Ecological Fiscal Transfers in Brazil – incentivizing or compensating conservation?

N. Droste[123], G. R. Lima[4], P. H. May[3] and I. Ring[1]

[1] UFZ – Helmholtz Centre for Environmental Research, Leipzig, Germany
[2] Martin-Luther-University Halle-Wittenberg, Halle, Germany
[3] Federal Rural University of Rio de Janeiro – UFFRJ, Rio de Janeiro, Brazil
[4] Federal University of Rio de Janeiro – UFRJ, Rio de Janeiro, Brazil

Abstract. Ecological fiscal transfers in Brazil, the so-called ICMS-Ecológico or ICMS-E, redistribute part of the state-level value-added tax revenues on the basis of ecological indicators to local governments. We analyze whether the introduction of this economic instrument in a state incentivizes nature conservation via further protected area (PA) designation or rather compensates for the opportunity costs of existing PAs. We provide a microeconomic model for the functioning of ICMS-E and test the derived hypothesis empirically. Employing an econometric analysis on panel data for two decades we estimate the correlation of the introduction of ICMS-E in Brazilian states with protected area coverage. We find that the introduction of ICMS-E correlates with a higher average PA share. While the introduction of ICMS-E schemes may be a compensation for a high share of federal and state PAs, there also is a clear incentive effect for municipalities to designate additional PAs.

Keywords: ecological fiscal transfers, conservation incentives, economic instruments, microeconometric policy evaluation, fiscal federalism, ICMS-Ecológico

1 Introduction

Against the backdrop of biodiversity and ecosystem services loss suitable and effective policy instruments that could help to halt this trend are of great interest to meet the Aichi biodiversity targets of the CBD's Strategic Plan to 2020 (CBD, 2010). Ecological Fiscal Transfers (EFT) could be one such instrument. Intergovernmental fiscal transfers redistribute tax revenue from higher to lower levels of government, based on a number of different indicators such as population or area of the relevant jurisdiction. EFT redistribute a share of these public revenues according to nature conservation or other environmental indicators. Several authors see EFT as an instrument that could potentially incentivize greater nature conservation (Grieg-Gran 2000; May et al. 2002; Ring 2008b; Young 2005; Loureiro 2002).

Since the pioneering implementation in the state of Paraná in 1991, a number of Brazilian states have adopted EFT from the state to the municipal level in the so called "Ecological Value-Added Tax" (ICMS-Ecológico, in short ICMS-E). To date there are 17 Brazilian states having implemented EFT schemes of which 16 have included explicit indicators relating to protected areas (PAs) in the criteria for tax revenue distribution. This setting provides an opportunity to analyze the effectiveness of the instrument with regard to its economic incentive effect for designating additional PAs.

In Brazil there are two broader categories of designated PAs: strictly protected areas (*proteção integral*) and less land-use restrictive ones that permit sustainable land use (*uso sustentável*). While the first category is essential to protect endangered species and ecosystems and provides services only supplied by healthy and intact ecosystems, the latter category increases the sustainability of e.g. agricultural practices. The benefits of designated PAs are mainly public in nature. However, the designation of further PAs incurs opportunity costs. These are mainly costs to private actors such as land-use restrictions for agriculture, infrastructure, housing and industry. But they also lead to a lower tax revenues for public jurisdictions and incur management costs for administrating bodies. This constitutes a problem of collective action and requires adequate institutions be put in place, defining who should be responsible for the required policies and who should bear their costs. The study of fiscal federalism analyzes how public functions and finance are and should best be distributed among different government levels in federal systems (Boadway & Shah 2009; Musgrave 1959; Oates 1972; Oates 2005; Bird & Smart 2002). The principle of "fiscal equivalence" basically states that those who receive benefits of a policy should also pay for the related costs (Olson 1969)[i]. In case of positive external effects beyond the boundaries of a jurisdiction that is paying for the provision of the relevant public good, this would require compensation payments. To address the issue, fiscal transfers are an adequate instrument to internalize spill-over effects (Bird & Smart 2002; Boadway & Shah 2009; Dahlby 1996; Dur & Staal 2008).

According to the Brazilian constitution the value-added tax (ICMS) is levied by states (Constituição da República Federativa do Brasil Art. 155 II). A quarter of this relevant state revenue is allocated according to the derivation principle, it belongs to the municipalities that generated it (Constituição da República Federativa do Brasil Art. 158 IV). Of this quarter, 75 per cent must be distributed proportionally to the contribution of each municipality to the value added of the state. The remaining 25 per cent (a total of 6.25 per cent) is redistributed to municipalities according to criteria established under state law (e.g. population or agricultural production) (ibid.). The ecological fiscal transfers (*ICMS-E: Imposto sobre Circulação de Mercadorias e Serviços - Ecológico*) introduce ecological criteria to redistribute this share, for instance considering registered PAs on municipal territory.

Differing from state to state the share of the ecological indicator is up to 8 per cent of the municipal value-added tax revenue (2 per cent of total ICMS). The ICMS-E scheme was first implemented to reward municipalities for hosting (federal and state) PAs, later on it was also thought to incentivize municipalities to designate additional municipal PAs (Grieg-Gran 2000; May et al. 2002; Ring 2008b; Loureiro 2002).

The scheme has several interesting attributes: i) it does not require any additional finance since it constitutes a change in the distribution of existing tax revenue – which is particularly interest with regard to the lack of conservation finance and overall budget constraints; ii) it partly decentralizes the decision of where to protect nature, taking into account local preferences and benefiting from local knowledge (Sauquet et al. 2014); iii) it is seen as an incentive for nature conservation and may provide a greater supply of an underprovided public good (Droste 2013; Grieg-Gran 2000; May et al. 2002; Ring 2008b), iv) it potentially benefits low income municipalities that would not receive much (value-added) tax revenue in the absence of the instrument (Grieg-Gran 2000), and v) the transaction costs for implementing such a scheme are considerably low since it represents only a rather marginal change in an existing fiscal transfer scheme (Ring 2008b; Vogel 1997).

