
Supplementary information

A global analysis of the social and environmental outcomes of community forests

In the format provided by the
authors and unedited

Supplementary Information for

A global analysis of the social and environmental outcomes of community forests

Reem Hajjar, Johan A. Oldekop, Peter Cronkleton, Peter Newton, Aaron J.M. Russell, Wen Zhou

Corresponding author: Reem Hajjar

Email: reem.hajjar@oregonstate.edu

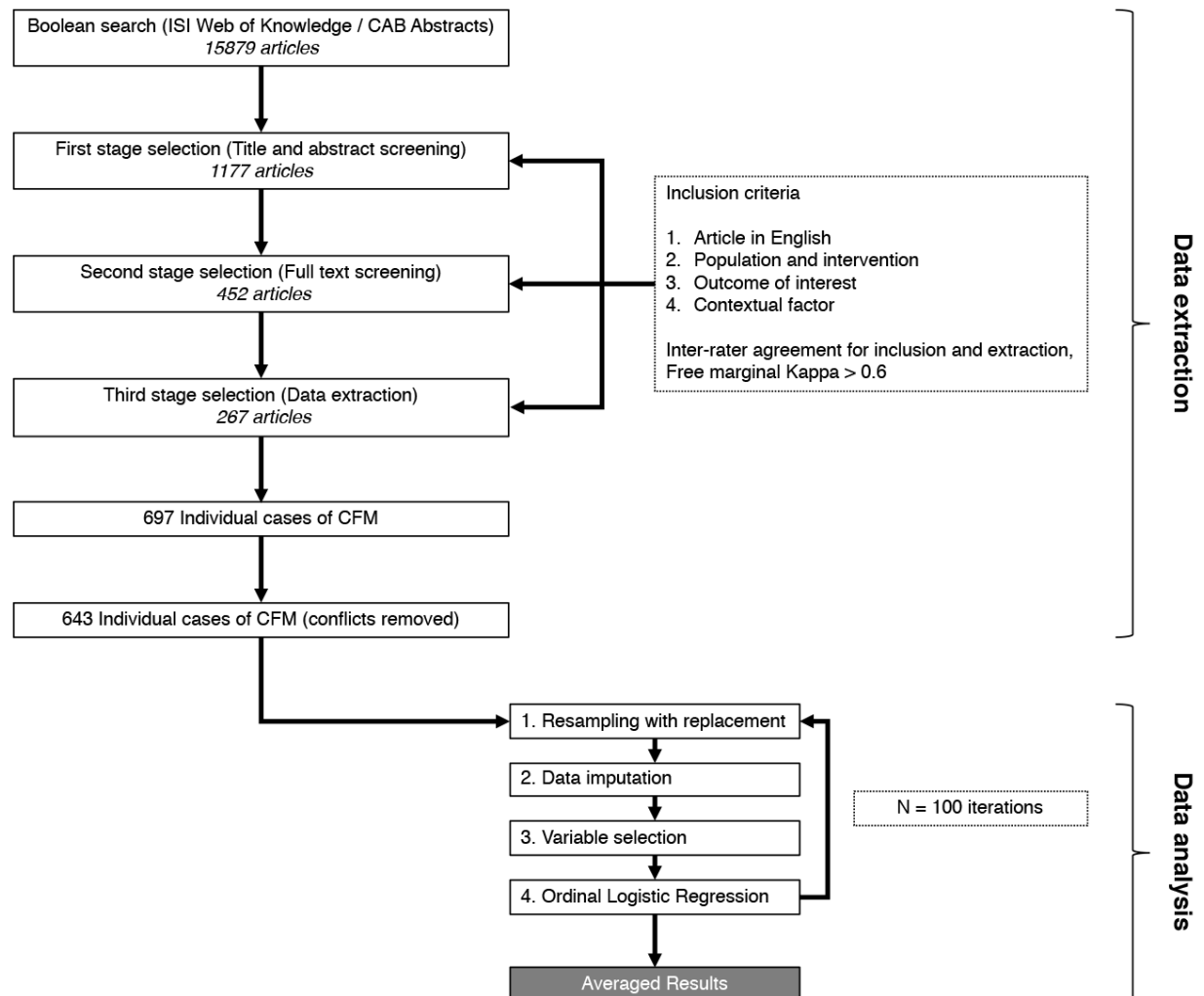
Corresponding author: Johan Oldekop

Email: johan.oldekop@manchester.ac.uk

This PDF file includes:

