A Online Appendix

A.1 Bolsa Floresta components

The first component to be rolled out to all participating families is the *Bolsa Floresta Family* component — a conditional payment to individual participating families for environmental services. All families living within the targeted reserves for longer than two years can participate. Each family receives a monthly payment of BRL 50, paid to the female household head or wife. Börner et al. (2013) and Newton et al. (2012) show that payments are most probably sufficient to offset the opportunity costs of conservation. The disbursement of the payments starts after signing a commitment to comply with the rules of the BFP. The restrictions of the BFP advance beyond the reserve rules, and include the prohibition of new clearing in primary forests and school attendance of all school-age children. Participation rates range from 70 to 100%, today covering over 9,400 families (Newton et al., 2012).

Investments to the local infrastructure are realized through the *Bolsa Floresta Social* component (social component). Through this channel the BFP conducts basic service infrastructure investments within the communities of a reserve. Yearly investments, amounting up to BRL 350 per family, flow into the establishment of electricity, water supply, sanitation and communications systems (Börner et al., 2013).

The *Bolsa Floresta Associação* (association component) component aims to support local associations and collaborations among communities and partnerships with other organizations and local governments. The program promotes meetings within communities and reserves in order to build leadership capacity and promote participation, secure social justice and the interests of all inhabitants. The annual grants amount to 10% of all Bolsa Floresta Familia Payments, and can be used autonomously by the communities (Börner et al., 2013; FAS, 2013; Newton et al., 2012).

The BFP expanded after the first year with its *Bolsa Floresta Renda* (income component). This component aims to foster forest-friendly production systems. Each participating community independently decides how to invest. Technical assistance on new production systems is provided by FAS staff. The most frequent investments include poultry, nuts, natural oil production, agroforestry, fruit production, and tourism. Annual investments of approximately BRL 350 per participating family aim to increase the productivity of supported activities while introducing new income generating opportunities (Newton et al., 2012). The idea is that the increased productivity shifts families' income sources towards more forest-friendly activities. Swartz (2015) analyzes the income component with data on over 200 households living on both banks of the *Rio Negro*.[16] On both

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[16] The RDS Rio Negro reserve on the southern river bank and the APA Rio Negro reserve on the northern river bank.

sides of the river, households participate in the BFP, though by the time of the survey the income component had only started on the southern side of the river. For the short period through which households benefited from the income component, the study could not find a statistically robust difference in income or asset levels between both groups.

The BFP is therefore composed of a PES to the individual families of the reserves, complemented by community development investments. The social, association and income components are added on top of the voluntary participation in the family component. BFP thus comes to be a PES+ program, where additional investment components are added to a PES scheme. The total support provided by the BFP in the Rio Negro Sustainable Development Reserve was calculated at BRL 1,413 per household per year (FAS, 2013). Newton et al. (2012) measured an average annual BFP support to families of 1,300 reais in the multiple-use reserve of Uacari.

A.2 Policy instruments in multiple-use reserves and the BF

Before hypothesizing on forest conservation outcomes of the BFP, we have to contextualize the program vis-à-vis its implementation in protected areas. Instruments used to manage multiple-use reserves can be grouped into external and community-based monitoring and enforcement, integrated conservation and development programs (ICDPs), revenue sharing, for example from tourism, and conditional payments or payments for environmental services (PES).

The instruments aim to reduce forest-harming outcomes such as deforestation, logging, game hunting, and over-exploitation of other natural resources (such as fish stocks). Although these activities produce economic gains, they can also cause economic and social risks. Individual households often engage in economic activities that harm the forest and thus face opportunity costs when forced to conserve.

As both PA residents and outsiders can obtain economic gains from forest-harming activities, PA managers and conservationist non-governmental organizations (NGOs) often try to reduce the opportunity cost of conservation. Residents have direct interests in the forest resources available to them. Individuals living outside of reserves have interests on the forest resources as they also represent possible economic gains, though outsiders have to compete or collude with residents either by migration or invasion. The policy instrument listed above can affect the opportunity costs of residents and outsiders in manifold ways.

A *monitoring and enforcement infrastructure*, for example satellite monitoring and ranger patrols in nature parks, is one of the most commonly employed PA policy instruments. These activities increase the risk of detection and punishment and thus reduce the opportunity costs of conservation for both residents and outsiders.

The BFP does not independently implement monitoring and enforcement activities. Nonetheless, indirect monitoring is conducted through the local presence of program staff. FAS employees frequently visit communities for the subscription of new families to the program or for technical assistance to the supported production lines (income component). Local violations against the BFP rules can easily be detected and reported to the FAS headquarters. The BFP issued warnings to 4.6% of participants through 2013 (Börner et al., 2013). Although we do not have any information on the suspension of payments as a direct enforcement instrument, it is credible to assume that the expectation of punishment exists.

Integrated conservation and development programs (ICDPs) implemented by the reserve management and its partners target internal opportunity costs within multiple-use protected areas. They aim to shift inhabitant's income sources towards sustainable forest-friendly activities that increase local wellbeing. The policy assumes that inhabitants lack technical knowledge or investment capacities to shift into sustainable income sources. The idea of ICDP investments is that once forest-friendly production systems are installed, they crowd out forest-harming activities. Nonetheless, following Weber et al. (2011) and Bauch et al. (2014) gains in production efficiency can have two diverging effects: (1) they can lead to increased production and divert labor away from forest-harming activities and into forest-friendly activities, whose rate of return has increased; (2) they can result in reduced labor needs for production in forest-friendly activity, freeing labor for forest-harming activities. Which of these effects predominates depends on a multitude of factors among which are: access to labor markets, markets to sell products, leisure preferences, etc.

