

APPENDIX B

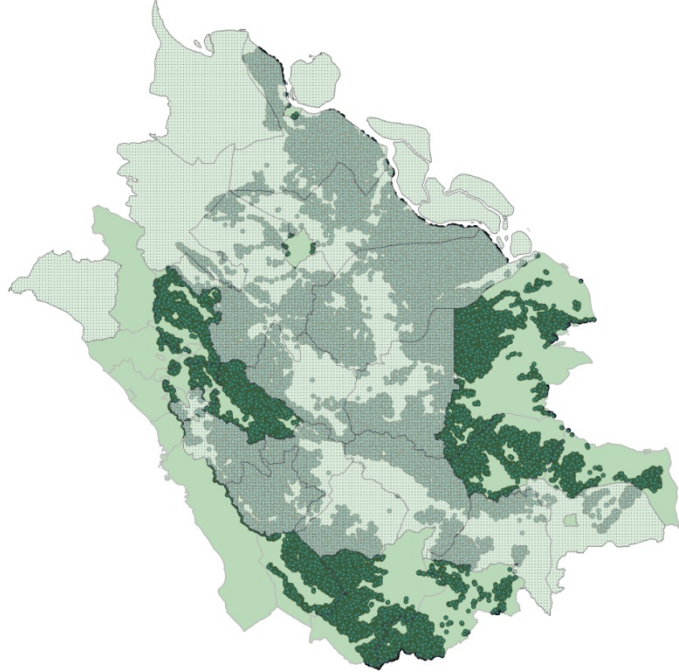


Figure 1: This figure illustrates the location of the 13,025 pixels located in the Sumatran Provinces of Jambi, Riau, and West Sumatra that were utilized in this analysis. The districts with the stippling were subdivided following the end of Suharto’s reign and prior to the year 2000. The non-stippled districts maintained their boundaries following the end of Suharto’s reign.

