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Appendix B

A discussion about the consistency of the surplus estimator

The statistic of the statistical Hicks-Kaldor test proposed in this paper is:

$$\bar{s} \equiv \widehat{\Omega_B} \frac{1}{N_B} \sum_{i=1}^{N_B} B_i - \widehat{\Omega_C} \frac{1}{N_C} \sum_{j=1}^{N_C} C_j = \widehat{\Omega_B} \bar{B} - \widehat{\Omega_C} \bar{C}$$

It must be stressed that $\widehat{\Omega_B}$ and $\widehat{\Omega_C}$ are not functions of the sample sizes of the stated preference surveys. Also, $\bar{B}$ and $\bar{C}$ are not functions of the sizes of the time-series and panel data samples used to estimate the population sizes (see section 3 of the main text). The size of smallholder's population, $\widehat{\Omega_C}$, was directly calculated as the count of all members of the population, not being, thus, an estimate, but the actual parameter. Thus, it will be hereafter denoted as Ω_C. Thus being, the consistency of $\bar{s}$ can be easily established, as follows.

Let it be assumed that $N_C = N_C(N_B)$, such that $\lim_{N_B \to \infty} \frac{N_B}{N_C(N_B)} = k$, for some constant k. This is a common assumption[1] (see, for instance, assumption 2 in Angrist and Krueger, 1992). An analogous hypothesis for the size of the better off population is that $N_{PD} = N_{PD}(N_{TS})$, such that $\lim_{N_{TS} \to \infty} \frac{N_{TS}}{N_{PD}(N_{TS})} = l$, with N_{PD} being the size of the panel data (second stage), N_{TS} the size of the time series (first stage) and "l" a generic constant (assuming that N_{PD} is a function of N_{TS} is reasonable as, considering the econometric exercises reported in section 3 of the main text, subsection "Estimates of Population Sizes", the two datasets had the same final year, 2016).

[1] The assumption can be understood, for the purpose of proving consistency, as an increase in the sample sizes of the stated preference surveys without any change in the target populations.

With "$plim_{N_B}$" and "$plim_{N_{TS}}$" denoting the probability limits as functions of, respectively, N_B and N_{TS}[2], and resorting to the properties of probability limits (Greene, 2003, theorem D.14), one has:

$$plim_{N_{TS}}\left[plim_{N_B}\left(\hat{\Omega}_{B,N_{TS}}\bar{B} - \Omega_C\bar{C}\right)\right] = plim_{N_{TS}}\left[\hat{\Omega}_{B,N_{TS}}\left(plim_{N_B}\bar{B}\right) - \Omega_C\left(plim_{N_B}\bar{C}\right)\right]$$

$$= plim_{N_{TS}}\left[\hat{\Omega}_{B,N_{TS}}\mu_B - \Omega_C\mu_C\right] = \Omega_B\mu_B - \Omega_C\mu_C = \mu_S$$

Since $B_1,\ldots,B_{NB}$ and $C_1,\ldots,C_{NC}$ are independent random samples from populations whose expected values are, respectively, $E[B_i] = \mu_B$, for all i, and $E[C_j] = \mu_C$, for all j. In addition, $\hat{\Omega}_{B,N_{TS}}$ is a product of two estimates of coefficients obtained with econometric models from two independent samples (3.4.1). Therefore, if the coefficients are consistently estimated, then the product converges to its population value (Greene, 2003, theorem D.14) and, consequently, the sample surplus estimator is consistent.

[2] The procedure of applying two probability limits to an estimator has a parallel in the proofs of consistency for some panel data estimators in which the cross-section sample size (which is analogous to N_B) is send to infinity with fixed time-series sample size (the analogous of N_{TS}), or both sample sizes are sent to infinity (see chapter 4.1 of Hsiao, 2003).