EFT have nowadays gained quite some attention outside of Brazil. Portugal has established a municipal EFT scheme in 2007 (Santos et al. 2012). In France, there are compensation schemes for municipalities in core areas of national parks (Borie et al. 2014). In Queensland, Australia, a multi-criteria analysis has been used for the allocation of environmental funds via fiscal transfers (Hajkowicz 2007). For Germany, Switzerland, Indonesia and India EFT schemes have been proposed to be introduced and the consequences simulated (Schröter-Schlaack et al. 2014; Ring 2008a; Kumar & Managi 2009; Mumbunan 2011; Irawan et al. 2014; Köllner et al. 2002; Ring 2002; Czybulka & Luttmann 2005; Perner & Thöne 2007). Farley et al. (2010) even suggest an adaptation to the global level. The studies for countries with implemented EFT schemes mainly focus on the institutional design of the instrument and provide limited empirical evidence of its effects on further PA designation. For Brazil, Saquet et al. (2014) provide a first econometric analysis of the effects of the ICMS-E by analyzing strategic interaction among municipalities in the state of Paraná. The effectiveness of the socio-environmental ICMS in Pernambuco regarding social policies, namely education and health, has been studied by da Silva Júnior and Sobral (2014) with a Markov Chain simulation.

This paper aims to contribute to the literature with an econometric approach that analyses the effectiveness of the instrument on the basis of the introduction of the ICMS-E in 17 Brazilian states over the last two decades. The research question is whether the ICMS-E creates an incentive to designate further PAs or whether it rather functions to compensate for the opportunity costs of nature conservation.

The econometric model estimates the correlation of introducing ICMS-E in Brazil with PA coverage in a panel data setting of all 27 Brazilian states from 1991-2009, controlling for socioeconomic and conservation policy variables. Hypothetically, municipalities are more inclined to increase their municipal-level PAs if these become a source of income via EFT (see section 4.1). The results will give insights about the functioning of the instrument, correlations of other variables with PA coverage, and provide lessons for the design of similar schemes.

The structure of the paper is as follows: Section 2 provides background information on the historical development and institutional details of ICMS-E schemes in Brazil. Section 3 briefly indicates the data source and gathering methods for the subsequent analysis. Section 4 presents a theoretical microeconomic model of the functioning of the instrument and describes the econometric model used to test our hypothesis generated from theory. Section 5 gives the result of the econometric analysis. Section 6 is about the discussion of our findings, their limitations and relevance, followed by our conclusion in section 7.

2 Background

The first ICMS-E scheme was introduced in Paraná after a number of municipalities with PAs for biodiversity conservation or watershed protection areas on their territory exerted pressure on the state government in 1990 (Grieg-Gran 2000). ICMS revenue was largely distributed among the municipalities that generated it while opportunity costs of PAs were not taken into account. Municipalities with PAs faced restrictions on land use and these were perceived as constraints in terms of both development and tax revenue generation. The mayors of the affected municipalities hence argued that complying with such land-use restrictions was difficult and demanded compensation (ibid.). In response, the first EFT scheme with a 5 per cent share of the valued-added tax revenue accounting for the existence of PAs for biodiversity conservation and watershed protection (2.5 per cent each) was implemented in late 1991 by the front-runner Paraná. The rationale for the first scheme was basically compensation for opportunity costs but it soon was thought of as an instrument that could also incentivize nature conservation (Grieg-Gran 2000; May et al. 2002). After Paraná, São Paulo was the next state to introduce an EFT scheme in 1993 (with a relatively low ecological share of 0.5 per cent). Step by step other states followed and implemented similar EFT schemes experimenting with different design options. As can be seen in table 1 the institutional design of the ICMS-E schemes varies among states (cf. The Nature Conservancy, 2014).

In some states the ICMS schemes incorporating environmental indicators are called socio-environmental ICMS (i.e. in Pernambuco and Ceará), and in the latter case it only refers to solid waste management. In Minas Gerais the law that includes the ICMS-E is officially called "Robin Hood Law" because it is designed to transfer tax revenues to poor regions and takes into account several social and environmental criteria (Fundação João Pinheiro 2014). The Robin Hood Law was originally enacted in 1997, revoked in 2000 and re-implemented in 2009 (ibid.). The most commonly used method for determining the amount of EFT to be distributed to local governments largely builds on the pioneering example of Paraná (see equations 1-3). An environmental index EI_i

$$EI_i = \frac{MCF_i}{SCF} \tag{1}$$

is calculated as a ratio of municipality *i*'s protected areas (*PA*) portion of total municipal area (*M*), the Municipal Conservation Factor

$$MCF_i = \frac{PA_i}{M_i} \tag{2}$$

over the sum of all municipalities ratios, the State Conservation Factor

$$SCF = \sum_{i=1}^{n} MCF_i \tag{3}$$

while weighting different PA_i categories according to their contribution to conservation goals (cf. Loureiro, 2002; Loureiro et al., 2008; Ring, 2008a; Sauquet et al., 2014).

Table 1: Introduction time and design of ICMS-E schemes in Brazilian states.

