

Appendix

A1. Examining the Representativeness of the NLSS Sample for Deforestation

This section compares the summary statistics and empirical distribution of deforestation between the NLSS sample and the statistical population of all wards in the country (hereafter *population*). There are six strata in NLSS, including Mountains (34 PSUs), Kathmandu valley urban area (34 PSUs), other urban areas in the Hills (28 PSUs), rural Hills (102 PSUs), urban Terai (34 PSUs), and rural Terai (102 PSUs). Ideally, the comparison would be conducted by stratum which is defined based on ecological zones and rural/urban classification. In the absence of data used for the identification of rural/urban areas in the entire country, we combined the urban and rural strata and focused on the comparison among ecological zones. This yields three subsamples: Hill, Terai, and Mountain as shown in Table A2. Column 1 of Table A2 presents descriptive statistics of deforestation calculated from the *population*. Columns 2 and 3 report summary statistics from the NLSS sample with and without stratum weights, respectively. Columns 4 and 5 report stratum-weighted and unweighted summary statistics from the sample from which missing observations of explanatory variables were excluded (hereafter study sample).

The comparison reaches several findings. First, after considering stratum weights, the mean and the standard deviation of deforestation calculated from the NLSS sample are nearly identical to the corresponding statistics calculated from the *population* in the ecological zones of Hill and Terai, which together constitute 88% of the NLSS sample. Second, in the Mountain area, the mean and standard deviation calculated from the NLSS sample with stratum weights are slightly larger than the corresponding *population* statistics. This deviation, however, does not affect the representativeness of the NLSS sample for the *population* on a national scale because the Mountain area only accounts for a small proportion of the total sample. Kolmogorov-Smirnov test fails to reject the null hypothesis that the *population* and the NLSS sample are drawn from the same distribution (p -value = 0.64). Consequently, on a national scale, the statistics derived from the NLSS sample are almost identical to those derived from the *population*. Third, removing ten missing observations from the NLSS sample does not change the probability density distribution of deforestation in each ecological zone and in the entire country. This consistency is also evidenced by the empirical distributions depicted in Figure A2 in this document. Fourth, the sample statistics with stratum weights deviate less from the corresponding *population* statistics than the statistics without stratum weights.

Therefore, we conclude that the stratified NLSS 2003–2004 sample is representative for the rate of deforestation at the ward level. The normalized stratum weights will be used in the empirical analysis.

A2. Additional Figures

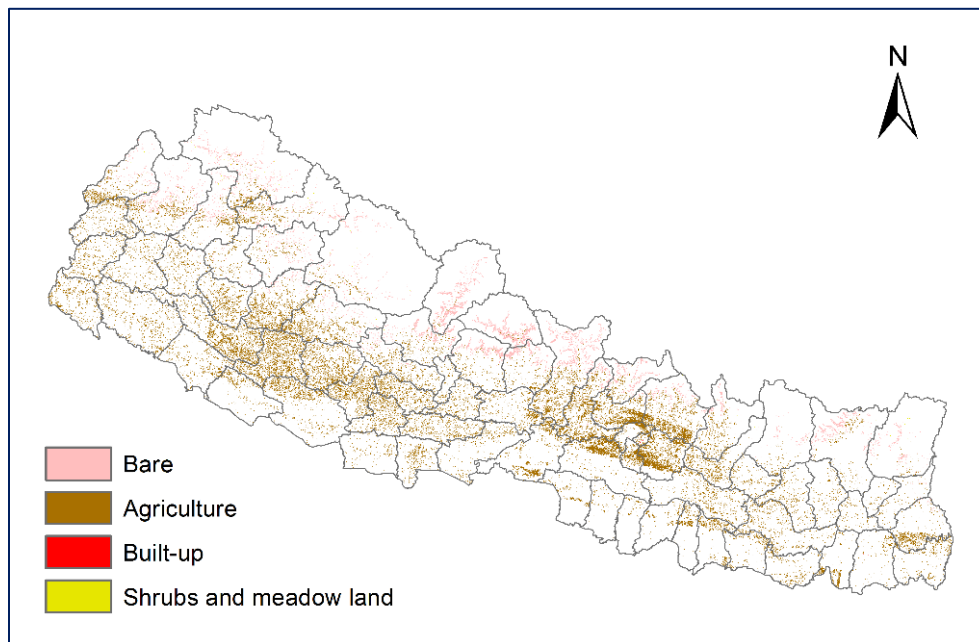


Figure A1. Land-use conversion from forests to other uses in Nepal, 2001–2010

Source: Guo et al. (2015)