Supplementary Figures 1 to 9

Supplementary Tables 1 to 3

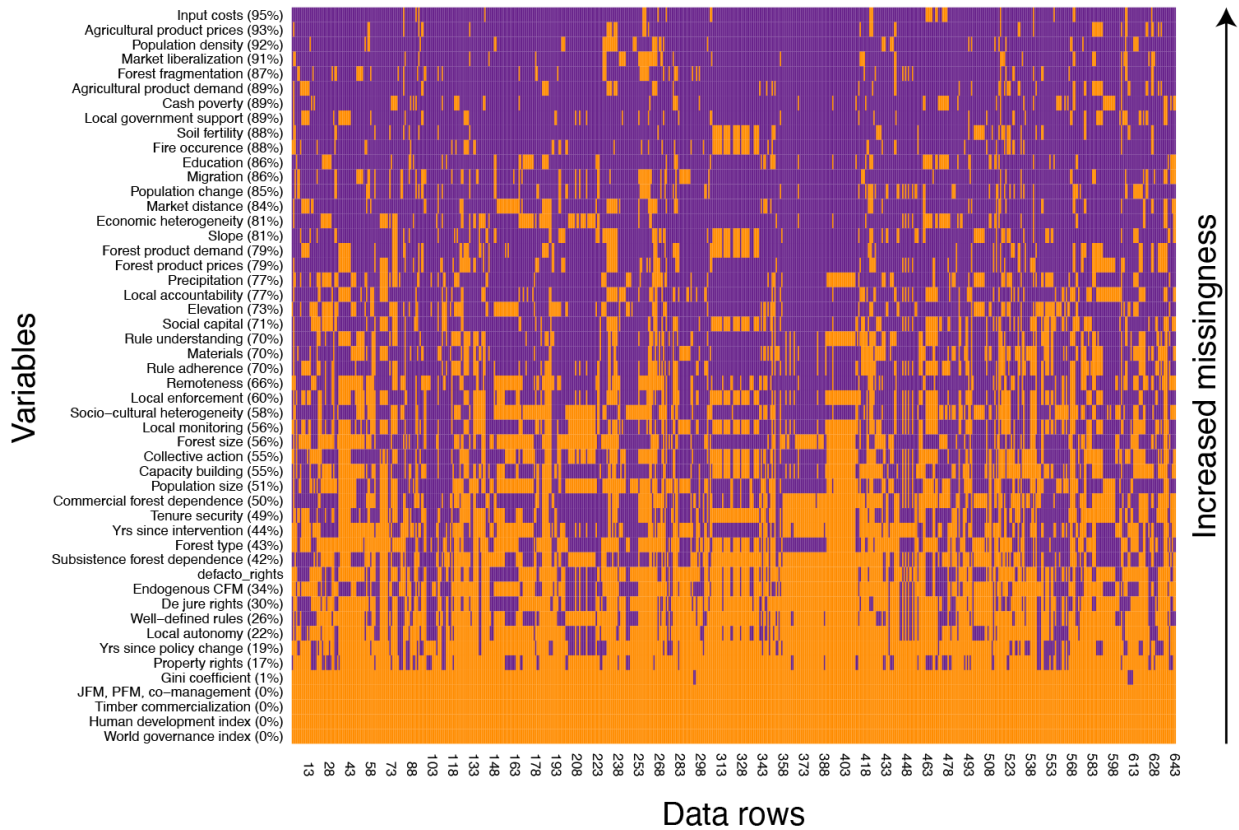


Supplementary Figure 1: Selection stages of the systematic review and analysis steps.

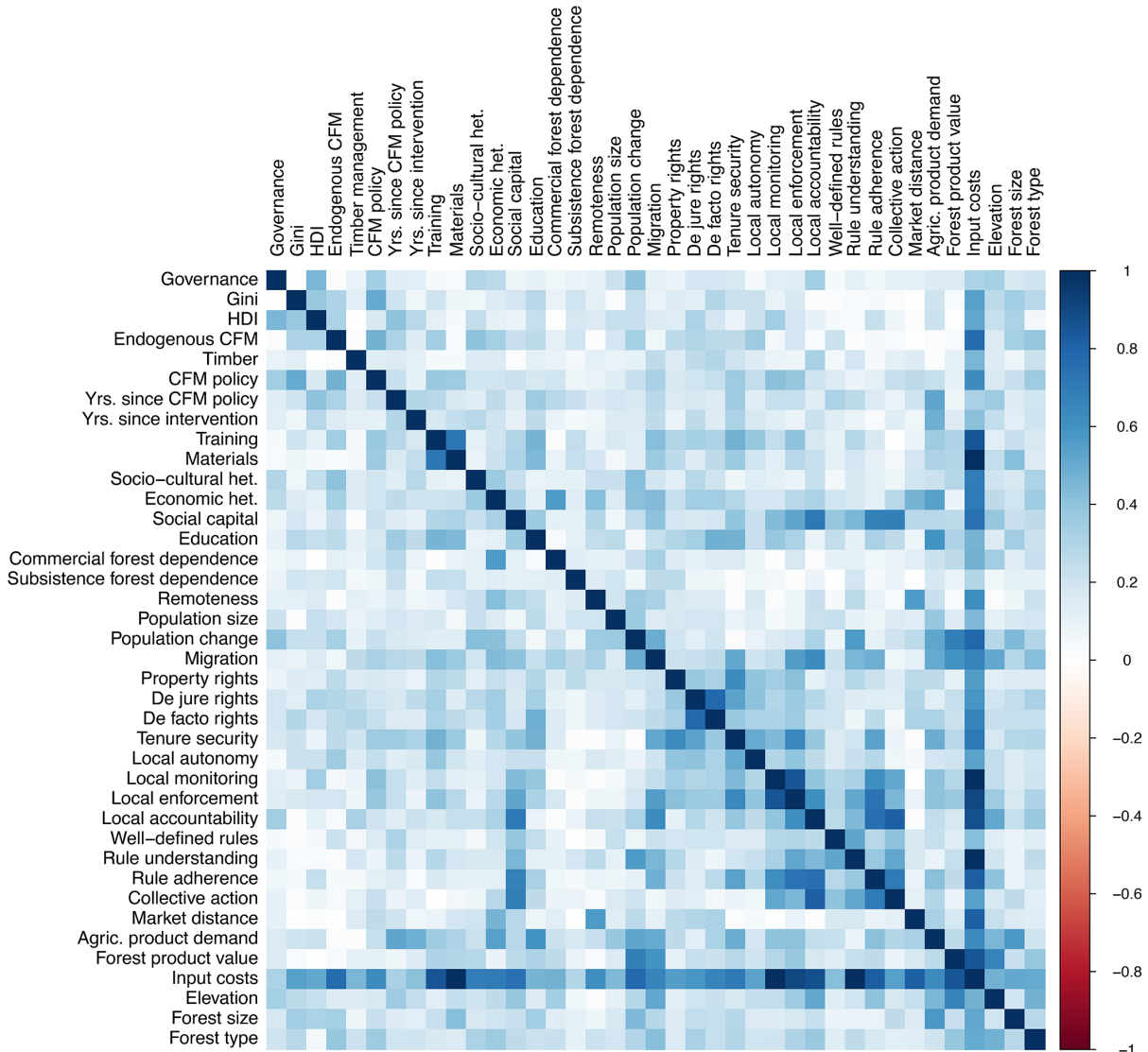
a	Dimension	Indicator	Exclusions
	Environment	Forest cover	n = 32
		Forest condition	
		Biodiversity	
	Income	Community income	n = 16
		Household income	
		Employment	
	Access rights	Commercial purposes	n = 6
		Subsistence purposes	