Brazilian states	**Year of first legislation**	**Year of legal enactment**	**Share of value-added tax for protected areas (PAs)**
Rondônia (RO)	1996	2003	5%
Acre (AC)	2004	2010	1% (2010), 2%(2011), 3%(2012), 4%(2013), 5% (from 2014)
Amazonas (AM)	-	-	-
Roraima (RR)	-	-	-
Pará (PA)	2012	2014	2% (2012), 4% (2013), 6% (2014), 8% (from 2015)
Amapá (AM)	1996	1998	1,4%
Tocantins (TO)	2002	2007	3,5%
Maranhão (MA)	-	-	-
Piauí (PI)	2008	2009	overall environmental criteria are 1,5% in 2009; 3,5% in 2010; 5%

			from 2011 (PAs 1 out of 9 environmental criteria)
Ceará (CE)	2007	2008	0% (only solid waste management is considered)
Rio Grande do Norte (RN)	-	-	5%
Paraíba (PB)	2011	not yet	5%
Pernambuco (PE)	2000	2001	1%
Alagoas (AL)	-	-	-
Sergipe (SE)	-	-	-
Bahia (BA)	-	-	1% and from 2011, 1.1%
Minas Gerais (MG)	1995	1997-2000, 2009	PAs 1 of 3 environmental criteria in 1997, was revoked in 2000 and re-enacted in 2009, 0.5% (2010), 0.45% from 2011
Espírito Santo (ES)	-	-	
Rio de Janeiro (RJ)	2007	2009	1% (2009), 1,8% (2010), 2,5% from 2011
São Paulo (SP)	1993	1994	0,5% only accounting for state PAs
Paraná (PR)	1991	1992	2.5% for PAs for biodiversity conservation and 2.5% for PAs for watershed
Santa Catarina (SC)	-	-	-
Rio Grande do Sul (RS)	1997	1998	7%
Mato Grosso do Sul (MS)	1994	2002	2% (2002), 3,5% (2003), 5% (2004)
Mato Grosso (MT)	2000	2002	5%
Goiás (GO)	2011	not yet	
Federal District of Brasilia (DF)	-	-	-

Source: compiled by authors from The Nature Conservancy (2014) and legal acts.

3 Data collection

This study builds on the analysis of legal documents regarding the introduction of state-level ICMS-E schemes and is based on data for PA coverage, socio-economic data of the share of value added by different sectors, population density and per capita GDP. The Nature Conservancy website (2014) on the ICMS-E schemes provides background information and links to the legal documents in which the schemes are specified. We have collected data on both the original state law that basically prepares the legal grounds and on the implementing decrees that actually enact the schemes.

The national cadaster of conservation units (CNUC) of the Brazilian Ministry of the Environment (Ministério do Meio Ambiente 2014a) provides data on PAs recognized within the national system of conservation units (SNUC) with respect to time of enactment, area and related legal acts. We have furthermore consulted the state environmental secretariats' websites for complementing the national cadaster, because the latter relies on input from the governing bodies and apparently is not entirely complete, i.e. with regard to municipal PAs. We only complemented the national cadaster data when a) the category of additional PAs complies with the national system of conservation areas, b) there was data on the area, and c) legal acts were indicated. We then used the i3Geo software of the Brazilian Government (Ministério do Meio Ambiente 2014b) to calculate the terrestrial PA size. We excluded marine PAs. Where we identified a spatial overlap in the available geo-referenced data we computed the overlap free PA share with the following hierarchy: i) in case there is both strict protection and sustainable use area we only accounted for the first; ii) in case there are two PAs of the same category from different government levels we only accounted for the highest government level PA. We thereby compiled a data set of the development of PAs at different government levels and their share of state territory by year among Brazilian states. Note that in Brazil, the local governmental level can also designate municipal-level PAs of all categories.

The governmental Institute for Applied Economic Research (IPEA) provides data on the value added by agriculture, industry, and service, on estimated population density and on GDP per capita of the Brazilian states for 1991-2009 (Instituto de Pesquisa Econômica Aplicada - IPEA 2014). All this data was gathered in a panel data set for the Brazilian states.

3 Theoretical and econometric models

3.1 Theoretical model

The theoretical model of the effects of fiscal transfers is based on (Boadway & Shah 2009, chapter 9) and represents a simplistic microeconomic model of a government body's spending behavior receiving a fiscal transfer (see figure 1). The model substantiates the derivation of hypotheses that are tested in the empirical part (section 4.2 and 5).

The ICMS-E in Brazil is a general budget support based on the share of PA on the municipal territory. When a government body receives such an unconditional general purpose transfer there are no obligations for a particular spending behavior, i.e. they are not ear-marked for specific purposes. Let us consider this in a two good model world. Let Y denote a composite non-nature conservation public good or service and *X* a nature conservation public good or service that both can be supplied by a government body by some sort of public expenditure. Let there be a budget constraint *BC* representing the amount that can be spent based on relative prices and a utility indifference curve *I* based on the utility gained by the satisfaction of preferences and the marginal rate of substitution among these two goods. A (bounded) rational government would maximize its utility where the marginal rate of substitution equals the budget constraint (see point A in figure 1). A general purpose transfer to this government shifts the budget constraint outwards, e.g. from BC_1 to BC_2. The government's budget increases with the transfer as does spending on both goods. Now, the ICMS-E is a general purpose transfer based on a particular public service, namely the existence of PAs on the territory of the municipality. This represents a price change in terms of relative prices since every unit of PA will be rewarded and a PA designation therefore has lower opportunity costs than without the instrument. In our model world this can be seen as the price change (BC_2 to BC_3). The spending effect of such a shift will reduce spending on *Y* (Y_2 to Y_3) and increase spending on *X*. Comparing the initial state without the fiscal transfer (point A) and the state with fiscal transfers (point C) spending on both goods increases. The effect of the fiscal transfers can be decomposed into two partial effects, namely the outward shift of the budget constraint and the price change. The empirical outcomes inter alia depend on the real structure in preferences, relative prices, marginal rates of substitution, and extent of rationality applied. Real world outcomes may be more complex than this simplified model suggests.

Nevertheless, the hypothesis that we derive from this model is that if there is an ICMS-E scheme in place municipal governments receiving the EFT will increase spending on both non-nature conservation and nature conservation. We suppose that such an increased spending on nature conservation should to some extent be reflected in an increased share of PA on the municipal territory, i.e. because they constitute a source of additional income. But EFT might also decrease the municipal resistance to accepting a state or federal PA on municipal territory due to the 'price effect' of lower opportunity costs for hosting PAs. Therefore, we hypothesize that in states and years where there is an ICMS-E scheme in place a higher (municipal) share of PAs should be observed.