The BFP incorporates a variety of investments with its social, association and income components. Investments focus on infrastructure (water, sanitation), education, healthcare and forest-friendly production systems. The latter relates to the idea of shifting residents' income base toward forest-friendly production. The program components fit the definition and goals of ICDPs. The impact of the BFP on the opportunity costs of conservation will first depend on the labor productivity of the supported production practices. But more importantly, it will depend on local context factors, such as market access and integration.

Conditional and non-conditional payments (including revenue sharing) or payments for environmental services (PES) are a third conservation instrument available to protected area managers. In the case of protected areas, the environmental service provided can be defined as the compliance with the reserve rules or inclusion of additional conservation rules (Wunder, 2005). Irrespective, the success of PES generally depends on whether the payments offset the opportunity costs of conservation and on the existence of a credible monitoring and enforcement system. Assuming perfect monitoring, payments reduce opportunity costs and lead to a reduction of forest harming activities. Nonetheless, in reality monitoring is costly. To observe and attribute infractions to individuals in remote areas is difficult and without enforcement, behavioral change cannot be expected. Especially under non-conditional revenue sharing, additional cash may offset capital constraints and enable farm-households to investments in forest-harming actives.

The BFP's family component adopts a PES logic, where families receive BRl 50 per month conditioned on their compliance with rules that somewhat exceed the PA regulations. Börner et al. (2013) and Newton et al. (2012) show that payments are on average sufficient to offset the opportunity costs of conservation. As described above, the conditionality condition of the BFP is only partially fulfilled with an indirect monitoring and enforcement via warnings of suspension from the program. Furthermore, some of the treated reserves are remotely located and thus exhibit rather limited market access and high monitoring and enforcement costs.

Monitoring & enforcement efforts by residents themselves can be induced informally by conditional payment schemes or ICDPs (Robinson et al., 2014; Hayes et al., 2017). As violations against many protected area rules (e.g., illegal logging or hunting) are difficult to observe, collective incentives are often used to encourage control (1) among fellow residents and (2) against outsider invasions and illegal settlers.[17] Note that collective residential monitoring can only develop if collusion with outsiders does not create higher benefits than the PES and associated benefits.

The BFP's explicit long-term goal is to build what they call 'conservation alliances' with the reserve dwellers. The FAS installed radio telephones in all reserve centers which facilitate communication and can be used to assure timely report of invasions from outsiders. Reportedly, residents demand to a greater extent that governmental institutions carry out their monitoring activities (Interview with Virgilio Viana, FAS director) Thereby, the conditions for monitoring and enforcement activities by residents are in place. The link between instruments and conservation outcomes are depicted in Figure A5.

Monitoring and enforcement activities from PA managers or residents reduce the potential rents of forest-harming activities, irrespective of the level of market integration. In contrast, ICDPs can have detrimental effects under specific circumstances. In market-remote settings, a productivity increase in forest-benign activities can set labor free for forest-harming activities. In remote areas with low levels of market integration, families are cash constrained. Payments ca relax the cash constraint and enable investments into forest-harming production activities. At the same time, remote areas are difficult to monitor and therefore PES with imperfect enforcement can have detrimental effects on forest conservation.

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[17] Enforcement could be exerted by social sanctions. However, if there are gainers from non-compliance and losers from compliance, a Coasean bargaining solution among residents might exist.

A.3 Data generation procedures

Covariates used for the matching procedures are summarized in Table 2. Summary statistics on covariates of the panel data set are presented in Table A9. Table A10 lists the data sources used.

Deforestation, fire and forest degradation. Our outcome variables are derived from the database of the Brazilian National Institute of Spatial Research (Instituto Nacional de Pesquisas Espaciais, INPE).INPE's deforestation measurement is based on LANDSAT imagery, and deforestation patches are defined as clear-cut deforestation - the complete loss of tree cover on a 30 m resolution. To find comparable control group we match on pre-treatment data from 2003 to 2007. For our estimations of the treatment effects we use data from 2004 to 2015, when deforestation rates started to decline in Brazil. INPE uses the August to July cycle for its yearly measurements - exploiting the relatively cloud-free dry period of the year.INPE started to record forest degradation data in 2007. Combining information from the LANDSAT and CBERS satellites, INPE classifies partially deforested areas as degraded. In this analysis we could only consider degradation data until 2013. As consequence, estimations rely increasingly on matching assumptions and less on Fixed Effects assumptions. The annual fire outcome is measured as the sum of counts of fire foci detected by several satellites on a daily basis, retrieved from INPE's spatial data base. Data comprises the years 2004 to 2014. All spatial data processing is conducted on a *PostgresSQL 9.2.3* data server with a *PostGIS 2.0.1* spatial extension.

Land use. Land use classes are obtained from the 2008 revision of INPE's TerraClass project.INPE classifies land use on deforested land into five categories: agricultural land, mixed land occupation, secondary vegetation, pasture land, and urban land. We use these classes to construct coverages for each cell. INPE classified these lands in the same year in which the BFP rolled out. As the data corresponds to the year, in which the BFP was actually rolled out, it is reasonable to assume that the program has not yet affected land use decisions and we can treat these variables as unaffected by the program.