b	Joint outcomes	Triple outcomes
	Positive Positive	Positive Positive Positive
	>	>
	Positive No Change	Positive Positive No Change
	>	>
	No Change No Change	Positive No Change No Change
	>	>
	No Change No Change	No Change No Change No Change
	>	>
	Positive Negative	Positive Positive Negative
	>	>
	Positive Negative	Positive No Change Negative
	>	>
	Negative No Change	Positive Negative Negative
	>	>
	Negative No Change	Negative Negative No Change
	>	>
	Negative Negative	Negative Negative Negative

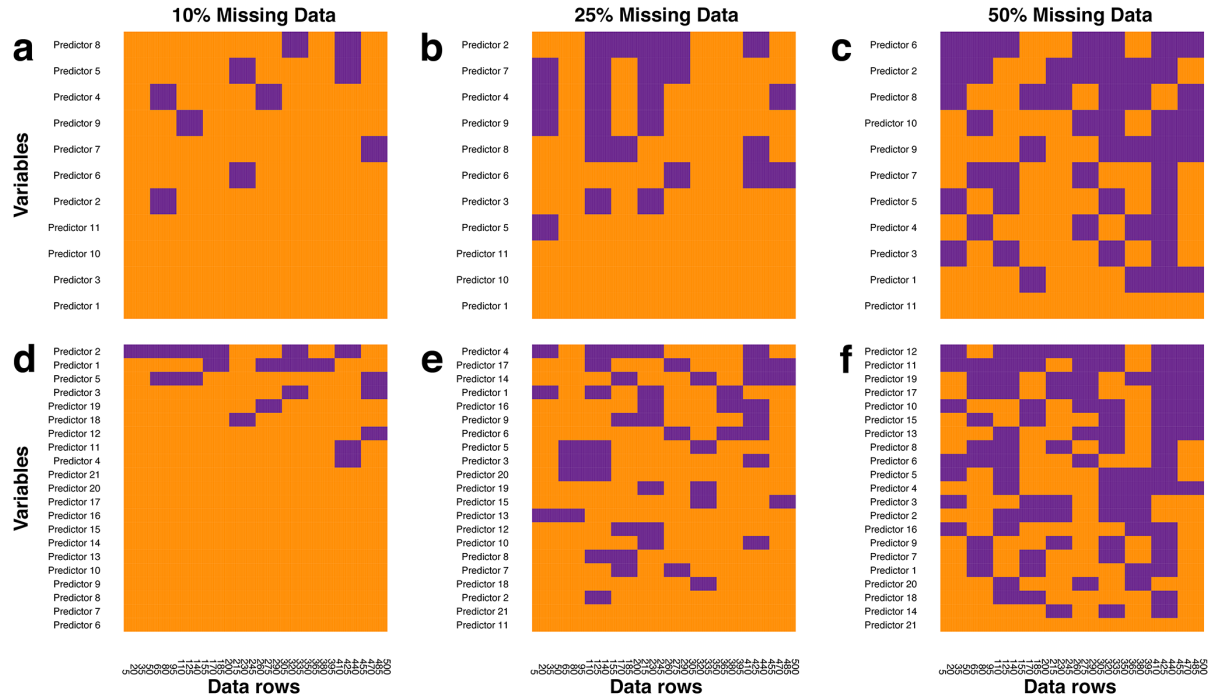
Supplementary Figure 2. Environmental and social indicators and dimensions of community forest management and the number of excluded data points due to conflicting outcomes (a). Conflicting cases were defined as those in which indicators within outcomes variables showed opposing trends (e.g., increases in forest condition and decreases in biodiversity). Ranked outcome variable levels (b). Levels in bold are outcome combinations included in our dataset.



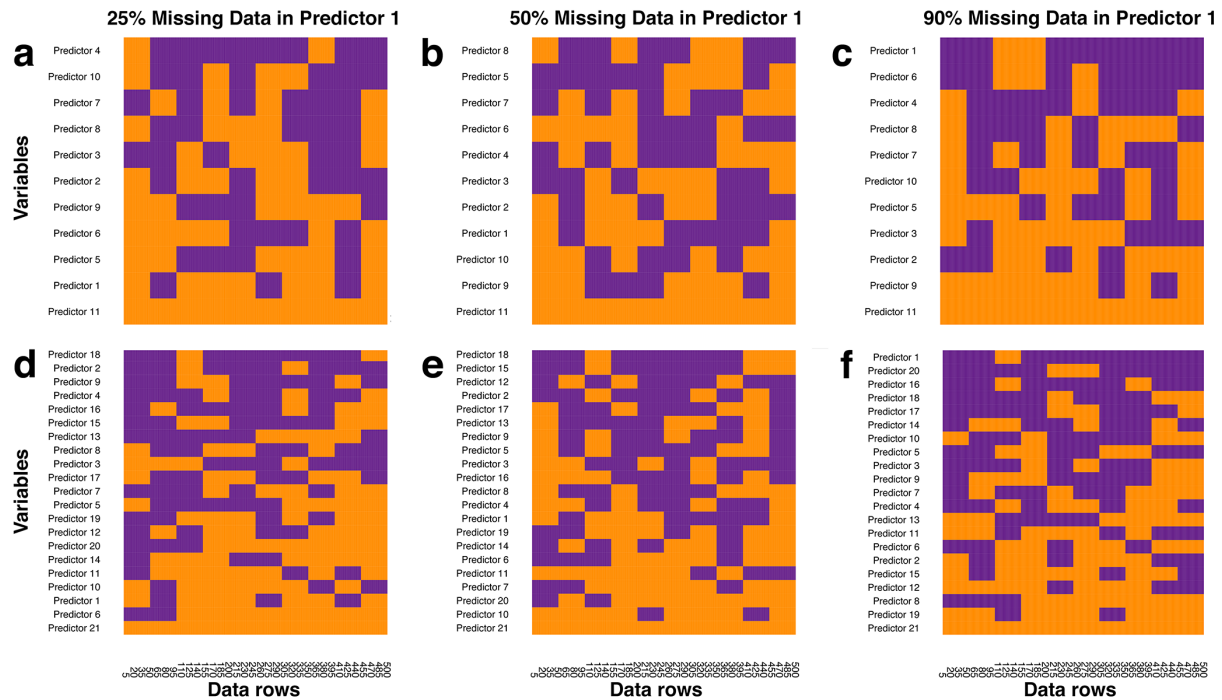
Supplementary Figure 3. Missing data map. The four datasets focusing on multiple outcomes used in our analysis range from 53% to 54% missingness, with great variation in the amount of missing data in different variables (purple = missing, orange = non-missing).