Additional figures and tables

Figure B1 The study region (dark grey area in the central map)

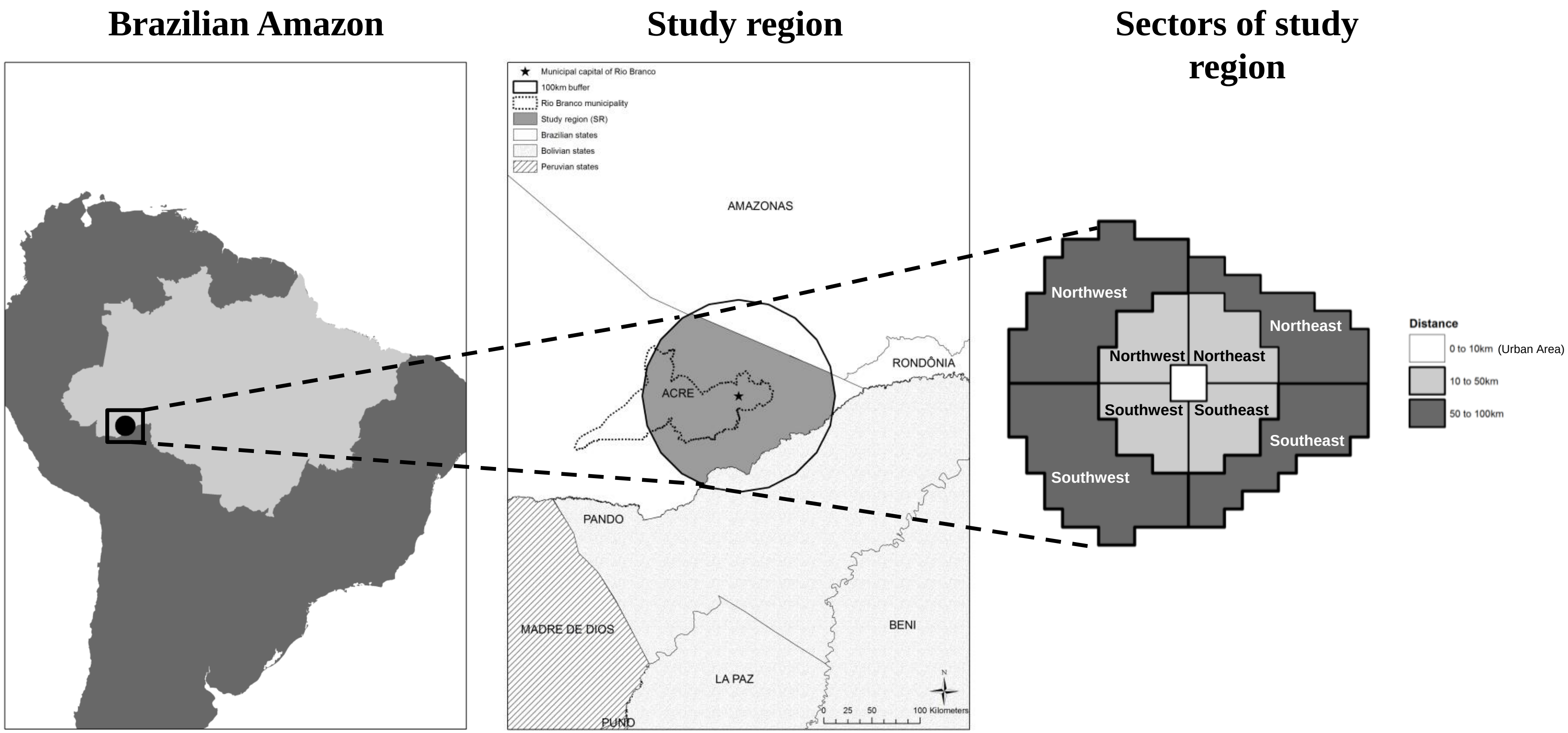

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Table B.1 Main incentive-based policy instruments for reduction of agricultural fires in Acre state