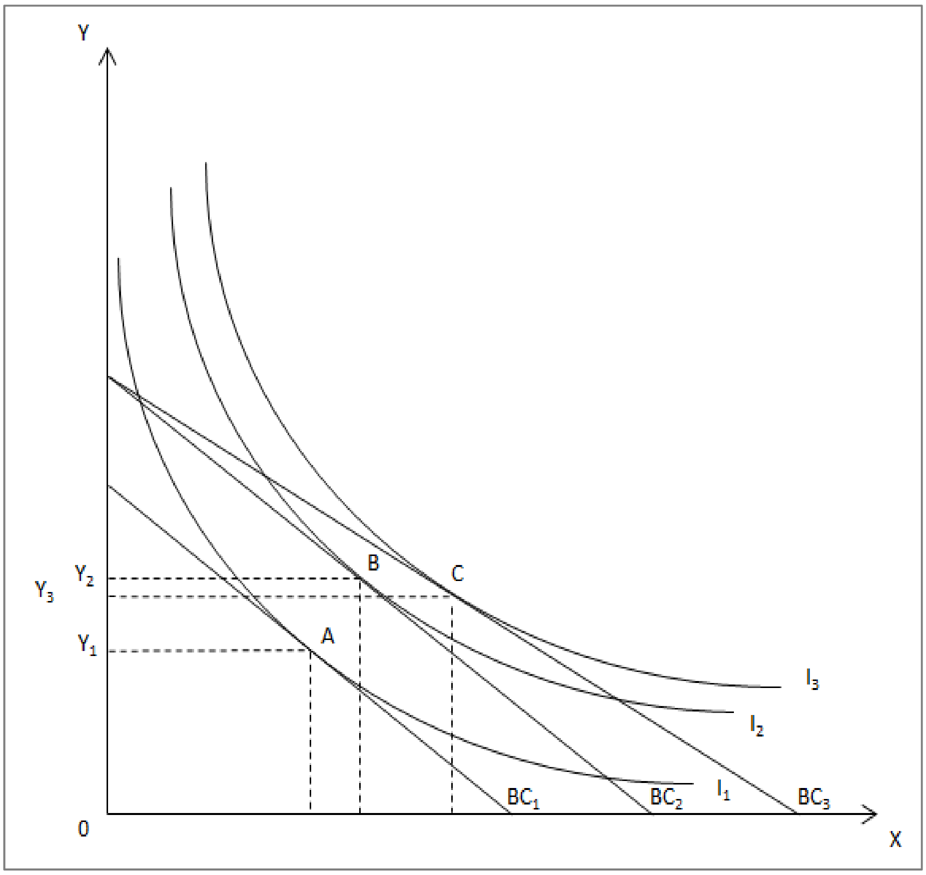

Fig. 1: Government spending behavior after introduction of fiscal transfers. Source: authors' work adapted from Boadway & Shah (2009, chap.9).

3.2 Econometric model

The econometric model estimates the correlation of ICMS-E schemes with nature conservation area share with fixed and random effects regressions controlling for other conservation instruments, biomes, and socio-economic variables for land-use pressure such as the share of value added by agriculture, service, industry, population density, and GDP per capita. The general structure of the regression is as outlined in equation 4.

$$\begin{aligned}\mathrm{PA}_{\mathrm{it}} &= \beta_0 + \beta_1 \mathrm{icms\_e}_{\mathrm{it}} + \beta_2 \mathrm{agr}_{\mathrm{it}} + \beta_3 \mathrm{ind}_{\mathrm{it}} + \beta_4 \mathrm{ser}_5 \\ &+ \beta_5 \mathrm{pop}_{\mathrm{it}} + \beta_6 \mathrm{inc}_{\mathrm{it}} + \beta_7 \mathrm{arpa}_{\mathrm{it}} + \beta_8 \mathrm{oPA}_{\mathrm{it}} + \beta_9 \mathrm{biome}_{\mathrm{ji}} \\ &+ \beta_{01}\ \mathrm{year} + \beta_{11} \mathrm{int}_{\mathrm{it}} + \mu_{\mathrm{i}} + \lambda_{\mathrm{t}} + \varepsilon_{\mathrm{it}}\end{aligned} \tag{4}$$

where $i = 1,\ldots,n$ indexes the Brazilian state and $t = 1,\ldots,T$ indexes years, and $j=1,\ldots,k$ indexes the biomes. PA_{it} is the share of PAs in year t of total territory of state i in per cent which will either be PA total (*PAtot*), federal (*PAfed*), state (*PAsta*) or municipal (*PAmun*) PA share[ii]. The policy variable *icms_e* is a dummy with the value of 1 in case of an existing ICMS-E scheme in state i in year t and 0 if otherwise. The socio-economic controls for states i and years t, agriculture *agr*, industry *ind*, and service *ser*, are the per cent shares of total value added by these three sectors (at constant prices of year 2000); *pop* is population density in inhabitants per km^2, and *inc* is GDP per capita at constant prices of year 2000[iii]. *arpa* is a dummy variable for the ARPA policy for PAs in the Amazon with a value of 1 in case of implementation in state i in year t and 0 if otherwise. Other PA *oPA* is only included when regressing federal, state or municipal PAs on the explanatory variables and consists of a vector of the other two PA share variables, e.g. federal level PA share *PAfed*, and state level PA share *PAsta* in case of a regression of municipal PA share *PAmun* on the controls. The vector of dummy variables *biome* indicates a large share of any of the 6 different biomes of Brazil in state i: Amazon (*ama*), Cerrado (*cer*), Caatinga (*caa*), Atlantic Forest (*mat*), Pantanal (*pan*), and Pampa (*pam*) which can be overlapping in case a state has different biomes[iv]. The continuous *year* variable is included only in individual fixed or random fixed regressions to detrend the development of PA designations. Variable *int* stands for a vector of interaction variables of the above-mentioned *icms_e* and the socio-economic control variables. The error terms are: μ_i = individual error term, λ_t = time specific error term, and ε_{it} = idiosyncratic error term – which are not always all included depending on whether it is a one- (individual specific) or twoway (individual and time specific) effects regression (Croissant & Millo 2008). The usual tests apply. The panel is balanced with n=27 for the 26 Brazilian states and the federal district of Brasilia, T=19 for the years 1991-2009, and N=513 for total observation. Hypothetically, states may have an incentive to enhance PA coverage if PAs become a source of income by the EFT scheme – hence, we should be able to observe a correlation of ICMS-E with PA coverage (H_1). The null-hypothesis (H_0) is that an increase in budget due to ICMS-E does not correlate with PA coverage – which could mean that the additional ICMS-E income has very likely been spent on different non-nature conservation public services.