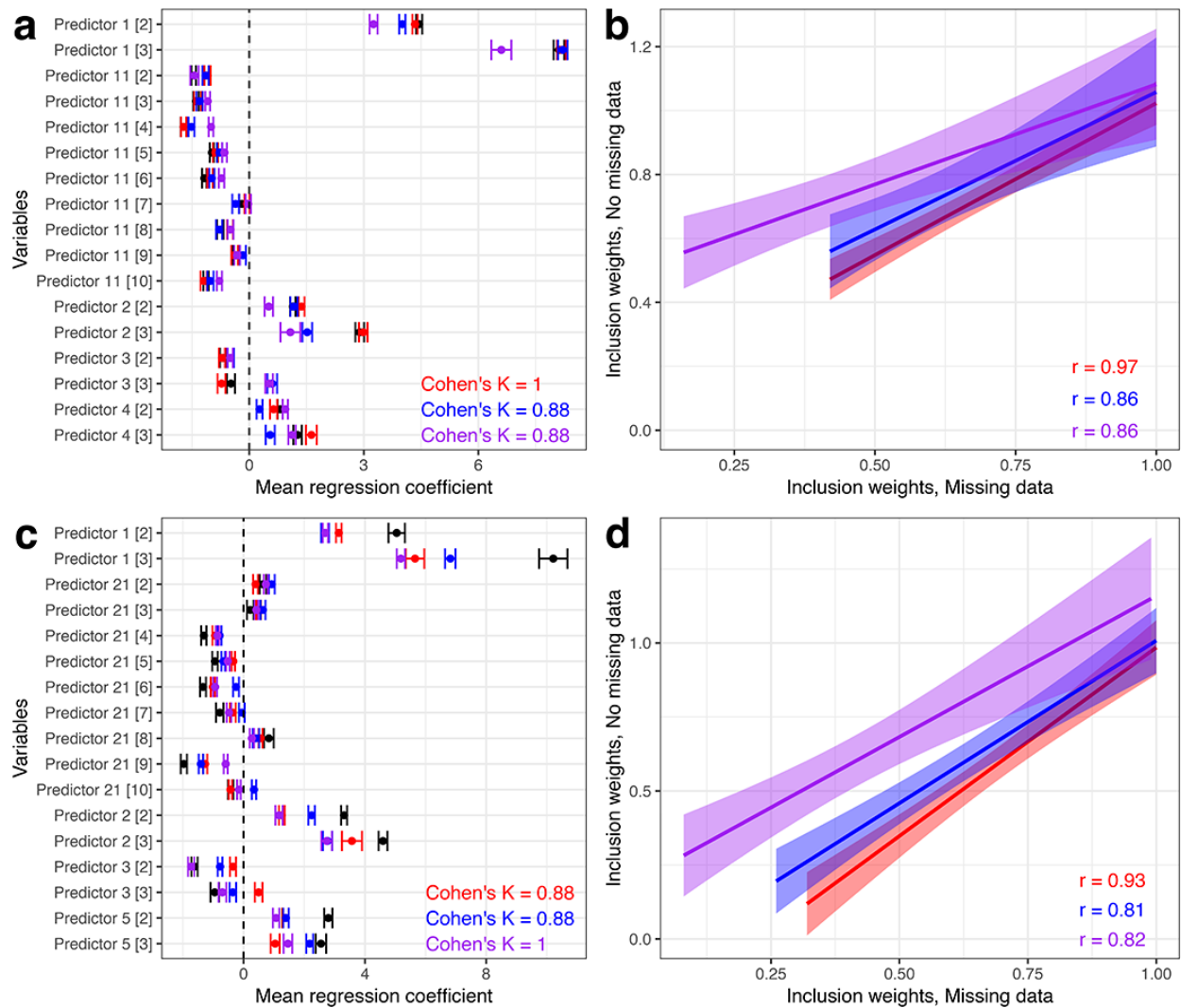
Supplementary Figure 4. Association matrix for predictor variables included in the principal analysis. Because predictor variables are both continuous and categorical, the matrix calculates association measures for three possible data combinations (13) (continuous - continuous: Pearson's correlation, with values between -1 to 1; continuous - categorical: R^2 values based on a linear regression, with values between 0 and 1; and categorical - categorical: Cramer's V with values between 0 and 1. It was not possible to compute associations for eleven variables (cash poverty, population density, weak state, market liberalization, forest product demand, agricultural product value, soil fertility, slope, precipitation, fire frequency, and forest fragmentation) because combinations between these and other categorical variables were based on less than two levels within categories.