Settlements. We include data on the location of federal agrarian settlement projects, using the shape file provided by the National Institute of Colonization and Agrarian Reform (Instituto Nacional de Colonização e Reforma Agrária, INCRA).

Land profitability. A land profitability map is provided by Bowman et al. (2012), indicating whether or not a particular plot of forest land can be considered as being potentially profitable if converted for cattle ranching. We intersect Bowman's layer with the cells to construct an index of land profitability that can capture the pre-existing deforestation pressures on the reserves.

District boundaries and economic data. We use district boundaries from 2007 from Brazilian Institute of Geography and Statistics (INPE, 2019). District characteristics include population densities in 2007 from the IBGE Demographic Census (IBGE, 2000), GDP per capita and agricultural GDP per capita in 2006 from IBGE Agricultural Census (IBGE, 2006). Information on farm coverage, the share of small farms and tractors per farm also come from the Agricultural census. Timber prices between 2003 and 2006 are constructed as the ratio between quantity and total value of timber produced and obtainable from the IBGE-PEVS report (IBGE, 2014).

Administrative data. Non-spatial attributes - district and reserve characteristics - to our cells database are cross-linked via the spatial location of the cell centroids within administrative entities.

A.4 Further analyses

Parallel pre-trends. We test for parallel pre-trends in our outcome variables during the pre-intervention years (2004–2007) running the logarithm of our outcomes, D_{irdt}, on a future treatment indicator BFP_r times a year trend t:

$$D_{irdt} \quad = \quad \gamma BFP_{rt} \times t + \mathbf{X}_{irdt}\beta + \mu_i + \eta_t + \varepsilon_{irdt} \tag{3}$$

A significant estimate of γ rejects the null-hypothesis of parallel pre-trends. An insignificant estimate of γ, hereby suffices as an indicator to parallel pre-trends. Table A3 presents the results for unmatched and matched data with for yearly deforestation and yearly fires as dependents. Due to missing data in pre-intervention years we cannot test for parallel pre-trend in forest degradation. Deforestation trends were already parallel before matching (column 1), whereby matching reassured the parallel pre-trend (column 2) while improving balance on other observable characteristics. Before matching BFP reserves had a 0.4% less fire incidences with respect to control reserves. After matching, the differences in fire incidences become insignificant.

Matching techniques. Although matching achieved a significant improvement of the covariate balance, remaining imbalance could bias our results. We use a variety of alternative matching procedures to test for misspecifications. We increase the stringency of 'similarity' between matched pairs. We restrict paired matches to

3.0, 2.0, and 1.0 caliper of standard deviation differences in their covariate values (Tables A5. Impact coefficients remain significant only with caliper set to three (column 1). Matching with caliper values below three reduces sample sizes by more than 40% leaving very few observations with any forest losses in the given time frame (columns 2–3). Furthermore, we test our matching procedure by increasing the number of matched control units from 2 to 5 nearest neighbor pairs, which slowly reduces the impact coefficient. (columns 4–7).

Matching criteria. Matching criteria and the underlying list of covariates which are used to approximate the treatment procedure can have a large influence on the selection of observation into the matched sample. We test for different matching criteria using the propensity score metric and alternative Mahalanobis distances with a reduced set of matching covariates. Table A6 presents the results. Propensity score matching after a logit regression on the treatment indicator using the main list of covariates, leads to a small decrease of the impact estimate. Column 1 shows a 8% reduction in deforestation using P-score matching. Columns 2 and 3 use Mahalnobis distances based on the first six or thirteen matching covariates of Table 2. Matching only on environmental outcomes, significantly improves the approximation of pre-intervention deforestation trends, which in consequence reduces the impact estimate further to 4% (column 2). Including economic and political indicators increases the balance among a larger set of covariates, at the expense of some imbalances among pre-trend deforestation rates. The impact estimate increases up to a 0.193. Estimates fluctuate depending on the set covariates and matching criteria, but remain negative with an impact range of 4–19%.

Sample properties. The distribution of our dependent variable is highly skewed due to the low deforestation rate within forest reserves of the Amazonas State. In the matched sample, 98.5% of all observations, across cells and years, report zero deforestation. Only 8.4% of all cells experience some deforestation during our time frame. This could bias the treatment estimates downward, as variations in the explanatory variables lack a response in large parts of the dependent variable. We estimate a weighted FE estimation, using weights constructed by the inverse probability of the cell experiencing some deforestation before treatment (2004–2007). Weighting the sample by probabilities gives less influence to observations that would not have been deforested in any case. Further, we weight by the size of our cell units, giving lower importance to small observational areas. This method controls for the probability of observations experiencing zero deforestation simply because small areas are less probable to be affected by deforestation (Table A7, columns 1–2). Weighting by pre-intervention deforestation probabilities reduces the coefficient estimate by almost half leaving it insignificant. Weighting by cell size on the other hand has no effect on the impact estimate.

Furthermore, our database includes smaller and larger cells due to slicing reserves into a 5x5 km grid (cf. section 4.1). In our preferred estimation model, we keep all irregular cells that are not fully covered by the original grid cells to avoid biases from the loss of information or misattribution and restrict the matching process to find only pairs where cells are equal in size (with a tolerance of 5%). To test whether this data structure drives our results, we examine whether estimates change when cells smaller than 12.5 or 25 km^2 are excluded. As can be seen in columns 3–4, excluding smaller cells has no larger effect on the impact estimate.