The regressions are computed with the **plm** package (Croissant & Millo 2008) in **R** (R Development Core Team 2013) with either fixed or random effects regressions to control for unobserved individual heterogeneity such as state preferences for nature conservation and unobserved time-variant heterogeneity such as common shocks (cf. Wooldridge 2010, chapter 10,11). Standard errors are computed with covariance matrix estimators robust to heteroskedasticity, serial and spatial (cross-sectional) correlation, with a maximum lag window of m(T)=2 (Driscoll & Kraay 1998; Millo 2014b) and heteroskedasticity consistent covariance estimation type 3 (Zeileis 2004; Long & Ervin 2000).

4 Results

We estimate the effect of ICMS-E schemes and several political, socio-economic and geographic indicators on the average PA share of 26 Brazilian states plus the federal district for the years 1991-2009. Summary statistics are provided in the appendix. For both regressions of total PA share and municipal level PA share (tables 2-3), we start with a simple model including the socio-economic control variables (model 1) in which we add-in further control variables for the biomes (model 2), the continuous year variable (model 3), and interaction terms (model 4).

Table 2: Overall protected area share and ICMS-E

Dependent variable: ln of total protected area share *PAtot* in percent of total area				
model:	(1)	(2)	(3)	(4)
variables:				
icms_e	0.263	0.370*	1.102***	-4.424
	(0.211)	(0.190)	(0.312)	(4.105)
ln(agr)	-0.221***	-0.204***	-0.268***	-0.285***
	(0.076)	(0.065)	(0.079)	(0.090)
ln(ind)	0.131	0.046	0.044	0.018
	(0.110)	(0.115)	(0.128)	(0.140)
ln(ser)	-0.709	-0.092	-0.565	-0.625
	(0.451)	(0.400)	(0.381)	(0.391)
ln(pop)	-0.556	-0.066	-0.253***	-0.219**
	(0.722)	(0.077)	(0.086)	(0.105)
ln(inc)	1.323***	1.257***	0.764*	0.775*
	(0.147)	(0.369)	(0.432)	(0.419)
arpa	-0.192	-0.144	-0.156	-0.164
	(0.208)	(0.192)	(0.167)	(0.197)
ama		2.033**	1.745*	1.793*
		(0.842)	(1.055)	(1.063)
cer		0.915***	0.994***	1.025***
		(0.138)	(0.245)	(0.306)

caa		0.154	-0.140	-0.151
		(0.204)	(0.204)	(0.267)
mat		-0.182	0.063	0.125
		(0.530)	(0.704)	(0.684)
pan		-2.602**	-2.505	-2.497
		(1.320)	(1.933)	(2.042)
pam		-0.735**	-0.604	-0.543
		(0.354)	(0.527)	(0.433)
year			0.098***	0.098***
			(0.010)	(0.011)
icms_e*year			-0.059***	-0.055***
			(0.011)	(0.015)
icms_e*ln(agr)				0.279
				(0.209)
icms_e*ln(ind)				0.423
				(0.395)
icms_e*ln(ser)				1.198
				(0.889)
icms_e*ln(pop)				0.003
				(0.116)
icms_e*ln(inc)				-0.743
				(0.641)
intercept		-0.478	2.040	2.273
		(1.710)	(1.406)	(1.665)
effects	*twoway fe*	*twoway re*	*individual re*	*individual re*
adj. R^2	0.08	0.26	0.56	0.57

The panel data sample is balanced with n=27, T=19, N=513. Robust standard errors are reported in parenthesis below the estimated coefficients. Individual coefficients are indicated with *10%, **5% or ***1% significance levels. Models specifications are fixed effects (fe) or random effects (re).

We find a significant and negative correlation of *ln(agr)* and a significant positive correlation of *ln(inc)* with the logarithm of PA-share *ln(PAtot)*. We furthermore find structural differences of how much nature is conserved among the biomes of Brazil. As soon as the biome dummies are included the explanatory power of the model increases much and the positive correlation of *icms_e* with the overall PA share becomes significant (model 2). The continuous *year* variable is positively and significantly correlated and its interaction term with *icms_e* is negatively and significantly correlated (model 3). Furthermore, *ln(pop)* has a negative and significant correlation when *year* and it's interaction term are included (model 3). An inclusion of further interaction terms of *icms_e* with socio-economic controls does not yield any significant correlation (Model 4).