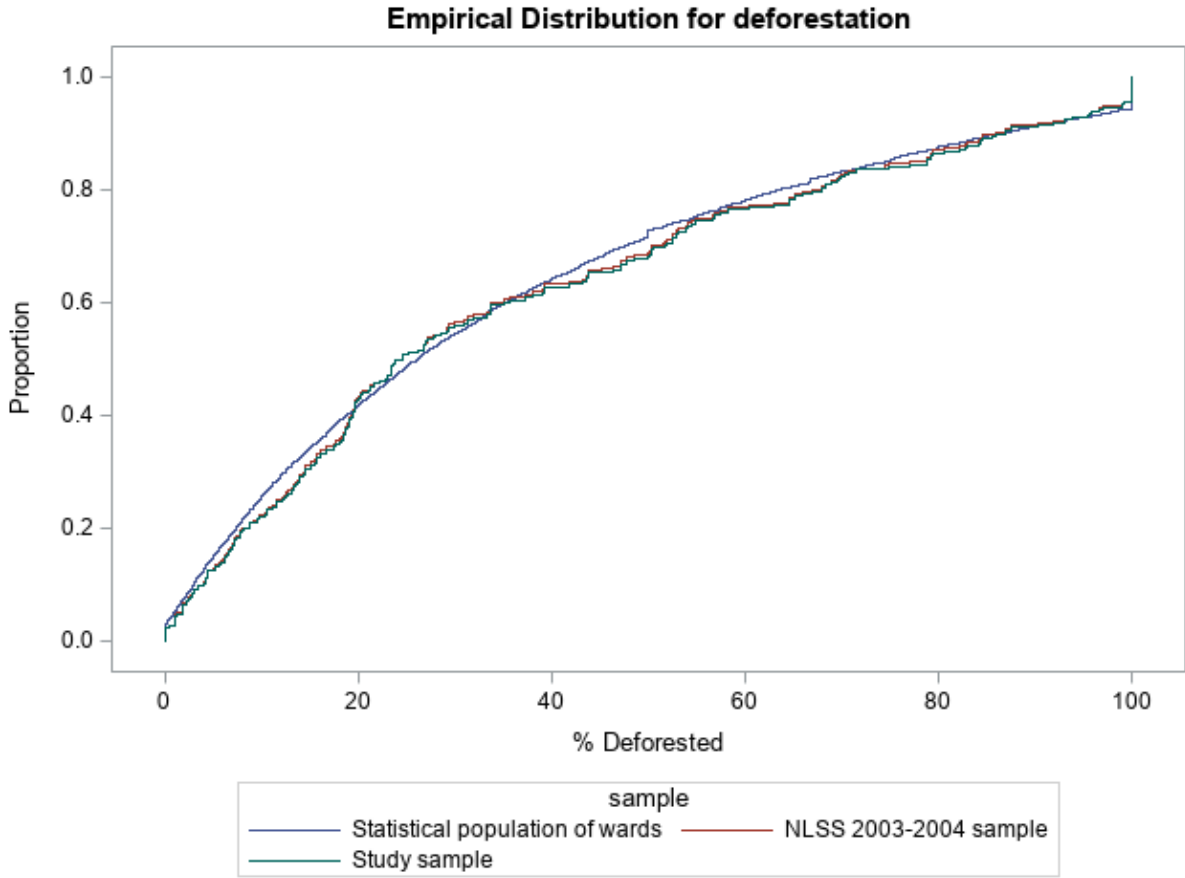


Figure A2. Empirical distribution of deforestation rate

Source: Authors' calculations using data from Guo et al. (2015) and the Nepal Living Standards Survey 2003–2004.