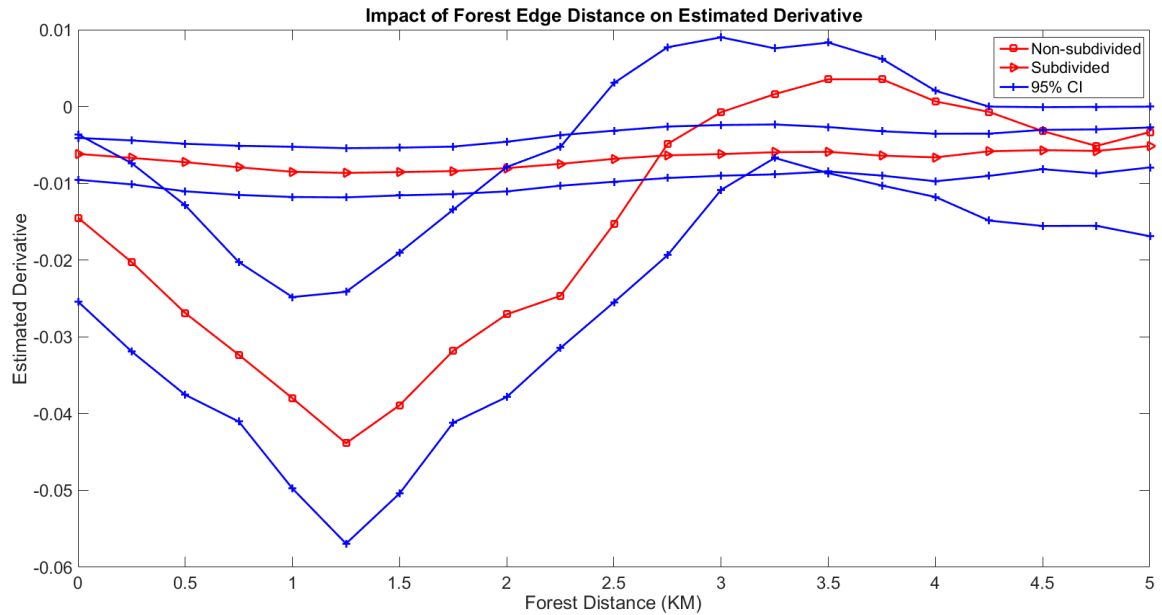


Figure 2: Impact of forest edge distance on estimated marginal effect

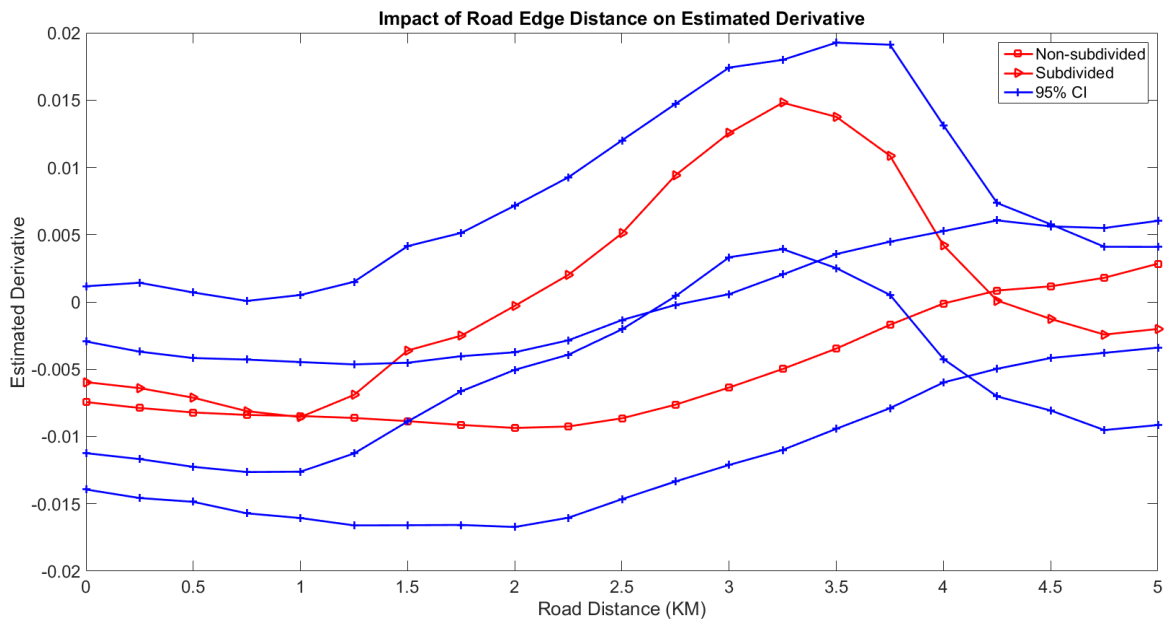


Figure 3: Impact of road distance on estimated marginal effect.

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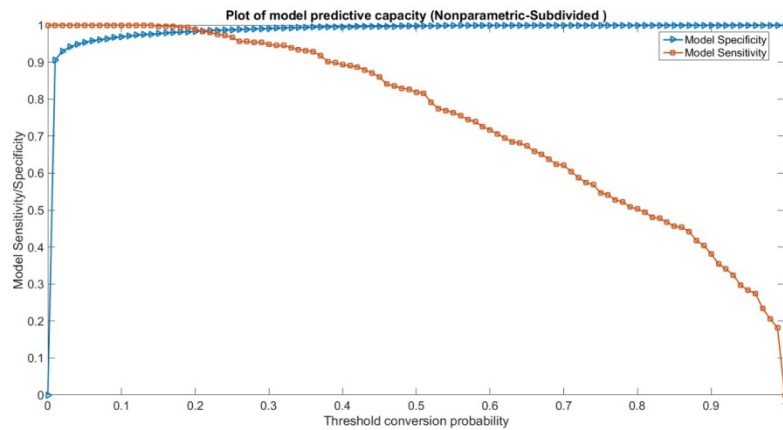


Figure 4: Model specificity and sensitivity for nonparametric model.

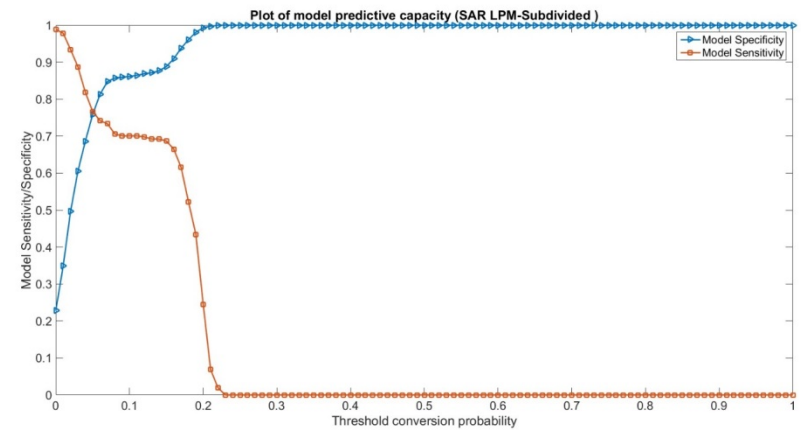


Figure 5: Model specificity and sensitivity for spatial linear probability model.

