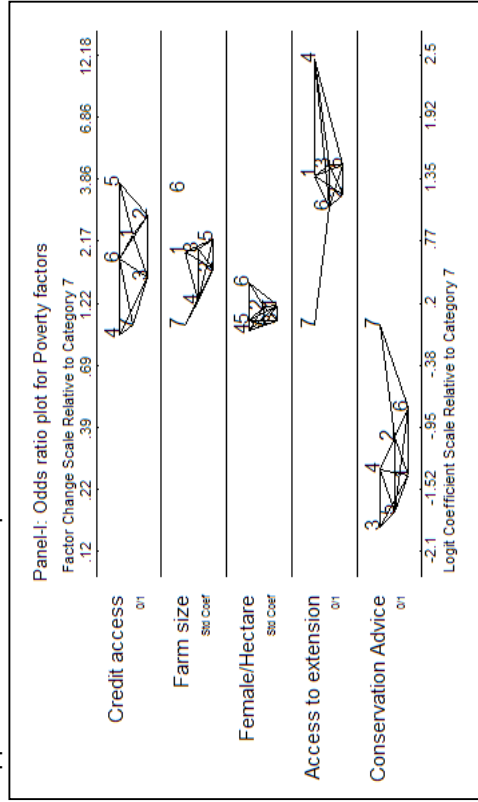
Appendix F: Discrete change plots*



* In figure 1, panel-A (also panel-B, C and D) depicts the changes in the probability along the horizontal axis, with the covariates listed on the vertical axis. The position of the numbers represents the magnitude of discrete change in the probability of an outcome for a given change in the covariate, all other variables held at their mean. Since the discrete changes of the continuous covariates are often too small to be informative, it would make more sense to look at the effects of a standard deviation change in the continuous independent variables. (Long and Freese, 2006).

Note: Preferredscw represents the dependent variable preferred land conservation investment, where 1=traditional rock terracing, 2=modern rock terracing, 3=traditional soil terracing, 4=modern soil terracing, 5=ditch digging, 6='kitir works', and 7='other' types' - including grass covers, contour farming, and forestation.

Appendix G: Odds ratio plots*



* 1=traditional rock terracing, 2=modern rock terracing, 3= traditional soil terracing, 4=modern soil terracing, 5=ditch digging, 6='kitir' works, and 7='other' types' – including grass covers, contour farming, and forestation.

Note: Panel I to Panel IV plot the coefficients relative to the base category outcome (i.e. 'other types'), which is located on the factor change scale (top) at 1. and the logit coefficient scale (bottom) at 0. The relative magnitude of the effects for each variable is shown by the distance between this comparison outcome [i.e. 7 ('other type')] and the respective outcome. If an outcome is to the right of another outcome, then increases in the covariate make the outcome to the right more likely. The connecting lines show whether or not the preference of one versus another type is differentiated by a particular independent variable.