State-administered reserves. Multiple-use reserves in Brazil are managed under federal, state, or district administration. The BFP is implemented within state-administered reserves. In our preferred matching procedure, we use federal- and state-administration types, to maximize the pool of potentially matched control cells. The matching procedure allows including federal administered reserves to the control sample, because after the procedure observations approximate similarity along the observed dimensions. On average federal reserves have higher deforestation rates, therefore we expect impact coefficients to fall when we exclude federal reserves from the pool of controls. Nonetheless, a bias will occur if federal reserves have sharply changed their management quality after the BFP start in 2007. For example, if federal reserves improved their protection capabilities significantly after 2007, they would not serve as good controls and lead to an under-estimation of the BFP's effects. Table A8 repeats the main specification of Table 3 but ex-ante restricts the matching procedure to find only pairs between state-administered reserves. The BFP impact coefficient increases indicating a 15% reduction in deforestation rates due to the program (column 2). Holding the selection bias constant this suggest an upward-bias when including federal-administered reserves to the control set. Nonetheless, the two types of bias are difficult to disentangle with matching on different control pools.

Year-wise effects. We analyze the dynamics of the BFP intervention regressing yearly newly deforested area on yearly treatment indicators:

$$D_{irdt} \quad = \quad \sum_{\tau=0}^{7} \gamma_\tau BFP^{y}_{rt-\tau} + \mathbf{X}_{irdt}\beta + \mu_i + \eta_t + \varepsilon_{irdt} \qquad (4)$$

whereby the treatment indicator BFP^{y}_{rt} is one in the year of the BFP start and zero otherwise. In relation to 2, $BFP^{y}_{rt} = \Delta BFP_{rt}$. γ-coefficients are depicted in Figure 2.

Non-parametric regression. The non-parametric estimation of treatment effect by distance to the closest treated community is conducted by firest regressing a reduced form of eq. 2, without the treatment indicator:

$$D_{irdt} \quad = \quad \mathbf{X}_{irdt}\beta + \mu_i + \eta_t + \varepsilon_{irdt} \tag{5}$$

Individual treatment effects are then calculated by taking the paired differences in the estimated residuals of the treated unit i and its matched control unit j: $\varepsilon_{irdt} - \varepsilon^C_{jrdt}$. Finally the average residual difference across treated and untreated years is taken. Results are plotted in Figure A4.The line represents a non-parametric LOESS estimator of the influence of distance to a treated community on the on individual individual treatment effects.

Online Appendix: References

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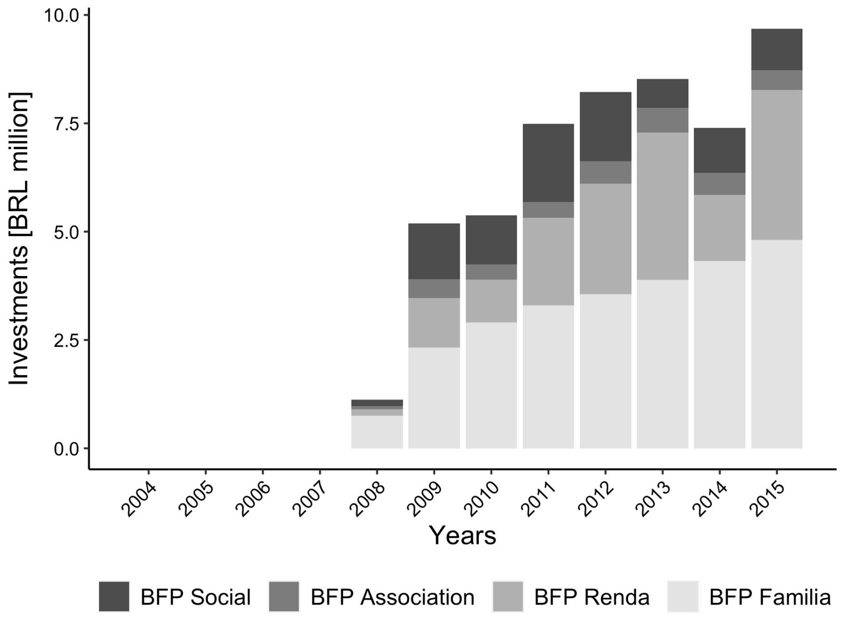
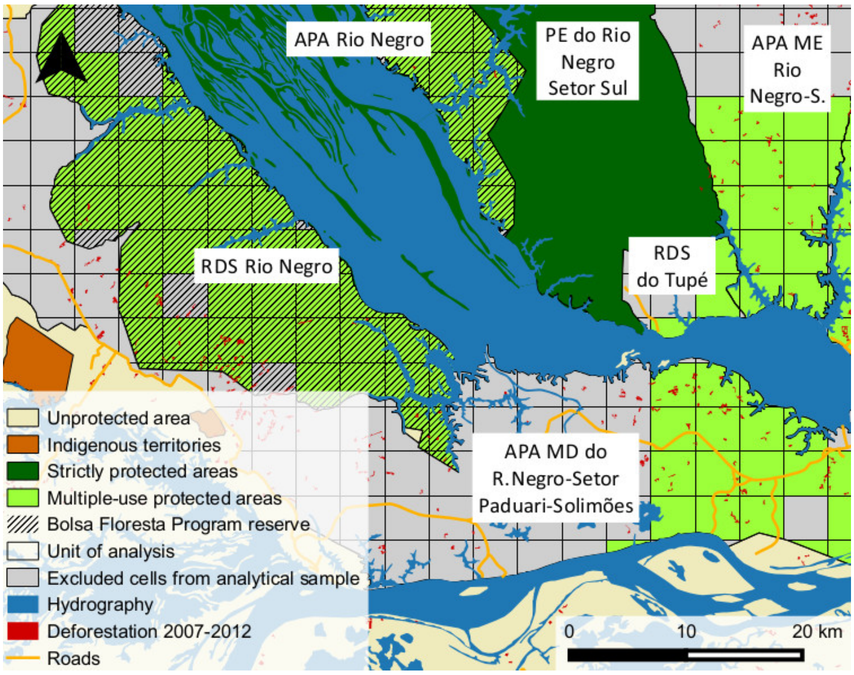
A.5 Online appendix: Figures