Program	Main objectives	Start	End	Funding
Farm certification	.Reduce deforestation in smallholdings; .Foster smallholders to substitute fire by mechanized land preparation and agroforestry	2009	2017	WWF, Sky TV (UK), Amazon fund, IDB, Acre state
Acre sustainable development plan	.Reduce deforestation; ."Increase the contribution of the forest sector to economic growth and poverty reduction (...) (IDB, 2011)" .Reduce deforestation and forest degradation	First phase: 2002; Second phase: 2013	First phase: 2010; Second phase: 2018	IDB, Amazon fund
Reduced emissions from deforestation and degradation for early movers (REDD-REM)	.Promote sustainable development of Acre with focus on smallholders, indigenous people and traditional forest-based communities; .Sell carbon credits from avoided deforestation and degradation to Germany; Reduce fires with awareness actions, direct regulation, subsidy to fire-free and sustainable land uses and expand fire bridages.	First phase: 2010; Second phase: 2016	First phase: 2013; Second phase: 2020	German Development Bank (KFW), UK Department for Business, Energy & Industrial Strategy (BEIS)

Sources: Seaprof, 2017, Costa et al., 2012, IDB, 2011, Eringhaus, 2016, UNFCCC, 2017, Sills et al. 2014.

Table B2 Estimation results for the first stage, better-off population estimation

Covariate	Fire	Fire * d_wind	global p-value
Urban area	0 (0.256)	33.81114	<0.01%
10 to 50km northeast	6.515465 (0.003)	-5.101886	<0.01%
10 to50km northwest	6.288946 (0.01)	14.57844	<0.01%
10 to 50km southwest	2.767259 (0.011)	0	0.0107
10 to 50km southeast	6.939803 (0.012)	-8.519066	<0.01%
50 to 100km northeast	2.03319 (0)	-1.108203	<0.01%
50 to 100km northwest	1.039057 (0.04)	0	<0.01%
50 to 100km southwest	0 (0.068)	0	0.0675
50 to 100km southeast	3.133181 (0)	0	<0.01%

Note: for "fire", p-values in parentheses. Estimates of fire and fire * d_wind interaction with p-value above 5% were zeroed. The last column is the F test for global significance of regression.

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Table B3 Estimation results for the second stage, better-off population estimation

#	Y	Model	Estimator	sig+5%	MFX	sig global
1	_total	Neg. binomial	fe	1	0.03807405	3.63E-87
2	_total	Neg. binomial	pa	1	0.04827318	1.16E-54
3	_total	Neg. binomial	re	1	NA	1.01E-78
4	_total	Poisson	fe	1	0.00177001	1.15E-49
5	_total	Poisson	pa	1	0.03988174	0
6	_total	Poisson	re	1	0.05960624	2.03E-67
7	age:00to04	Neg. binomial	fe	1	0.02637946	7.88E-70
8	age:00to04	Neg. binomial	pa	1	0.0139944	9.95E-73
9	age:00to04	Neg. binomial	re	1	0.04670287	1.80E-74
10	age:00to04	Poisson	fe	1	1.16E-03	2.37E-27
11	age:00to04	Poisson	pa	1	0.0085372	1.148E-32
12	age:00to04	Poisson	re	1	0.01384758	2.10E-42
13	age:05to17	Neg. binomial	fe	1	0.01547938	2.67E-46
14	age:05to17	Neg. binomial	pa	0.8	0.00672019	7.09E-41
15	age:05to17	Neg. binomial	re	0.96	0.01473627	1.67E-68
16	age:05to17	Poisson	fe	0.96	1.34E-03	1.51E-26
17	age:05to17	Poisson	pa	0.36	0.00606013	7.44009E-31
18	age:05to17	Poisson	re	1	0.01052391	1.56E-28
19	age:18to65	Neg. binomial	fe	1	0.08339824	1.65E-41
20	age:18to65	Neg. binomial	pa	1	0.02415458	1.56E-26
21	age:18to65	Neg. binomial	re	1	0.12323252	9.81E-29
22	age:18to65	Poisson	fe	1	0.00292055	1.03E-25
23	age:18to65	Poisson	pa	1	0.02346801	0.00E+00
24	age:18to65	Poisson	re	1	0.03314945	4.40E-37
25	age:above65	Neg. binomial	fe	0.84	0.03049067	1.34E-04
26	age:above65	Neg. binomial	pa	0.92	0.00230573	1.20E-11
27	age:above65	Neg. binomial	re	0.44	0.00234759	6.37E-05
28	age:above65	Poisson	fe	0.72	0.00148342	1.31E-05
29	age:above65	Poisson	pa	0.44	0.00216951	2.62E-09
30	age:above65	Poisson	re	0.72	0.00274734	9.54E-10
31	ill:influenza	Neg. binomial	fe	1	0.00686978	1.30E-21
32	ill:influenza	Neg. binomial	pa	1	0.00469576	1.70E-21
33	ill:influenza	Neg. binomial	re	1	0.00904186	3.29E-25
34	ill:influenza	Poisson	fe	1	0.00385428	4.20E-14
35	ill:influenza	Poisson	pa	1	0.00588139	3.91E-32
36	ill:influenza	Poisson	re	1	0.0077634	4.24E-21
37	ill:other	Neg. binomial	fe	1	0.05464071	7.36E-80
38	ill:other	Neg. binomial	pa	1	0.04376022	2.64E-89
39	ill:other	Neg. binomial	re	1	NA	2.25E-83
40	ill:other	Poisson	fe	1	0.0018119	2.19E-56
41	ill:other	Poisson	pa	1	0.03281892	0.00E+00