A3. Additional Tables

Table A1. Variable Definition

Variable	Description	Source
% deforestation	Area deforested during 2001–2010 divided by area in forests in 2001	Land use data (Guo et al. 2015)
Remittances	The amount of remittances received by all members in a household during the last 12 months prior to the survey interview	NLSS 2003–2004
Migration	The number of remittance senders during the last 12 months prior to the survey interview	NLSS 2003–2004
Absentees	The number of adults who spent at least one month away from home in a household during the last 12 months prior to the survey interview	NLSS 2003–2004
Median annual precipitation	Median of annual precipitation observed from the closest weather station over the period of 1990–2010	Department of Hydrology and Meteorology, Government of Nepal
Interquartile range of annual precipitation	Interquartile range of annual precipitation observed from the closest weather station over the period of 1990–2010	Department of Hydrology and Meteorology, Government of Nepal
Conflict-related death toll	The total number of people killed in a district over the period 2002–2004	
Community forestry program (CFP)	Dummy variable indicating whether there are community forestry user groups in a ward	Community Forestry Division, Department of Forest, Nepal (2014)
Exchange rate shocks	Changes in real exchange rate of combined foreign currencies against Nepalese rupees over the period of 2000–2003	IMF rates database
Travel time to cities	Minutes used to travel from each location to cities of 10,000 or more people	Guo and Cindy (2014) http://dx.doi.org/10.2499/9780896298460_28

Table A2. Summary Statistics of the Rate of Deforestation by Ecological Zone

	NLSS 2003–2004 sample			Study sample	
	Statistical population of wards (1)	Normalized stratum weights (2)	Unweighted (3)	Normalized stratum weights (4)	Unweighted (5)
Hill					
Mean	27.0	27.5	32.4	27.8	31.8
Standard deviation	23.5	23.4	29.1	23.2	28.2
Observations	18,460	138	138	130	130
Terai					
Mean	52.8	51.2	48.5	51.2	48.5
Standard deviation	34.3	35.3	36.4	35.3	36.4
Observations	10,633	119	119	119	119
Mountain					
Mean	27.2	33.2	33.2	33.0	33.0
Standard deviation	27.3	28.9	28.9	29.7	29.7
Observations	4,921	34	34	32	32
Total					
Mean	35.1	36.0	39.1	36.4	39.0
Standard deviation	30.3	30.4	33.1	30.5	33.0
Observations	34,014	291	291	281	281

Note: Data are from Guo *et al.* (2015). Wards not covered by forests in 2001 are excluded. The minimum is zero for all data groups and the maximum is 100 except for the two samples in the mountain area, where the maximum equals 99.0.

Table A3. Pearson Correlation Coefficients between Exchange Rate Shocks and Migration (Change)

	Number of migrants	Migration ratio in a household
	A. Level (ward), 2003	
Exchange rate shocks, 2000–2003	0.076 (0.22)	0.022 (0.72)
	B. Change (household), 2003–2010	
Exchange rate shocks, 2003–2010	0.044 (0.28)	0.025 (0.54)

Note: *P*-value is in parentheses.

Table A4. Pearson Correlation Coefficients between Migration Destination and Deforestation

Location	Area in forest	Area deforested	Rate of deforestation	Number of total migrants
A. Share of migrants to each country				
Nepal	-0.009	-0.007	-0.013	-0.118 *
India	0.048	0.056	0.094	0.065
Saudi Arabia	-0.046	-0.054	-0.075	0.078
Malaysia	-0.045	-0.089	-0.143 **	0.017
Qatar	-0.014	0.035	0.044	0.073
United Arab Emirates	0.012	0.069	-0.054	0.073
United States	-0.017	-0.019	-0.037	0.082
United Kingdom	-0.026	-0.059	-0.092	0.063
Hong Kong, China	-0.010	-0.042	-0.063	0.018
Japan	-0.004	-0.009	-0.056	0.037
Other countries	-0.029	-0.053	-0.020	-0.068
B. Number of migrants to each country				
Nepal	-0.039	-0.027	0.040	0.590 ***
India	0.060	0.014	-0.009	0.530 ***
Saudi Arabia	-0.043	-0.030	-0.050	0.276 ***
Malaysia	-0.043	-0.069	-0.094	0.173 ***
Qatar	-0.003	0.050	-0.005	0.194 ***
United Arab Emirates	0.013	0.095	-0.039	0.096
United States	-0.021	-0.032	-0.054	0.116 *
United Kingdom	-0.029	-0.060	-0.099	0.137 **
Hong Kong, China	-0.010	-0.044	-0.078	0.037
Japan	-0.004	-0.007	-0.050	0.040
Other countries	-0.040	-0.074	-0.008	0.074