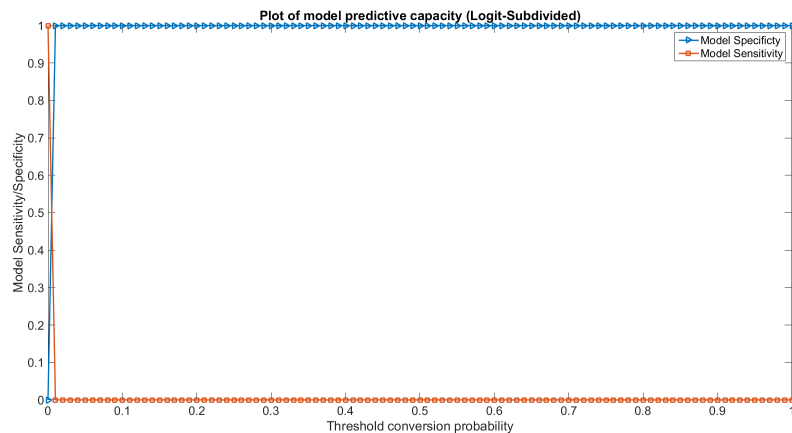


Figure 6: Model specificity and sensitivity for logit model

Table 1: P-values under different null models:

P-values under H_0 :	
H_0 : Logistic Model	
Subdivided	Non-subdivided
0	0
H_0 : Multinomial Logistic Model	
Subdivided	Non-subdivided
0	0
H_0 : SAR LPM	
Subdivided	Non-subdivided
0.005	0.0075

Notes: P-values under $H_0 : Pr[\phi(R = k|X = x) = \phi(R = k|X = x, \beta)] = 1$ for some $\beta \in \Omega$.

Table 2: Impact of a one standard deviation change in a X variable on conversion probability relative to σ_y and its relative impact.

Variable	Impact Subdivided	Impact Non-subdivided	Relative Impact
Forest Edge Distance (km)	0.0149***	0.085***	5.68***
Road Distance (km)	0.0114	0.055***	4.82
Protected Area	0.0011***	0.019***	17.14***

Notes: The impact is defined as $I_i = \left| \frac{\sigma_x \hat{\theta}_i}{\sigma_y} \right|$ for $i=SD, NSD$ with the relative impact given by $RI = \frac{I_{NSD}}{I_{SD}}$.

Table 3: Impact of a one standard deviation change in a X variable on conversion probability relative to unconditional conversion probability (μ_y) and its relative impact.

Variable	Impact Subdivided	Impact Non-subdivided	Relative Impact
Forest Edge Distance (km)	0.176***	0.736***	4.19***
Road Distance (km)	0.134	0.477***	3.55
Protected Area	0.013***	0.164***	12.64***

Notes: The impact is defined as $I_i = \left| \frac{\sigma_x \hat{\theta}_i}{\mu_y} \right|$ for $i=SD, NSD$ with the relative impact given by $RI = \frac{I_{NSD}}{I_{SD}}$.

Robustness Checks

Table 4: Nonparametric Results for Determinants of Smallholder Forest Conversion Within 5 km of Border

Independent Variable	$\hat{\theta}_{SD}$	$\hat{\theta}_{NSD}$	$\hat{\theta}_{SD} - \hat{\theta}_{NSD}$
Elevation (10s m)	-.000091 (.00029)	-.0063*** (.0024)	.0062*** (.0024)
Slope	-.0005 (.00036)	.00015 (.00015)	-.00064* (.00039)
Square-root Soil Depth	0 (0)	0 (0)	0 (0)
Precipitation	0 (0)	-.000075 (.00012)	.000075 (.00012)
Forest Edge Distance	0 (0)	-.007* (.0036)	.007* (.0036)
Road Distance	.0018 (.0017)	-.0029*** (.00069)	.0047** (.0019)
Settlement Distance	-.0053* (.0029)	-.0014** (.00067)	-.0039 (.003)
Town Distance	.002** (.0014)	-.0002** (.0001)	.0022** (.0014)
Protected Area	0 (0)	-.051*** (.0087)	.051*** (.0087)
Province Indicators	Yes	Yes	Yes
District Indicators	No	No	No
Observations	847	594	

Notes: The binary dependent variable takes on a value of 1 if the pixel is converted from forest to smallholder production (mixed agriculture, palm oil, rubber, with plasma oil palm production excluded) between 2000 and 2008. The unit of observation is a 30-meter by 30-meter pixel. Average marginal effects, based on evaluations of each $\hat{\phi}$ function on all 13,025 pixels, reported. 1 km clustered, bootstrapped standard errors are reported in parentheses. The difference column reports $\hat{\theta}_{SD} - \hat{\theta}_{NSD}$ with the bootstrapped standard errors in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance levels, respectively.