Table 3: Municipal level protected area share and ICMS-E

Dependent variable: ln of municipal protected area share in percent of total area				
model:	(1)	(2)	(3)	(4)
variables:				
icms_e	0.849***	0.869***	0.549	12.356
	(0.208)	(0.164)	(0.466)	(26.215)
ln(agr)	0.931***	1.093***	1.053***	0.803***
	(0.328)	(0.264)	(0.261)	(0.199)
ln(ind)	-1.508**	-1.120**	-1.163**	-1.305***
	(0.743)	(0.551)	(0.534)	(0.452)
ln(ser)	0.603	1.777	0.856	0.181
	(2.104)	(1.499)	(1.986)	(1.751)
ln(pop)	3.468*	1.735***	1.164*	1.294*
	(1.967)	(0.625)	(0.678)	(0.686)
ln(inc)	2.199***	2.142***	1.142*	0.198
	(0.682)	(0.771)	(0.678)	(0.461)
ln(fed)	0.640***	0.728***	0.642***	0.607***
	(0.204)	(0.152)	(0.135)	(0.133)
ln(sta)	0.138	0.158	0.118	0.074
	(0.110)	(0.103)	(0.141)	(0.143)
arpa	0.132	0.506	0.468	1.168***
	(0.539)	(0.326)	(0.353)	(0.445)
ama		-1.553	-2.117	-2.497
		(2.583)	(2.137)	(1.744)
cer		-3.954***	-3.646***	-3.732***
		(1.160)	(1.324)	(0.906)
caa		0.573	-0.107	-1.142
		(2.312)	(1.961)	(1.779)
mat		2.476	3.427*	3.678**
		(1.639)	(2.049)	(1.706)
pan		4.626	4.311	3.088
		(6.226)	(6.771)	(2.547)
pam		-1.949	-1.936	-3.959*
		(2.365)	(2.503)	(2.323)
year			0.066	0.082*
			(0.061)	(0.048)
icms_e*year			0.019	0.070**
			(0.027)	(0.029)
icms_e*ln(agr)				-0.953*
				(0.527)
icms_e*ln(ind)				-0.016
				(2.415)
icms_e*ln(ser)				-2.066
				(4.180)
icms_e*ln(pop)				-1.697***

				(0.621)
icms_e*ln(inc)				3.363*
				(1.967)
icms_e*ln(fed)				-1.941***
				(0.616)
icms_e*ln(sta)				-0.819**
				(0.392)
intercept		-21.515***	-14.818	-9.376
		(6.777)	(9.566)	(7.933)
effects	*individual fe*	*individual re*	*individual re*	*individual re*
adj. R^2	0.34	0.36	0.36	0.42

The panel data sample is balanced with n=27, T=19, N=513. Robust standard errors are reported in parenthesis below the estimated coefficients. Individual coefficients are indicated with *10%, **5% or ***1% significance levels. Models specifications are fixed effects (fe) or random effects (re).

Regarding the effect of the ICMS-E on municipal-level PA designation, we find a positive and significant correlation of *ln(agr)*, *ln(pop)*, and *ln(inc)*, and a negative significant correlation of *ln(ind)* with the municipal PA-share (model 1 and 2). We furthermore find a positive significant correlation of the natural logarithm of federal level PA-share *ln(fed)*. Once the interactions with other socio-economic controls are included the picture becomes more complex, e.g. both the time trend and its interaction term show a significant and positive correlation (model 3), the interactions with *ln(agr)*, *ln(pop)*, *ln(fed)*, and *ln(sta)* are significant and negative, the interaction with *ln(inc)* is positively and significantly correlated (model 4).

5 Discussion

First of all, there are some methodological remarks to consider. Generally, the panel data setting with time and individual effects would allow for estimating causal effects, or the ‘average treatment effect on the treated’ with Brazilian states self-selecting into ‘treatment’ of implementing ICMS-E schemes (see e.g. Woolridge 2010, chapter 18 for a discussion of causal effects estimations). This analysis of the IMCS-E effects, however, is among the very first of its kind and there are no reference models neither on causal factors for protected area designation nor on the causal effects of policies such as ICMS-E schemes on protected area coverage (except to some extent Sauquet et al. 2014 who focus on spatial interaction). We therefore tend to be cautious on the issue and speak of an observed correlation rather than a causal effect.

With regard to the coefficients and their magnitude we also tend to be cautious and will not elaborate too much on the strength of the marginal effects[v] of introducing ICMS-E schemes, i.e. because we know that there is data missing for municipal PAs and this may bias estimations (see below for further limitations). For the purpose of illustrating the apparent functioning of the ICMS-E schemes we mainly elaborate on the direction of correlations, that is to say the signs and significance. Figure 2 furthermore provides an overview about interactions which we discuss for some examples found in the data in more detail. Consider the ICMS-E dummy variable D in Figure 2. If there is an interaction with IMCS-E this means that the intercept will be $\beta_0 + \beta_1$ and the slope $\beta_2 + \beta_4$, and for the cases where there is no ICMS-E it will be β_0 and β_2, respectively.

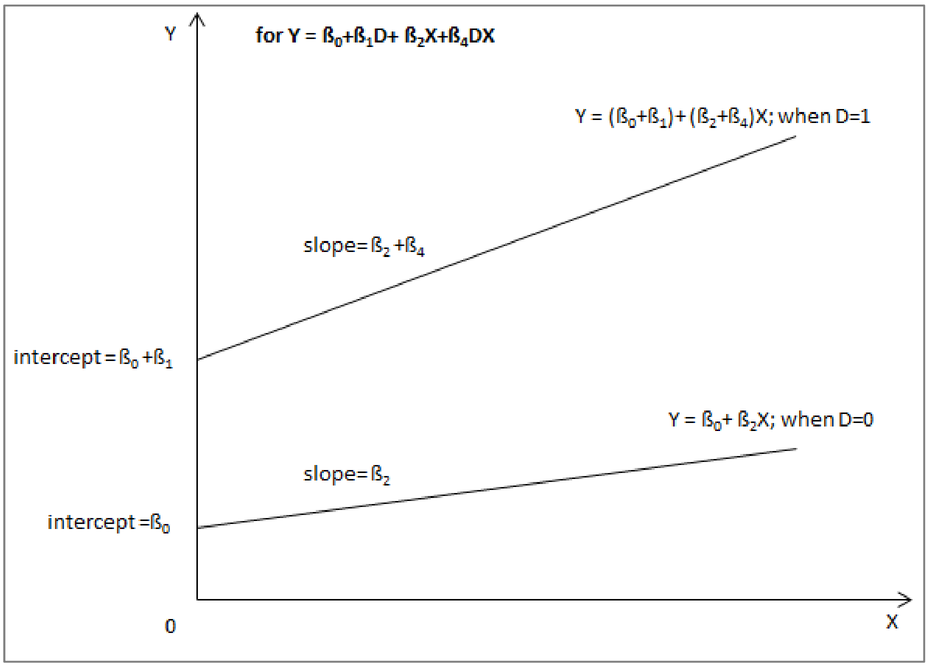

Figure 2: The inaction of the ICMS-E dummy variable D with a continuous variable. Source: authors' work adapted from (Brambor 2005)