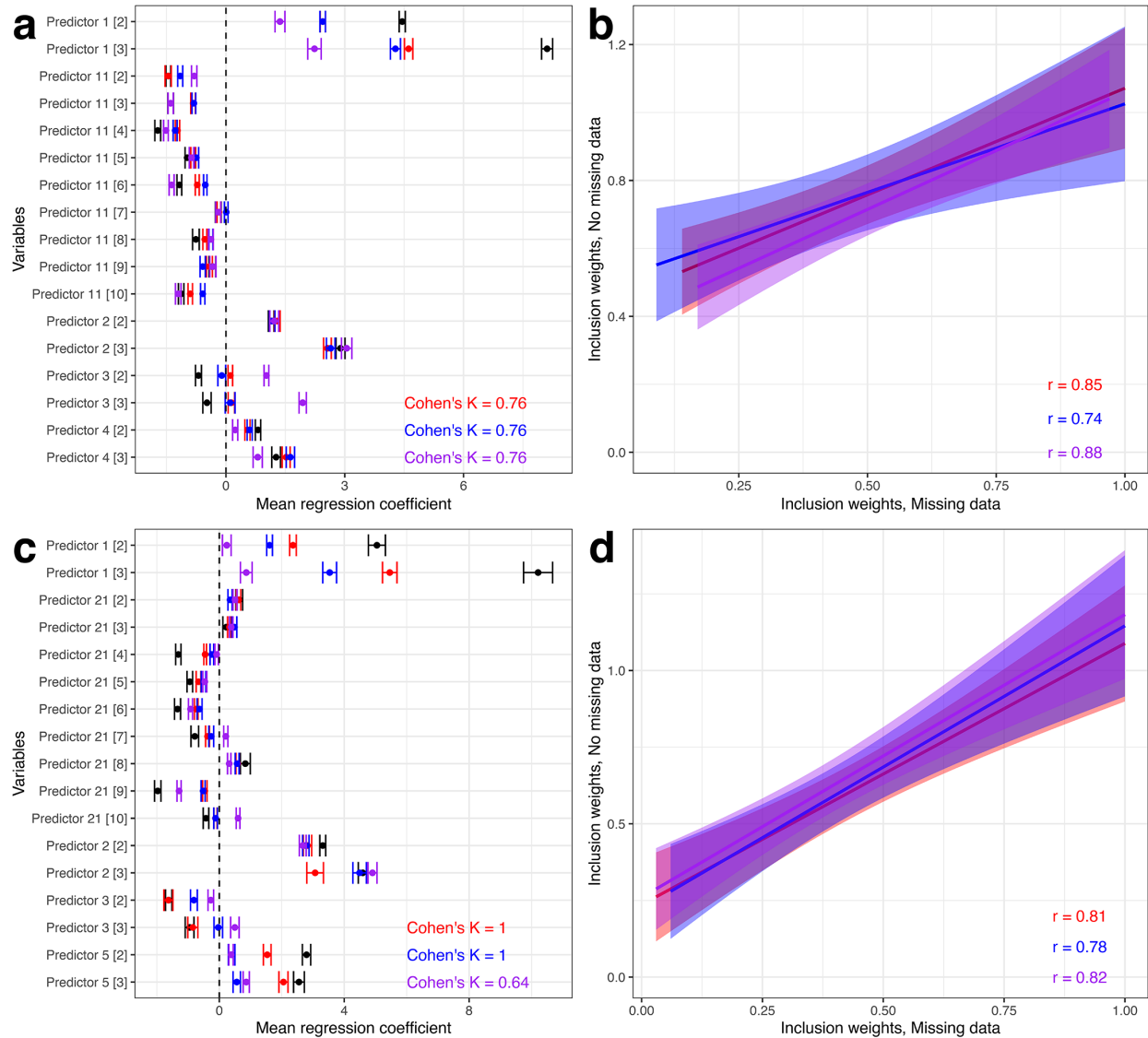
Supplementary Figure 5. Missing data map for simulated datasets with 11 (a-c) and 21 (d-f) predictor variables with 10%, 25% and 50% missing data (purple = missing, orange = non-missing).