Table 5: Test Results for Group Unconfoundedness by km Grouping

km	$\hat{\tau}$	km	$\hat{\tau}$
1	0.0096 [-0.061, 0.045]	11	-0.032 [-0.051, -0.00078]
2	-0.0078 [-0.027, 0.028]	12	-0.015 [-0.036, 0.013]
3	0.0038 [-0.022, 0.028]	13	-0.021 [-0.042, 0.0083]
4	0.0019 [-0.021, 0.031]	14	-0.02 [-0.044, 0.0071]
5	-0.036 [-0.099, 0.02]	15	-0.018 [-0.037, 0.009]
6	-0.031 [-0.091, 0.013]	16	-0.025 [-0.045, 0.0014]
7	-0.037 [-0.097, 0.0052]	17	-0.025 [-0.044, 0.0012]
8	-0.029 [-0.05, -0.00003]	18	-0.017 [-0.052, 0.0068]
9	-0.027 [-0.042, 0.0044]	19	-0.03 [-0.065, 0.0027]
10	-0.022 [-0.045, 0.0068]	20	-0.031 [-0.065, 0.0019]

Notes: The binary dependent variable takes on a value of 1 if the pixel is converted from forest to smallholder production (mixed agriculture, palm oil, rubber, with plasma oil palm production excluded) between 2000 and 2008. The unit of observation is a 30-meter by 30-meter pixel. The observed difference between each group is reported as $\hat{\tau}$ along with the 95% confidence interval in brackets below the observed difference.

Table 6: Normalized Differences

	Subdivided	Full Sample Non- Subdivided	Normalized Difference	Subdivided	Within 5 km of Border Non- Subdivided	Normalized Difference
Elevation	8.47 (9.64)	13.47 (14.73)	0.284	14.09 (12.50)	17.23 (14.31)	0.166
Slope	2.70 (4.21)	5.31 (6.58)	0.334	4.25 (5.18)	6.66 (7.27)	0.271
Soil Depth	2924.94 (2297.23)	2174.42 (1862.10)	-0.254	2464.04 (2200.73)	2010.31 (1923.94)	-0.155
Precipitation	2459.22 (154.55)	2500.62 (151.79)	0.191	2487.03 (173.58)	2484.97 (151.91)	-0.009
Forest Edge Distance (Km)	1.43 (2.03)	0.92 (1.25)	-0.211	1.29 (1.54)	1.04 (1.18)	-0.128
Road Distance (Km)	4.49 (4.37)	5.55 (5.78)	0.147	4.88 (4.56)	5.02 (4.98)	0.02
Town Distance (Km)	58.71 (26.92)	70.24 (47.70)	0.210	16.69 (8.75)	15.71 (8.39)	-0.081
Settlement Distance (Km)	17.46 (9.53)	16.66 (8.77)	-0.062	55.19 (33.20)	53.35 (25.62)	-0.044
Protected Area	0.172 (0.31)	0.103 (0.38)	-0.141	0.28 (0.45)	0.23 (0.42)	-0.077

Notes: The normalized difference is the difference in means for an observable pixel characteristic between subdivided and non-subdivided districts, divided by the square root of the sum of the variances across both district types (Rosenbaum and Rubin 1985; Stuart 2010). The comparison of the normalized differences of our observable characteristics shows that they are quite similar in both the full sample and the sample of pixels within five kilometers of a district with the other subdivision status (Imbens and Wooldridge 2009; Rubin, 2001).