In the following we discuss both the overall PA share and municipal PA share regressions as well as some overarching issues such as reverse causality and inferences.

Overall PA share regressions: We find that there is positive and significant correlation of the existence of an ICMS-E scheme with overall PA share among Brazilian states for the years 1991-2009. This means on average there is a higher PA ratio in states and years with an ICMS-E scheme in place.

Furthermore, we find one significant correlation in almost all regressions: a positive correlation of PA coverage with GDP per capita. This means on average, where and when there is a higher per capita income more PAs are observed. A potential explanation may be that nature conservation is not the first thing to think about when there is no or little income available. Once basic needs are covered a healthy environment becomes more important. Above all, we also find a negative and significant correlation of population density and overall PA coverage (see model 3 in table 2). Where there is more land available for protection, i.e. where fewer people live, there are on average higher shares of PAs.

Municipal PA share regressions: On the municipal level the regressions reveal complex patterns. We find a positive and significant correlation of the share of value added by agriculture, population density and GDP per capita, and a negative significant correlation of the share of value added by industry with the municipal PA-share. On average the share of value added by industry constitutes the highest opportunity costs for municipal PA designation. Contrasting the findings on total PA coverage municipalities with high population density more often designate PAs. When interaction terms with socio-economic controls are included the coefficients of the ICMS-E interaction with both agriculture and population density are significant and slightly negative. Thus, where there is an ICMS-E scheme in place the correlation with both is negative. Considering Figure 2 one can interpret the correlation of agriculture with municipal PA share ($\beta_{ln(agr)}$=0.803) where there is an ICMS-E scheme ($\beta_{icms\_e*ln(agr)}$=-0.953) as slightly negative ($\beta_{ln(agr)}+\beta_{icms\_e*ln(agr)}$=-0.153). A similar pattern applies to the correlation of population density ($\beta_{ln(pop)}+\beta_{icms\_e*ln(pop)}$=1.294-1.697=-0.403). A reverse pattern applies to GDP per capita ($\beta_{ln(inc)}+\beta_{icms\_e*ln(inc)}$=0.198+3.363=3.561)[vi]. There is an increasing return of PA on GDP per capita. Additionally, we find a positive significant correlation of federal level PA-share with municipal level PA-share and a significant negative interaction of federal level PA coverage with ICMS-E schemes. This means that on average, the ICMS-E creates a crowding out effect of federal (and state) PAs on municipal PAs – which constitutes some sort of government level competition. This pattern does not exist when there is no ICMS-E scheme in place. Considering that on average there is a lower total PA share in states and years without ICMS-E (table 2), this crowding out pattern may relate to the relative scarcity of available area and becomes only apparent once there is no longer abundant area available for conservation.

Overarching issues: There are positive and significant correlations of ICMS-E schemes with both total and municipal PA coverage. But this may relate to a reverse causal effect such as that of the introduction of ICMS-E following the designation of a large share of PAs instead of the ICMS-E providing an incentive to designate additional PAs.

Therefore we included a continuous time variable to detrend the data and an interaction of the ICMS-E dummy with the time variable. For total PA coverage the time variable is positively and significantly correlated and its interaction term with ICMS-E is negatively and significantly correlated (table 2). This means that the average yearly increases in overall PA share is lower once an ICMS-E scheme is in place. Although this may also be due to a increasing opportunity costs of additional PA designation, the reverse causal relation cannot be ruled out for the overall PA share. ICMS-E may be a consequence of an above average designation of federal and state level PAs. The additional budget may hence compensate for the corresponding land-use restrictions and thus changes the mind-set of local governments that previously commonly perceived PAs as an obstacle to economic development.

Indeed, for municipal PA coverage the pattern is different. Both the time variable and its interaction term have positive and significant coefficients. This means that the average yearly increase in municipal PA share increases once there is an ICMS-E scheme. This clearly indicates an incentive effect for municipalities to designate additional PAs when there an EFT scheme is in place. By acknowledging the spillover benefits of conservation, and thus compensating for the local costs associated with conservation, the provision of the public good municipal PAs is increased.

Altogether, this means that the hypothesis we derived from the simplistic microeconomic model presented in section 4.1 can be confirmed. Although the ICMS-E schemes may be a consequence of a high overall share of PAs, on average there is an incentive to designate additional municipal PAs through the fiscal transfers that provide additional municipal budget for the existence of PAs. This also means a decentralization effect regarding the location of further PAs because they are designated at municipal level.