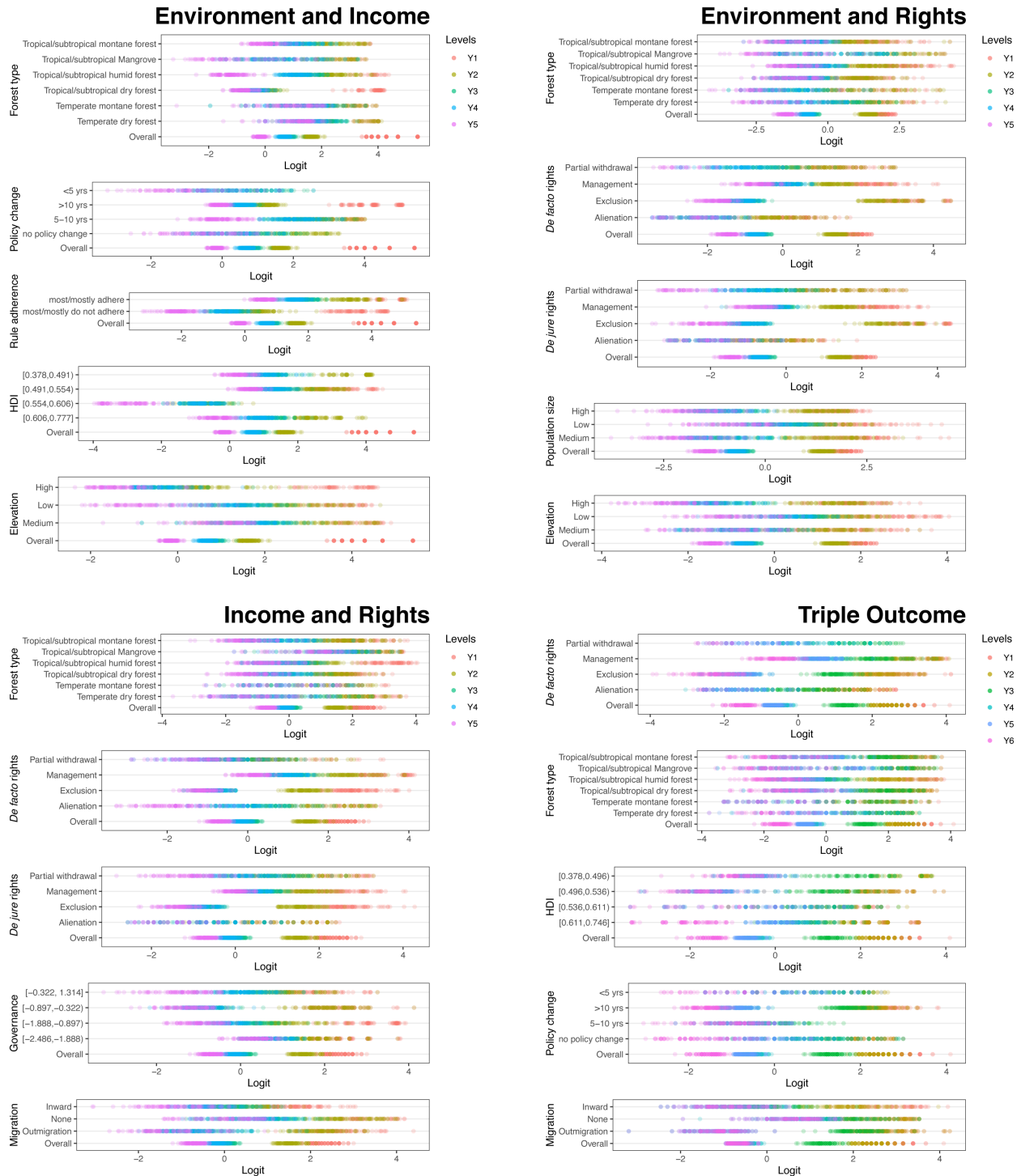
Supplementary Figure 6. Missing data map for simulated datasets with 11 (a-c) and 21 (d-f) predictor variables with 50% overall missingness, and 25%, 50% and 90% missingness in the predictor variable (Predictor 1) with largest statistical association with the outcome variable (purple = missing, orange = non-missing).



Supplementary Figure 7. Analysis results for simulated datasets with 11 (a-b) and 21 (c-d) predictor variables, demonstrating the mean regression coefficients for the five most frequently selected predictor variables in the run with no missing data (a, c), and correlation of inclusion weights (b, d) between datasets with no missing data, and datasets with various degrees of missingness (black = no missing data, red = 10% missingness, blue = 25% missingness, purple = 50% missingness).



Supplementary Figure 8. Analysis results for simulated datasets with 11 (a-b) and 21 (c-d) predictor variables, demonstrating the mean regression coefficients for the five most frequently selected variables in the run with no missing data (a, c), and correlation of inclusion weights (b, d) between datasets with no missing data, and datasets with 50% overall missingness and various degrees of missingness in the predictor variable (Predictor 1) with the strongest statistical relationship with the outcome variable (black = no missing data, red = 25% missingness in Predictor 1, blue = 50% missingness in Predictor 1, purple = 90% missingness in Predictor 1).



Supplementary Figure 9. Proportional odds comparisons among individual levels within the five most common selected predictor variables for each level, for the four outcome variables. Visual inspection of these suggest that while a small number of outcome variable levels overlap for individual variables, for the most part the levels in the outcome are stratified and display similar distances between levels within predictor variable levels. We interpret this to signify that the proportional odds assumption is largely met in our analysis.

Supplementary Table 1: List of contextual (predictor) variables, their definitions and levels.

Category	Variable	Description	Levels
User group	1. Socio-cultural heterogeneity	What is the socio-cultural heterogeneity of the community?	high mixed low
	2. Economic heterogeneity	What is the economic or wealth disparity of the community?	high mixed low
	3. Social capital	What is the level of social capital in the community?	high medium low
	4. Education	What is the level of education of the majority of the community?	< than 5 yrs > than 5 yrs
	5. Commercial forest dependence	What is the group's commercial forest dependence?	high low
	6. Subsistence forest dependence	What is the group's subsistence forest dependence?	high low
	7. Remoteness	How accessible is the community?	accessible inaccessible
	8. Cash poverty	How cash-poor is the majority of the community?	above below poverty line
	9. Population size	What is the community's population size	high medium low
	10. Population density	What is the community's population density?	high medium low
	11. Population change	How has the local population changed?	increase stable decrease
	12. Migration	What kind of migration has there been in the community?	inward none outward
Institutional / economic factors	13. World governance index*	Aggregate index of six governance dimensions	<i>Continuous variable</i>
	14. Human development index*	Composite index of income, education and health dimensions	<i>Continuous variable</i>
	15. Gini coefficient*	Measure of economic inequality at the national level	<i>Continuous variable</i>
	16. Local government support	Are higher levels of governance able to provide support to local communities (e.g., through enforcement of regulations)?	strong weak
	17. Property rights	What is type of formal property rights held by the community?	communally owned customary rights open access private state owned
	18. De jure rights	What is the bundle of de jure rights held by the community?	access withdrawal management exclusion alienation
	19. De facto rights	What is the bundle of de facto rights held by the community?	access withdrawal management exclusion alienation
	20. Tenure security	How secure are the tenure rights held by the community?	secure insecure
	21. Local autonomy	To what degree can communities make their own decisions about resource use?	mostly local formal mostly local informal mostly non-local
	22. Local monitoring	Does the community actively monitor its resources?	yes no
	23. Local enforcement	Does the community actively enforce transgressions or incursions?	yes no
	24. Local accountability	What is the level of accountability of local community leaders to the community?	high low
	25. Well-defined rules	How well defined are formal or informal local-rules on resource use?	defined undefined
	26. Rule understanding	Does the majority of the community understand (or is aware) of local rules?	most understand/are aware