Parametric Results

Table 7: Logit Results for Determinants of Smallholder Forest Conversion

Independent Variable	$\hat{\theta}_{SD}$	$\hat{\theta}_{NSD}$	$\hat{\theta}_{SD} - \hat{\theta}_{NSD}$
Elevation (10s m)	-.0033*** (.001)	-.0011*** (.0004)	-.0023** (.001)
Slope	-.0021 (.0014)	-.0023*** (.00093)	.00021 (.0016)
Square-root Soil Depth	-.000018*** (.0000047)	-.0000048 (.0000053)	-.000013* (.0000072)
Precipitation	.00022*** (.000043)	.000041*** (.00001)	.00018** (.000044)
Forest Edge Distance	-.046*** (.0072)	-.044*** (.011)	-.0019 (.013)
Road Distance	.0022 (.0016)	-.0023** (.0014)	.0046** (.0022)
Settlement Distance	.00071 (.0005)	-.00039 (.00065)	.0011 (.00082)
Town Distance	.00033* (.00019)	-.00027* (.00015)	.00059** (.00024)
Protected Area	-.042*** (.0057)	-.0042 (.012)	-.038*** (.014)
Province Indicators	Yes	Yes	Yes
District Indicators	Yes	Yes	Yes
Observations	9,192	3,258	

Notes: The binary dependent variable takes on a value of 1 if the pixel is converted from forest to smallholder production (mixed agriculture, palm oil, rubber, with plasma oil palm production excluded) between 2000 and 2008. The unit of observation is a 30-meter by 30-meter pixel. Average marginal effects, based on evaluations of each $\hat{\phi}$ function on all 13,025 pixels, reported. 2 km clustered, bootstrapped standard errors are reported in parentheses. The difference column reports $\hat{\theta}_{SD} - \hat{\theta}_{NSD}$ with the bootstrapped standard errors in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance levels, respectively.

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Table 8: Multinomial Logit Results for Determinants of Smallholder Forest Conversion

Independent Variable	$\hat{\theta}_{SD}$				$\hat{\theta}_{NSD}$				$\hat{\theta}_{SD} - \hat{\theta}_{NSD}$			
	Mixed	Oil	Rubber	Plasma	Mixed	Oil	Rubber	Plasma	Mixed	Oil	Rubber	Plasma
Elevation (10s m)	-.000083 (.00026)	-.0028*** (.00091)	-.00031 (.00045)	-.00034 (.00032)	-.001*** (.00033)	-.0011*** (.00061)	.00002 (.000075)	.000059 (.00022)	.00091** (.00042)	-.0016* (.0011)	-.00033 (.00045)	-.0004 (.00037)
Slope	-.00054 (.00037)	-.0011 (.0011)	-.0011 (.00085)	.00037 (.00042)	-.0000052 (.0007)	-.0022** (.0013)	-.00038*** (.0002)	-.00024 (.00043)	-.00054 (.00078)	.0011 (.0018)	-.00074 (.00086)	.00061 (.00063)
Square-root Soil Depth	-.0000035*** (.000001)	-.0000039 (.0000049)	-.000006** (.0000034)	.0000019 (.0000015)	-.0000042* (.0000042)	.0000026 (.0000041)	-.0000052* (.0000032)	-.00000032 (.0000011)	.00000072 (.0000044)	-.0000064 (.0000064)	-.0000079 (.0000047)	.0000022 (.0000019)
Precipitation	-.000014 (.00001)	.00029*** (.000042)	.000048* (.00003)	.000098*** (.000023)	.000011* (.000007)	.000011** (.0000084)	.0000041* (.0000024)	-.000012*** (.0000057)	-.000025* (.000013)	.00028*** (.000044)	.000042 (.00003)	.00011*** (.000024)
Forest Edge Distance	-.0072*** (.003)	-.0084*** (.0033)	-.03*** (.0073)	-.0049** (.0025)	-.016*** (.0082)	-.025** (.028)	-.005*** (.0025)	-.0097*** (.0076)	.0082 (.0087)	.017** (.028)	-.025*** (.0079)	.0048 (.008)
Road Distance	-.00067* (.00038)	.00083 (.0011)	.0017 (.0014)	.0006 (.00052)	-.0027*** (.0024)	-.00094 (.0026)	.000047 (.00034)	-.0015*** (.00082)	.0021 (.0024)	.0017 (.0028)	.0016 (.0014)	.0021** (.00099)
Settlement Distance	-.00028*** (.00013)	.0014*** (.00036)	-.00055 (.00041)	-.00089*** (.00032)	-.0013*** (.0005)	.00077 (.0009)	-.000057 (.00017)	.000048 (.00029)	.00099** (.00052)	.00066 (.00097)	-.00049 (.00044)	-.00094*** (.00044)
Town Distance	.000085* (.000061)	-.00035*** (.00014)	.00034*** (.00012)	-.00025*** (.000082)	.00013 (.000098)	-.00024 (.00013)	.000018 (.000042)	-.000072 (.000069)	-.000041 (.00012)	-.00011 (.00019)	.00032*** (.00013)	-.00018 (.00011)
Protected Area	.003 (.0049)	-.027*** (.0042)	-.017*** (.0038)	.0053 (.0073)	.00012 (.015)	-.0075 (.055)	.0011 (.0035)	-.0058*** (.0023)	.0029 (.015)	-.019** (.055)	-.018*** (.0052)	.011** (.0076)
Province Indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,192	9,192	9,192	9,192	3,258	3,258	3,258	3,258				