Last, but not least we also have to comment on the limitations of our analytical approach. Although we used the most complete data available there may be missing data points, i.e. for municipal protected areas. We found indications that there are more municipal PAs, but could not gather information on their area, year of enactment or legal acts and therefore refrained from including these. We consider this a potential source for biased estimates. Although we have computed standard errors robust to spatial or cross-sectional and serial dependence (Millo 2014b; Driscoll & Kraay 1998) which are quite conservative, this might still be a potential source of biased estimates (cf. King & Roberts 2012). A task for future research is to employ spatial estimations for panel data (cf. Millo 2014a) regarding the ICMS-E schemes in Brazil. We also did not include a continuous variable of ICMS-E schemes that accounts for the different institutional designs (see table 1) and could give evidence of the strength of different ICMS percentages since it is not in all cases clear how much percentage is finally dedicated for the existence of PAs (i.e. for Piauí). One particular aspect is worth mentioning, since the quantitative analysis conducted does not take into account the quality of the management of PAs. Only in Paraná there are already quality criteria included in the ICMS-E law (Loureiro et al. 2008). The fact that the ICMS-E apparently leads to an increase in PAs does not necessarily mean that the current land-use practice is altered much – although we suspect that the designation of a PA helps nature conservation in general goals, the topic of management quality has not been touched upon by our analysis.

5 Conclusion

We analyzed the effect of introducing ecological fiscal transfers in Brazilian states for a panel data covering the years 1991 to 2009, following the pioneering introduction of IMCS-E in Paraná. Our research question was whether the ICMS-E creates an incentive to designate further PA. We presented a simplifying microeconomic model and tested the derived hypothesis econometrically controlling for unobserved individual and time effects, socio-economic variables and conservation policies (such as ARPA).

We find that the introduction of ICMS-E schemes on average corresponds, ceteris paribus, with higher total PA coverage. This may be a consequence of an ICMS-E introduction following a high PA share, so to say a compensation for hosting other government level PAs. On the municipal level there are clear indications for an incentive effect to designate additional PAs. This signals a decentralizing effect for nature conservation.

We thereby have contributed to the literature with a first comprehensive econometric approach covering all Brazilian states and provide insights by providing a first estimation of the effects of introducing ICMS-E schemes among these states on PA designation. The results of this study may advance the design of EFT schemes in other Brazilian states or other nations. These findings are particularly relevant for countries in which an introduction might be expected (e.g. Germany, Poland) or is already in place (Portugal) (cf. Schröter-Schlaack et al., 2014). Especially since EFT schemes do not require any additional budget but constitute a (rather marginal) change in the allocation of tax revenue they are relatively easy to implement. With regard to the shortage in public budgets especially at local levels and the shortfall of conservation budgets EFT schemes are of eminent relevance for conservation policies. Ecological fiscal transfers can help the implementation of (inter)national biodiversity targets such as the Aichi targets, the goals of the EU Biodiversity strategy, and national biodiversity strategies and action plans.

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[i] This principle basically internalizes external effects of public policy. In case of spill-over effects to other regions a more centralized government might be better suited to take account of the relevant public goods and services to avoid them being underprovided.

[ii] In case of state and municipal PAs there are reasonable zeros in the data. We added a constant *c* of half the minimum observed value for each state and municipal data to allow for log transformation.

[iii] The data was given in year 2010 prices and has been recalculated with consumer price indexes (IBGE, 2015).

[iv] The value of the biome dummies is set according to the following categorization (see table 1 for abbreviation of the states): RO=ama, AC=ama, AM=ama, RR=ama, PA=ama, AP=ama, TO=cer, MA=ama&cer, PI=cer&caa, CER=caa, RN=caa, PB=caa, PE=caa, AL=caa, BA=cer,caa&mat, MG=cer&mat, ES=mat, RJ=mat, SP=cer&mat, PR=mat, SC=mat, RS=mat&pam, MS=cer&pan, MT=ama,cer&pan, GO=cer, and DF=cer.

[v] When both dependent and independent variables are log transformed, the coefficients can be interpreted as a percentage change, say a 1 % change in *agr* corresponds to a $[(1.01)^{\beta_1} - 1]*100$ percentage change in *PAtot* holding everything else constant, for $PAtot = \beta_0 + \beta_1 \text{agr} + u_i$. Note, however, that coefficients of binary variables have to be interpreted as a $100[\exp(c - 1/2\hat{v}(\hat{c})) - 1]$, where $\hat{v}(\hat{c})$ is the estimated variance of $\hat{c}$ or the square of the standard error (Kennedy 1981; Giles 2011).

[vi] One has to consider that the coefficient on GDP per capita (*inc*) is not significant when the interaction is included. Nevertheless, the interaction coefficient of *icms_e* and *inc* alone is greater than the coefficient of *inc* when there are no interaction terms included (e.g. model 2 in table 2).

Appendix

Table 4: Descriptive statistics

Variable	Mean	St. Dev.	Min	Max	N
year	2000	5.5	1991	2009	513
total protected area share of state territory in per cent (PAtot)	11.2	15.2	0.05	98.9	513
federal protected area share of state territory in per cent (PAfed)	6.9	12.9	0.03	92.9	513
state protected area share of state territory in per cent (PAsta)	4.0	4.9	0.0	22.8	513
municipal protected area share of state territory in per cent (PAmun)	0.2	1.1	0.0	7.5	513
ICMS-E dummy (icms_e)	0.2	0.4	0	1	513
share of valued added by agriculture in per cent (agr)	10.7	7.2	0.2	41.5	513
share of valued added by industry in per cent (ser)	27.7	11.5	3.6	66.1	513
share of valued added by service in per cent (ind)	61.5	12.5	31.7	96.0	513
population density cap/km² (pop)	26.3	31.5	0.9	174.2	513
GDP per capita, R$ in thousands (inc)	6.6	4.4	2.1	27.5	513
ARPA program dummy (arpa)	0.1	0.3	0	1	513
Amazon biome dummy (ama)	0.3	0.5	0	1	513
Cerrado biome dummy (cer)	0.4	0.5	0	1	513
Caatinga biome dummy (caa)	0.3	0.5	0	1	513
Mata atlantica biome dummy (mat)	0.3	0.5	0	1	513
Pantanal biome dummy (pan)	0.1	0.3	0	1	513
Pampa biome dummy (pam)	0.04	0.2	0	1	513

Source: authors' calculation based on The Nature Conservancy (2014) and IPEA (2014). Monetary values in constant prices (2000R$).

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