Figure A1: Bolsa Floresta investments



Note: Based on annual FAS reports from 2008 to 2015. Values are deflated to the base of 2015.

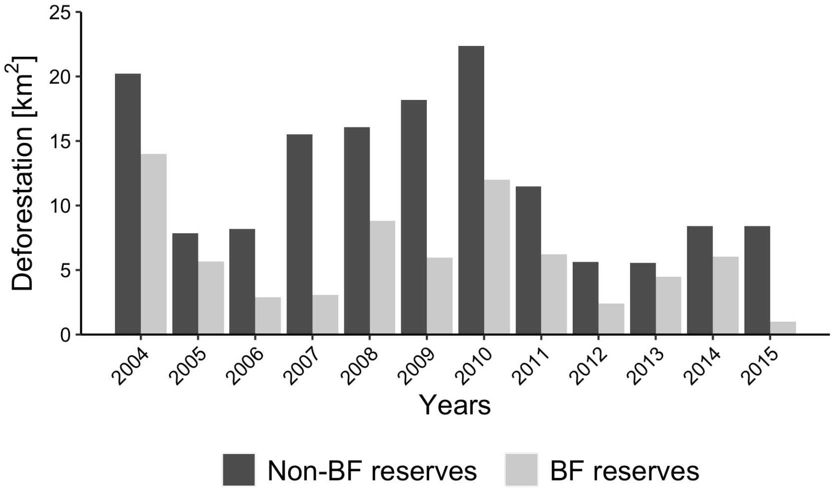
Figure A2: Slicing reserves into cells



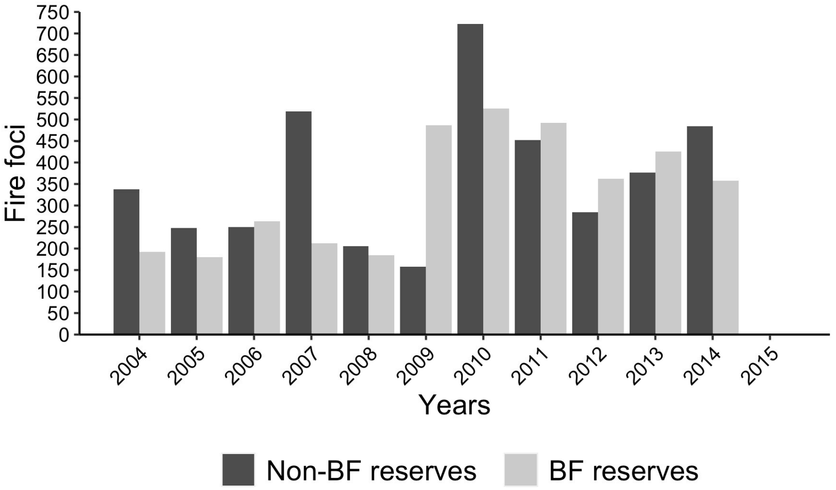
The figure depicts the slicing of reserves into spatial units of 5 to 5 km. Multiple-use reserves are in light-green. Dashed reserves are participating BFP reserves.