Notes: The dependent variable takes on a value of 1 if the pixel is converted from forest to mixed agriculture, 2 if the pixel is converted from forest to palm oil, 3 if the pixel is converted from forest to rubber, and 4 if the pixel is converted from forest to plasma oil palm between 2000 and 2008. The unit of observation is a 30-meter by 30-meter pixel. Average marginal effects, based on evaluations of each $\hat{\phi}$ function on all 13, 025 pixels, reported. 2 km clustered, bootstrapped standard errors are reported in parentheses. The difference columns report $\hat{\theta}_{SD} - \hat{\theta}_{NSD}$ with the bootstrapped standard errors in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance levels, respectively.

Table 9: SAR LPM ($k = 2$) Results for Determinants of Smallholder Forest Conversion

Independent Variable	$\hat{\theta}_{SD}$	$\hat{\theta}_{NSD}$	$\hat{\theta}_{SD} - \hat{\theta}_{NSD}$
Elevation (10s m)	-.0018*** (.00063)	-.0018*** (.00052)	.000042 (.00082)
Slope	-.00048 (.00077)	-.0035*** (.00089)	.003** (.0012)
Square-root Soil Depth	-.0000033*** (.0000011)	-.0000006 (.0000029)	-.0000027 (.0000031)
Precipitation	.00017*** (.000047)	.00017*** (.000051)	.0000057 (.000069)
Forest Edge Distance	-.0053*** (.0016)	-.0075** (.0033)	.0022 (.0037)
Road Distance	.0019*** (.0007)	.00014 (.00091)	.0017 (.0012)
Settlement Distance	.00019 (.00026)	-.00056 (.00051)	.00074 (.00057)
Town Distance	-.00019** (.00009)	-.00027 (.00017)	(.000076) (.00019)
Protected Area	-.037*** (.01)	.025* (.014)	-.062 (.017)
ρ^{\wedge}	0.052 (.23)	.32** (.13)	-0.26 (.26)
Province Indicators	Yes	Yes	Yes
District Indicators	Yes	Yes	Yes
Observations	9,192	3,258	

Notes: The binary dependent variable takes on a value of 1 if the pixel is converted from forest to smallholder production (mixed agriculture, palm oil, rubber, with plasma oil palm production excluded) between 2000 and 2008. The unit of observation is a 30-meter by 30-meter pixel. The reported coefficients are based on evaluations of each $\hat{\phi}$ function on all 13,025 pixels. Asymptotic standard errors are reported in parentheses. The difference column reports $\hat{\theta}_{SD} - \hat{\theta}_{NSD}$ with the bootstrapped standard errors in parentheses. One, two, and three stars indicate 10 percent, 5 percent, and 1 percent significance levels, respectively.

Bandwidth selection

Table 10: Optimal bandwidths for binary and multinomial nonparametric models.

Variable	Binary		Multinomial	
	Subdivided	Non-subdivided	Subdivided	Non-subdivided
Conversion	0.003417204	0.006317783	0.004966546	0.00861
Elevation (10s m)	5.88E+00	25020140	8.437085	4.409206
Slope (percent)	1.49E+07	11.62745	7.197138	5320717
Square-root Soil Depth (mm)	5186197231	4610.643	4482.164	2547.73
Precipitation (km)	27.18313	29.88205	21.99456	111721695
Forest Edge Distance (km)	0.5643313	0.3404008	0.6046659	0.4188318
Road Distance (km)	0.5918519	0.9241033	0.6263591	1.532027
Settlement Distance (km)	2.161359	0.8394453	1.957415	1.075925
Town Distance (km)	0.9639768	5.252566	0.8906773	1.064054

Notes: The bandwidths are chosen for the binary nonparametric model excluding plasma production and the multinomial nonparametric model including plasma production. Bandwidths for the other models under consideration are available upon request.