Table B3 Estimation results for the second stage, better-off population estimation (cont.)

#	Y	Model	Estimator	sig+5%	MFX	sig global
42	ill:other	Poisson	re	1	0.04984971	8.52E-87
43	ill:pneumonia	Neg. binomial	fe	0	0.00960418	1.04E-07
44	ill:pneumonia	Neg. binomial	pa	0	0.00052717	4.67E-24
45	ill:pneumonia	Neg. binomial	re	0	0.00123189	1.89E-11
46	ill:pneumonia	Poisson	fe	0	0.00033734	5.33E-08
47	ill:pneumonia	Poisson	pa	0	0.00064162	9.92E-11
48	ill:pneumonia	Poisson	re	0	0.00116538	1.43E-15

Note: the table show statistics for estimates across definitions of dependent variable and dose-response econometric models. First column is the definition of the dependent variable, second and third column define the econometric estimation with "fe" standing for fixed-effect, "pa" for population-averaged and "re" for "random-effect". The column sig+5% is the share of models for which AOD was significant at 5% level and positive (significance rate), MFX is the marginal effect averaged across bootstrap replications. The last column is the p-value of the chi-square global significance test.

Table B4 Aggregate values at the level of SR sectors*

Sector	Half hectare burning limit, most efficient policy				Zero burning limit, most efficient policy			
	Aggregate WTA	Aggregate WTP	Surplus	Ordering: surplus vs agg. WTA vs agg. WTP	Aggregate WTA	Aggregate WTP	Surplus	Ordering: surplus vs agg. WTA vs agg. WTP
10 to 50 km northeast	- 9,176	77	9,253	4 vs 4 vs 1	- 9,793	83	9,876	4 vs 4 vs 1
10 to 50 km northwest	- 4,944	22	4,966	7 vs 7 vs 6	- 5,951	26	5,977	7 vs 7 vs 6
10 to 50 km southwest	- 8,718	28	8,746	5 vs 5 vs 4	- 8,744	31	8,775	5 vs 5 vs 5
10 to 50 km southeast	- 5,575	27	5,601	6 vs 6 vs 5	- 6,352	31	6,383	6 vs 6 vs 4
50 to 100 km northeast	- 14,591	36	14,627	1 vs 1 vs 3	- 14,594	39	14,633	2 vs 2 vs 3
50 to 100 km northwest	- 11,126	11	11,137	3 vs 3 vs 7	- 11,372	12	11,385	3 vs 3 vs 7
50 to100 km southwest	- 1,308	-	1,308	8 vs 8 vs 9	- 1,250	-	1,250	8 vs 8 vs 9
50 to100 km southeast	- 13,696	37	13,733	2 vs 2 vs 2	- 15,680	43	15,723	1 vs 1 vs 2
Urban area, 0 to 10 km	- 746	2	748	9 vs 9 vs 8	- 1,077	3	1,080	9 vs 9 vs 8

*Sectors are defined in function of distance and direction from urban perimeter of Rio Branco that belongs to the "urban area" sector. Direction was classified in the four trigonometric quadrants (figure A.1). All monetary values in R$1,000. Top-ranked eastern sectors highlighted in grey.

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