Figure A3: Trends in environmental outcomes

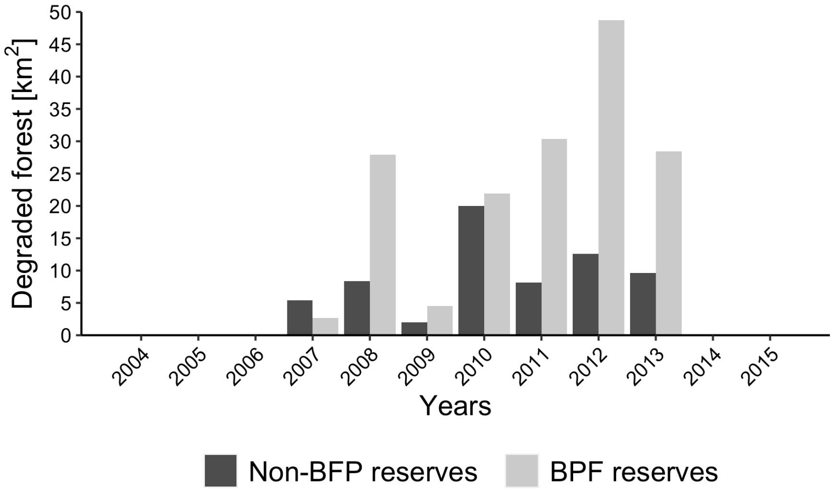
(a) Forest loss



(b) Forest fire

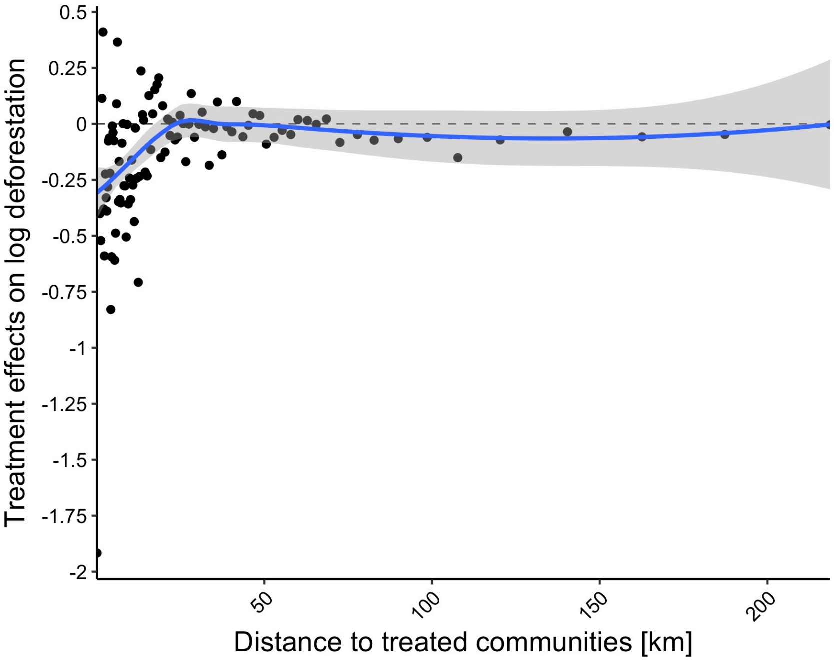


(c) Forest degradation



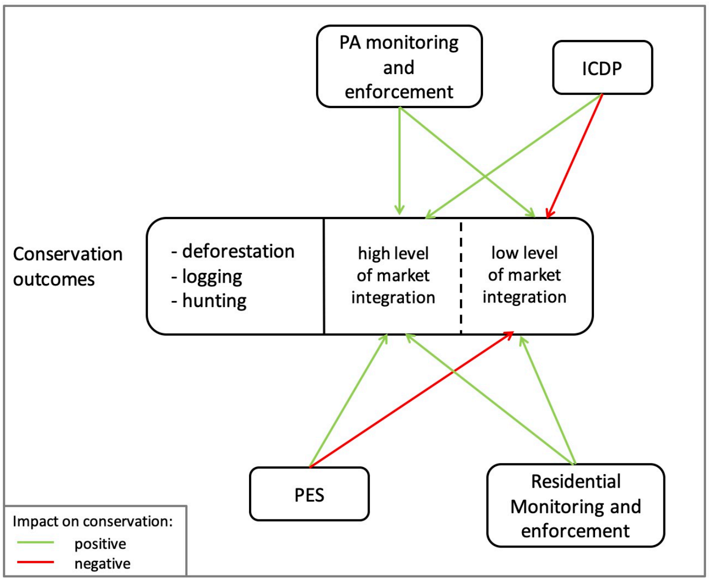
Bars show aggregate values of newly deforested area (a), fire foci (b) and forest degradation (c) within 15 Bolsa Floresta reserves and 18 state-administered multiple-use reserves of the Amazonas State.

Figure A4: Decreasing Bolsa Floresta effects by distance



Points represent the quantile averages of individual cell level treatment effects. The empirical strategy is described in the Appendix section A.4.

Figure A5: Instruments and mechanisms for protected area management



A.6 Online Appendix: Tables

Table A1: Reserve characteristics in the state of Amazonas

	Protected	Year of BFP start	Size [km^2]	Def. pressure per total area [%]	
				within	buffer
	(1)	(2)	(3)	(4)	(5)
Bolsa Floresta reserves:					
FE de Maués	2003	2008	4140	0.11	0.28
RDS Cujubim	2004	2008	24219	0.00	0.02
RDS do Juma	2006	2008	5808	0.12	0.37
RDS do Uatumã	2004	2008	4244	0.06	0.18
RDS Mamirauá	1990	2008	13108	0.00	0.21
RDS Piagaçu-Purus	2004	2008	7925	0.02	0.03
RDS Rio Madeira	2006	2008	2796	0.08	0.13
RDS Uacari	2005	2008	6245	0.01	0.01
RESEX Catuá-Ipixuna	2004	2008	2123	0.13	0.04
RDS Amanã	1999	2009	22334	0.02	0.01
RDS Canumã	2005	2009	224	0.46	0.45
RDS do Rio Negro	2009	2009	1031	0.37	0.37
RDS Rio Amapá	2005	2009	2148	0.00	0.03
RESEX do Rio Gregório	2007	2009	3076	0.13	0.02
APA Rio Negro	1995	2010	5710	0.05	0.09
All other reserves:					
APA Caverna de Pres.Figueiredo-Caverna do Maroaga	1990		4086	0.7	0.28
APA Guajuma	1990		563	0.82	0.85
APA MD do R.Negro Setor Paduari-Solimões	2009		4637	0.47	0.34
APA ME R. Negro Setor Tarumã-Açu-Tarumã-Mirim	2001		559	1.58	0.29
APA Nhamundá	1990		2016	0.04	0.56
FE Canutama	2009		1506	0.01	0.16
FE do Apuí	2005		1806	0.05	0.03
FE do Aripuanã	2005		3275	0.03	0.11
FE do Rio Urubu	2004		271	0.00	0.18
FE do Sucunduri	2005		4807	0.01	0.07
FE Manicoré	2005		820	0.05	0.85
FE Tapauá	2009		8799	0.01	0.08
RDS Aripuanã	2005		2189	0.01	0.11
RDS Bararati	2005		1077	0.07	0.03
RDS Igapó-Açu	2009		3946	0.00	0.01
RDS Matupiri	2009		1770	0.00	0.01
RESEX Canutama	2009		1979	0.18	0.65
RESEX do Guariba	1996		1466	0.02	0.12