			most do not understand/are not aware
	27. Rule adherence	Does the majority of the community generally adhere to local rules?	most adhere most do not adhere
	28. Collective action	What is the level of collective action at the local level?	high low
Market factors	29. Market liberalization	Does the author provide evidence that the country or region has undergone any liberalization policies?	present absent
	30. Market distance	How far away is the nearest admin/market centre using the community's main mean of transport?	equal less than a days travel more than a days travel
	31. Forest product demand	What is the level of market demand for the main forest product?	high low
	32. Agricultural product demand	What is the level of market demand for the main agricultural product?	high low
	33. Forest product prices	What is the commercial value of the principal forest product?	high low
	34. Agricultural product prices	What is the commercial value of the principal agricultural product?	high low
	35. Input costs	What is the level of input costs for the main forest or agricultural product?	high forest cost low forest cost high agricultural cost low agricultural cost high forest & high agricultural cost low forest & low agricultural cost high forest & low agricultural cost low forest & high agricultural cost
Biophysical factors	36. Soil fertility	What is the level of soil fertility in the community?	high low
	37. Slope	How steep is the area of the community?	steep not steep
	38. Elevation	What is the elevation of the community?	high medium low
	39. Precipitation	How much rainfall does the community experience?	high medium low
	40. Fire	What is the level of fire frequency in the community?	high low
	41. Forest fragmentation	What is the level of forest fragmentation in the community?	high low
	42. Forest size	What is the size of the forest?	large medium small
	43. Forest type	What is the local forest type?	temperate dry forest temperate humid forest temperate montane forest tropical/sub-tropical humid dry forest tropical/subtropical humid forest tropical/subtropical montane forest mangrove
Intervention factors	44. Endogenous CFM	Do the authors mention or provide evidence of community forestry existence prior to the intervention or policy change?	yes no
	45. JFM, PFM, co-management	Does the study specifically mention PFM, JFM, or co-management?	JFM PFM co-management other

46. Years since policy change	What is the time since the latest major policy change at the national or regional level?	no policy change > 10 years 5-10 years < 5 years
47. Years since intervention	What is the time since the latest localized intervention or localized implementation of policy?	no intervention > 10 years 5-10 years < 5 years
48. Timber commercialization	Was timber commercialization part of intervention?	yes no
49. Training	Did the community receive training as part of the intervention	yes no
50. Materials	Did the community receive any materials or technologies as part of the intervention?	yes no

*indicates country-level data obtained from the World Bank's Development indicators, recorded for the year the study indicated data collection occurred.

Supplementary Table 2: Regression results from the 11 predictor variable simulated dataset for the five most frequently selected predictor variables in runs with no missing data, including standard ordinal logistic regression results for no missing data, and bootstrapped results selected variables for no missing data, and 10%, 25% and 50% missing data.

Predictor Variable	OLR	Bootstrap						
	Overall Missingness				Missingness in Predictor 1			
	0%	0%	10%	25%	50%	25%	50%	90%
	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
Predictor 1 [2]	4.06 (0.53)***	4.45 (0.08)	4.34 (0.07)	4.01 (0.08)	3.26 (0.10)	2.45(0.07)	2.44(0.07)	1.36(0.13)
Predictor 1 [3]	7.44 (0.85)***	8.11 (0.14)	8.18 (0.12)	8.21 (0.12)	6.60 (0.26)	4.61(0.11)	4.28(0.13)	2.23(0.17)
Predictor 2 [2]	1.16 (0.61)	1.14 (0.07)	1.37 (0.08)	1.17 (0.09)	0.51 (0.11)	1.30(0.07)	1.17(0.07)	1.22(0.11)
Predictor 2 [3]	2.81 (0.90)**	2.89 (0.11)	2.99 (0.11)	1.52 (0.13)	1.08 (0.26)	2.56(0.10)	2.64(0.11)	3.05(0.13)
Predictor 3 [2]	-0.47 (0.68)	-0.69 (0.07)	-0.71 (0.08)	-0.49 (0.08)	-0.50 (0.08)	0.11(0.06)	-0.11(0.10)	1.16(0.06)
Predictor 3 [3]	-0.49 (0.95)	-0.48 (0.11)	-0.73 (0.10)	0.60 (0.13)	0.52 (0.10)	0.14(0.08)	0.10(0.12)	1.94(0.09)
Predictor 4 [2]	0.72 (0.64)	0.81 (0.07)	0.64 (0.09)	0.27 (0.08)	0.94 (0.07)	0.54(0.07)	0.60(0.06)	0.23(0.07)
Predictor 4 [3]	1.36 (0.96)	1.27 (0.11)	1.63 (0.14)	0.55 (0.12)	1.12 (0.10)	1.52(0.10)	1.63(0.11)	0.80(0.12)
Predictor 11 [2]	-1.46 (0.65)*	-1.46 (0.06)	-1.09 (0.08)	-1.14 (0.08)	-1.44 (0.11)	-1.46(0.08)	-0.59(0.05)	-0.80(0.07)
Predictor 11 [3]	-1.38 (0.68)*	-1.40 (0.07)	-1.36 (0.09)	-1.30 (0.08)	-1.09 (0.06)	-0.83(0.06)	-1.16(0.06)	-1.40(0.07)
Predictor 11 [4]	-1.75 (0.66)**	-1.72 (0.07)	-1.72 (0.07)	-1.52 (0.08)	-1.00 (0.06)	-1.22(0.05)	-0.81(0.05)	-1.52(0.06)
Predictor 11 [5]	-0.93 (0.67)	-0.98 (0.05)	-0.89 (0.07)	-0.78 (0.07)	-0.65 (0.06)	-0.83(0.06)	-1.28(0.05)	-0.87(0.06)
Predictor 11 [6]	-1.17 (0.64)	-1.18 (0.06)	-1.03 (0.07)	-0.98 (0.07)	-0.73 (0.07)	-0.73(0.05)	-0.75(0.06)	-1.37(0.06)
Predictor 11 [7]	-0.23 (0.62)	-0.20 (0.07)	-0.06 (0.06)	-0.36 (0.09)	-0.03 (0.07)	-0.18(0.05)	-0.52(0.04)	-0.19(0.07)
Predictor 11 [8]	-0.73 (0.67)	-0.76 (0.08)	-0.50 (0.08)	-0.79 (0.08)	-0.49 (0.08)	-0.53(0.05)	0.01(0.05)	-0.38(0.06)
Predictor 11 [9]	-0.33 (0.70)	-0.34 (0.08)	-0.39 (0.08)	-0.17 (0.08)	-0.32 (0.07)	-0.42(0.08)	-0.38(0.05)	-0.33(0.08)
Predictor 11 [10]	-1.13 (0.66)	-1.13 (0.07)	-1.19 (0.08)	-1.02 (0.08)	-0.78 (0.07)	-0.90(0.06)	-0.59(0.07)	-1.21(0.07)