Note: The sample includes 266 wards. Normalized stratum weights are applied to the calculation.

*, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

Table A5. Examining the Stable Unit Treatment Value Assumption with respect to Domestic Migrants

	Fractional logit		Two-stage fractional logit		
	Deforestation (1)	Linear (2)	Remittances (3a)	Migration (3b)	Deforestation (3c)
<i>Panel A. Parameter estimates</i>					
Remittances	-2.074*** (0.675)	-0.421* (0.229)			-2.102** (0.818)
Migration	0.441 (0.315)	0.088 (0.100)			0.561 (0.789)
Exchange rate shocks (ward level)			0.012*** (0.003)	-0.001 (0.008)	
Developed countries			0.171*** (0.047)	0.203* (0.123)	
Share of migrants to rural areas while working in agricultural sectors	-0.725*** (0.195)	-0.139 (0.095)	0.003 (0.026)	0.127* (0.067)	-0.702*** (0.252)
Control variables W and X	Yes	Yes	Yes	Yes	Yes
<i>Panel B. Test and fit statistics</i>					
Instrument <i>F</i> -test (<i>p</i> -value)			55.4*** (<.0001)	2.700* (0.069)	
Wu-Hausman test (<i>p</i> -value)					0.335 (0.940)
R^2		0.279	0.510	0.378	

Note: The sample includes 281 wards. Normalized stratum weights are applied to the estimation of all the models. Standard errors are in parentheses except the two test statistics reported in Panel B where the associated *p*-value is in parentheses.

*, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

Table A6. Estimated Remittances Effect on Deforestation Using Alternative Measure of Migration (Including Household Absentees)

	Fractional logit	Two-stage fractional logit					
	Deforestation (1)	Remittances (2a)	Migration (2b)	Deforestation (2c)	Remittances (3a)	Migration (3b)	Deforestation (3c)
<i>Panel A. Parameter estimates</i>							
Remittances	-2.041*** (0.687)			-1.911** (0.746)			-1.936*** (0.730)
Migration	0.393 (0.342)			0.126 (0.501)			0.127 (0.501)
Exchange rate shocks (ward level)		0.012*** (0.003)	-0.006*** (0.010)		0.011*** (0.003)	-0.007 (0.010)	
Developed countries		0.171*** (0.047)	0.244 (0.138)		0.193*** (0.048)	0.250* (0.141)	
Exchange rate shocks (district level)					0.017** (0.008)	0.005 (0.023)	
Control variables W and X	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Panel B. Test and fit statistics</i>							
Instrument <i>F</i> -test (<i>p</i> -value)		55.6*** (<.0001)	2.050 (0.131)		39.3*** (<.0001)	1.380 (0.251)	
Wu-Hausman test (<i>p</i> -value)				0.396 (0.918)			0.323 (0.953)
Overidentification test (<i>p</i> -value)							1.568 (0.211)
R^2		0.510	0.401		0.519	0.401	

Note: The sample includes 281 wards. Normalized stratum weights are applied to the estimation of all the models. Standard errors are in parentheses except the three test statistics reported in Panel B where associated *p*-value is in parentheses.

*, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

Table A7. Estimated Remittances Effect on Deforestation in Wards with Migrants

	Fractional logit	Two-stage fractional logit		
	Deforestation (1)	Remittances (2a)	Migration (2b)	Deforestation (2c)
<i>Panel A. Parameter estimates</i>				
Remittances	-1.906*** (0.603)			-1.611** (0.792)
Migration	0.401** (0.185)			-0.363 (0.681)
Exchange rate shocks (ward level)		0.012*** (0.003)	-0.009 (0.008)	
Developed countries		0.174*** (0.048)	0.265** (0.122)	
Control variables W and X	Yes	Yes	Yes	Yes
<i>Panel B. Test and fit statistics</i>				
Instrument <i>F</i> -test (<i>p</i> -value)		50.6*** (<.0001)	2.77* (0.064)	
Wu-Hausman test (<i>p</i> -value)				0.559 (0.830)
R^2		0.499	0.395	

Note: The sample includes 266 wards. Normalized stratum weights are applied to the estimation of all the models. Standard errors are in parentheses except the two test statistics reported in Panel B where associated *p*-value is in parentheses.

*, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

Table A8. Summary Statistics of Household Characteristics

	Observations	Mean	Standard deviation
Ln(agricultural yields in metric tons per ha.)	2,810	0.88	0.93
Ln(agricultural outputs in metric tons)	2,810	0.26	1.23
Expenditure on fertilizer & pesticides (1,000 NPR)	2,810	1.39	2.80
Irrigation/watercourse maintenance (1,000 NPR)	2,810	0.13	0.53
Expenditure on hired labor (1,000 NPR)	2,810	1.73	7.30
Number of crop varieties that adopted improved seeds	2,810	0.32	0.86
Household size	2,810	5.87	2.75
Average size of plots (ha)	2,810	0.30	0.37
Number of new rooms made of wood materials	3,721	0.29	1.08
Number of new rooms made of non-wood materials	3,721	0.93	1.95
Cooking materials (1 if wood/firewood)	3,721	0.71	0.45
Cooking materials (1 if cylinder gas/kerosene/biogas)	3,721	0.12	0.33
Average remittances received by household (100,000 NPR)	3,721	0.11	0.37
Number of migrants	3,721	0.40	0.67
Share of high-caste members (including Newar)	3,721	0.38	0.48
Share of Dalits and low-caste members	3,721	0.13	0.34
Share of Janajati members	3,721	0.33	0.47
Age of head (years)	3,721	45.71	14.19
Head is male (1 if yes)	3,721	0.80	0.40
Years of formal education of head	3,721	2.94	4.35
Per capita land endowment (ha)	3,721	0.19	0.27

Note: Data are from NLSS 2003–2004. Household weights are applied to the calculation.

Table A9. Estimated Remittances Effects on Farming Activities and Household Consumption without Instrumental Variables

	Household farming activities					Household consumption				
	Linear		Tobit			Poisson	Tobit		Probit	
	Ln(Yield)	Ln(Total Outputs)	Fertilizer and Pesticides	Irrigation /Water Course Maintenance	Expenditure on Labor Hiring	Adoption of Improved Seeds	Rooms Made of Wood Materials	Rooms Made of Nonwood Materials	Firewood for Cooking	Fossil Fuels for Cooking
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	
Remittances	0.016 (0.053)	0.076 (0.081)	0.182 (0.205)	0.031 (0.152)	1.836** (0.731)	0.012 (0.139)	-1.650** (0.802)	0.873*** (0.311)	-0.172** (0.076)	0.405*** (0.094)
Migration	-0.073*** (0.027)	-0.052 (0.038)	-0.105 (0.111)	-0.072 (0.086)	0.195 (0.422)	-0.325*** (0.108)	0.203 (0.293)	0.259 (0.197)	0.040 (0.044)	-0.167*** (0.065)
Travel time to cities	0.113 (0.191)	0.418** (0.185)	-2.981*** (0.394)	0.329 (0.363)	-7.027*** (1.542)	0.354 (0.523)	0.672 (1.112)	1.111 (0.763)	1.799*** (0.208)	-2.192*** (0.279)
Observations	2,810	2,810	2,810	2,810	2,810	2,810	3,721	3,721	3,721	3,721
Control variables W and X	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes

Note: Normalized household weights are applied to the estimation of all the models. Standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.