Abbreviations indicate to the subcategories of multiple-use reserves in Brazil: Sustainable Development Reserves (RDS), Environmental Protection Areas (APA), Extractive Reserves (RESEX), and State Reserves (FE). The deforestation pressure metric in column 5 is based on a 20 km buffer zone outside of reserves.

Table A2: Selection and variance inflation factors

Dependent variable	Participation	
	Regression	VIF
	(1)	(2)
Forest cover	0.001 (0.084)	1.676
Av. deforestation growth rate	−0.288*** (0.085)	1.703
Settlement cover	0.268*** (0.074)	1.306
Forest management plan	−0.450 (0.358)	3.351
Reserve area	0.140 (0.085)	1.697
Reserve age	0.102 (0.145)	5.003
Av. GDP growth rate	0.000 (0.083)	1.655
Population density	−0.241** (0.096)	2.172
Travel time	−0.073 (0.093)	2.032
Land speculation cover	0.014 (0.112)	2.964
State-party affiliation	0.175 (0.210)	1.804
Observations	33	
Adj. R^2	0.473	

Note: The estimation sample is restricted to 33 state administered reserves, from which 15 reserves are considered as treated. Standard errors are reported in parentheses. Significance at or below 1 percent (***), 5 percent (**) and 10 percent (*).

Table A3: Parallel trend tests

Dependent	*asinh* Deforestation		*asinh* Fires	
	Unmatched	Matched	Unmatched	Matched
	(1)	(2)	(3)	(4)
Future BFP × t	−0.022	−0.017	−0.004**	−0.002
	(0.015)	(0.014)	(0.002)	(0.002)
Year FE	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes
Observations	45644	37976	45644	37976
Groups	11411	9494	11411	9494
Group level	Cell	Cell	Cell	Cell
Adj. R^2	0.280	0.196	0.362	0.222

The dependent variable is the inverse hyperbolic sine of yearly newly deforested area and fire incidences. Samples in Columns 2 and 4 are based on one-to-one nearest neighbour matching with replacement on the Mahalanobis distance. Further controls include yearly cloud coverage over remaining forest area and a dummy for protection status to control for the effect of reserve protection. Clustered standard errors are reported in parentheses. *,**,*** denote significance at the 10/5/1% level, respectively.

Table A4: The Bolsa Floresta effects on forest loss, degradation and fire (full)

Dependent	*asinh* Deforestation Unmatched (1)	 Matched (2)	*asinh* Degradation Matched (3)	*asinh* Fires Matched (4)
BFP	0.048	−0.100	−0.108	0.000
	(0.020)**	(0.020)***	(0.024)***	(0.003)
	[0.040]	[0.098]	[0.108]	[0.015]
Cloud cover	−0.252	−0.225	−0.356	0.010
over initial forest area	(0.019)***	(0.019)***	(0.025)***	(0.003)***
	[0.075]	[0.070]	[0.237]	[0.011]
Protected area status	−0.014	−0.169	−0.019	−0.011
	(0.024)	(0.036)***	(0.033)	(0.004)**
	[0.060]	[0.105]	[0.100]	[0.015]
Year FE	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes
Observations	136932	113928	66458	104434
No. cells	11411	9494	9494	9494
No. reserves	53	48	48	48
Adj. R^2	0.263	0.201	0.012	0.193

The dependent variable is the inverse hyperbolic sine of yearly newly deforested area, degraded forest area and fire incidences. Samples in Columns 2–7 are based on one-to-one nearest neighbour matching with replacement on the Mahalanobis distance. Further controls include yearly cloud coverage over remaining forest area and a dummy for protection status to control for the effect of reserve protection. Clustered standard errors are reported in parentheses. *,**,*** denote significance at the 10/5/1% level, respectively.

Table A5: Effects by varying matching techniques

Dependent	*asinh* Deforestation						
Matching technique	3 caliper	2 caliper	1 caliper	no caliper	no caliper	no caliper	no caliper
	1:1	1:1	1:1	1:2	1:3	1:4	1:5
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
BFP	−0.104	0.011	0.004	−0.121	−0.108	−0.089	−0.078
	(0.018)***	(0.014)	(0.012)	(0.015)***	(0.012)***	(0.010)***	(0.009)***
	[0.100]	[0.016]	[0.012]	[0.117]	[0.099]	[0.083]	[0.072]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	109200	69024	30048	227856	341784	455712	569640
No. matched cells	9100	5752	2504	18988	28482	37976	47470
No. reserves	48	46	28	48	49	49	50
Adj. R^2	0.263	0.201	0.201	0.201	0.201	0.004	0.263

The dependent variable is the inverse hyperbolic sine of yearly newly deforested area. Data sets are based on 1:N nearest neighbour matching with replacement on the Mahalanobis distance with or without caliper. Further controls include yearly cloud coverage over remaining forest area and a dummy for protection status to control for the effect of reserve protection. Clustered standard errors at the matched cell level and the reserve level are reported in round and square brackets respectively. *,**,*** denote significance at the 10/5/1% level, respectively.