Note: *** P < 0.001, ** P < 0.01, *P < 0.05. Standard errors for bootstrapped coefficients are based on the mean coefficient from N = 100 iterations.

Supplementary Table 3: Regression results from the 21 predictor variable simulated dataset for the five most frequently selected predictor variables in runs with no missing data, including standard ordinal logistic regression results for no missing data, and bootstrapped results selected variables for no missing data, and 10%, 25% and 50% missing data.

Predictor Variable	OLR		Bootstrap					
			Overall Missingness			Missingness in Predictor 1		
	0%	0%	10%	25%	50%	25%	50%	90%
	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)	Coef (SE)
Predictor 1 [2]	4.39 (0.89)***	5.05 (0.27)	3.14 (0.09)	2.69 (0.13)	2.70 (0.09)	2.36(0.11)	1.61(0.09)	0.24(0.14)
Predictor 1 [3]	8.52 (1.31)***	10.21 (0.47)	5.65 (0.30)	6.82 (0.17)	5.18 (0.14)	5.46(0.23)	3.53(0.22)	0.86(0.19)
Predictor 2 [2]	2.99 (0.63)***	3.31 (0.14)	1.26 (0.09)	2.24 (0.11)	1.17 (0.12)	2.82(0.13)	2.77(0.10)	2.67(0.11)
Predictor 2 [3]	4.34 (1.16)***	4.59 (0.14)	3.57 (0.33)	2.76 (0.15)	2.74 (0.17)	3.07(0.27)	4.49(0.22)	4.91(0.14)
Predictor 3 [2]	-1.75 (0.80)*	-1.62 (0.11)	-0.35 (0.10)	-0.77 (0.10)	-1.73 (0.10)	-1.63(0.14)	-0.81(0.11)	-0.27(0.09)
Predictor 3 [3]	-1.30 (1.11)	-0.95 (0.14)	0.50 (0.13)	-0.36 (0.11)	-0.70 (0.13)	-0.85(0.16)	-0.03(0.14)	0.50(0.14)
Predictor 5 [2]	3.39 (0.90)***	2.79 (0.13)	1.38 (0.11)	1.40 (0.09)	1.07 (0.11)	1.53(0.12)	0.40(0.10)	0.38(0.07)
Predictor 5 [3]	2.89 (1.18)*	2.55 (0.17)	1.04 (0.15)	2.18 (0.11)	1.46 (0.15)	2.05(0.15)	0.56(0.12)	0.86(0.10)
Predictor 21 [2]	0.75 (0.87)	0.64 (0.11)	0.39 (0.08)	0.93 (0.10)	0.74 (0.07)	-0.12(0.05)	0.34(0.07)	0.50(0.06)
Predictor 21 [3]	0.50 (0.88)	0.22 (0.11)	0.5 (0.08)	0.64 (0.08)	0.42 (0.06)	0.62(0.07)	0.49(0.08)	0.38(0.06)
Predictor 21 [4]	-0.77 (0.81)	-1.31 (0.09)	-0.94 (0.09)	-0.79 (0.06)	-0.86 (0.06)	0.32(0.06)	-0.24(0.06)	-0.08(0.04)
Predictor 21 [5]	-0.63 (0.84)	-0.94 (0.09)	-0.34 (0.06)	-0.67 (0.06)	-0.52 (0.05)	-0.45(0.04)	-0.50(0.07)	-0.46(0.06)
Predictor 21 [6]	-0.56 (0.81)	-1.34 (0.10)	-1.02 (0.07)	-0.25 (0.09)	-0.94 (0.06)	-0.67(0.08)	-0.63(0.08)	-0.92(0.07)
Predictor 21 [7]	-0.46 (0.84)	-0.78 (0.12)	-0.35 (0.09)	-0.06 (0.09)	-0.48 (0.08)	-0.74(0.06)	-0.26(0.08)	0.21(0.07)
Predictor 21 [8]	0.80 (0.85)	0.83 (0.16)	0.56 (0.06)	0.41 (0.10)	0.27 (0.07)	-0.38(0.06)	0.57(0.06)	0.32(0.05)
Predictor 21 [9]	-1.52 (0.80)	-1.97 (0.10)	-1.27 (0.07)	-1.41 (0.10)	-0.59 (0.06)	0.58(0.05)	-0.52(0.06)	-1.29(0.07)
Predictor 21 [10]	-0.04 (0.86)	-0.43 (0.09)	-0.43 (0.06)	0.34 (0.07)	-0.15 (0.06)	-0.46(0.07)	-0.12(0.06)	0.60(0.06)

Note: *** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$. Standard errors for bootstrapped coefficients are based on the mean coefficient from $N = 100$ iterations.