Table A6: Effects by varying matching criteria

Dependent	*asinh* Deforestation		
Matching criteria	P.score	Mahal.	Mahal.
	(1)	(2)	(3)
BFP	−0.081	−0.041	−0.193
	(0.022)***	(0.020)***	(0.020)***
	[0.198]	[0.042]	[0.192]
Year FE	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes
Observations	127464	113928	113928
No. matched cells	10622	9494	9494
No. reserves	50	51	48
Adj. R^2	0.170	0.178	0.176

The dependent variable is the inverse hyperbolic sine of yearly newly deforested area. Samples are based on 1:1 nearest neighbour matching with replacement. In columns 3 and 4 a restricted set of matching covariates are used to calculate the Mahalanobis distance. Column 3 uses only pre-intervention forest cover and deforestation rates (first six variables of Table 2). Column 4 further includes covariates on reserve characteristics and economic factors (first 13 variables of Table 2). Further controls include yearly cloud coverage over remaining forest area and a dummy for protection status to control for the effect of reserve protection. Clustered standard errors at the matched cell level and the reserve level are reported in round and square brackets respectively. *,**,*** denote significance at the 10/5/1% level, respectively.

Table A7: Effects and sample properties

Dependent	*asinh* Deforestation			
	weighted by Def. probability (1)	weighted by cell size (2)	Matching with cells >12.5 km^2 (3)	Matching with cells $=25$ km^2 (4)
BFP	−0.060	−0.119	−0.107	−0.110
	(0.049)	(0.022)***	(0.022)***	(0.024)***
	[0.148]	[0.114]	[0.097]	[0.115]
Year FE	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes
Observations	113928	113928	97440	76752
No. matched cells	9494	9494	8120	6396
No. reserves	48	48	47	42
Adj. R^2	0.217	0.206	0.202	0.191

The dependent variable is the inverse hyperbolic sine of yearly newly deforested area. Samples are based on one-to-one nearest neighbour matching with replacement on the Mahalanobis distance. Further controls include yearly cloud coverage over remaining forest area and a dummy for protection status to control for the effect of reserve protection. Clustered standard errors at the matched cell level and the reserve level are reported in round and square brackets respectively. *,**,*** denote significance at the 10/5/1% level, respectively.

Table A8: Effects with state-administered reserves

Dependent	*asinh* Deforestation Unmatched (1)	 Matched (2)	*asinh* Degradation Matched (3)	*asinh* Fires Matched (4)
BFP	0.048	−0.153	0.006	−0.024
	(0.034)	(0.030)***	(0.023)	(0.004)***
	[0.062]	[0.148]	[0.040]	[0.023]
Year FE	Yes	Yes	Yes	Yes
Cell FE	Yes	Yes	Yes	Yes
Observations	80340	113928	66458	104434
No. cells	6695	9494	9494	9494
No. reserves	33	31	31	31
Adj. R^2	0.272	0.188	0.036	0.193

The dependent variable is the inverse hyperbolic sine of yearly newly deforested area. Observations are restricted to state-administered reserves before matching. Samples are based on one-to-one nearest neighbour matching with replacement on the Mahalanobis distance. Cells Further controls include yearly cloud coverage over remaining forest area and a dummy for protection status to control for the effect of reserve protection. Clustered standard errors at the matched cell level and the reserve level are reported in round and square brackets respectively. *,**,*** denote significance at the 10/5/1% level, respectively.

Table A9: Panel data summary statistics after matching

	Mean	St. Dev.	Min.	Max.
Deforested area	0.15	1.96	0.00	179.97
Degraded forest	0.49	8.79	0.00	918.10
Fires	0.06	0.42	0.00	19.00
BFP indicator	0.32	0.47	0.00	1.00
Reserve protection indicator	0.95	0.22	0.00	1.00
Cloud cover	0.08	0.22	0.00	1.00

Note: Statistics refer to 4747 treated BFP cells and 4747 matched control cells.

Table A10: Data sources

Variable	Data type / level	Source
Reserve characteristics and boundaries	Vector layer	IBAMA (2015)
Deforestation	Vector layer (30×30 m)	INPE / PRODES (2015)
Clouds	Vector layer	INPE / PRODES (2015)
Forest area	Vector layer	INPE / PRODES (2015)
Non-forest land	Vector layer	INPE / PRODES (2015)
Water bodies	Vector layer	INPE / PRODES (2015)
Travel time to next large city	Raster (1×1 km)	Schielein and Börner (2018)
Agricultrual land use	Vector layer (30×30 m)	INPE /TerraClass
Urban land	Vector layer (30×30 m)	INPE /TerraClass
Land speculation coverage	Raster (2×2 km)	Bowman et al. (2012)
Settlements	Vector layer	INCRA
Population density	District	IBGE Demo. Census (2007)
GDP per capita	District	IBGE
Farm coverage	District	IBGE Agr. Census
Share of small farms	District	IBGE Agr. Census
Tractors per farm	District	IBGE Agr. Census