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# Integrating Ecological Indicators into Federal-State Fiscal Relations: A policy design study for Germany

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ABSTRACT
Protected areas (PA) provide conservation benefits and ecosystem services that spill over the boundaries of jurisdictions to other regions. In this paper we analyse the foundations of and design options for ecological fiscal transfers (EFT) that may internalize such positive external effects. We propose a model for integrating ecological indicators into the intergovernmental fiscal transfer system between federal and state-level governments in Germany. Our approach is performance oriented and would thus compensate those states that designate an above-average share of their area for nature conservation purposes. The suggested EFT design builds upon the existing fiscal equalization system and complies with the legal requirements for indicators determining fiscal needs. We employ an econometric analysis to demonstrate that, on average, sparsely populated states in Germany provide more PA per capita and would thus be eligible for increased fiscal transfers. A quantitative model of the fiscal transfer scheme is then used to estimate the marginal financial effects of integrating ecological indicators into federal–state fiscal relations in Germany. Moving beyond the specific case presented, we discuss the implications in terms of the specific role of EFT as a policy instrument within the broader conservation policy mix. Copyright © 2017 John Wiley & Sons, Ltd and ERP Environment

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## Introduction

THE UNPRECEDENTED SCALE OF BIODIVERSITY LOSS AND ECOSYSTEM DEGRADATION HAS INCREASINGLY COME TO LIGHT (MEA, 2005). IN many respects, this can be considered a problem of undersupplied public goods and services (Perrings and Gadgil, 2003). The benefits of biodiversity and ecosystem conservation have not yet been sufficiently integrated into decision making (Daily *et al.*, 2009; TEEB, 2011). As a result of such insights, the role,

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functioning and interplay of conservation policy instruments have started to attract greater attention from concerned individuals and institutions in society, politics and academia (Larigauderie and Mooney, 2010; Nesshöver *et al.*, 2016; Ring and Barton, 2015). Within the conservation policy mix, different policy instruments address different groups of actors: payments for environmental services (PES) address private land users, while ecological fiscal transfers (EFT) address public actors in their role as providers of environmental public goods (Ring and Schröter-Schlaack, 2015).

EFT close an important gap in the policy mix by internalizing conservation costs and benefits within the decision-making rationale of public actors. While the designation of protected areas (PA) builds on nature conservation laws, i.e. regulatory instruments, economic instruments such as EFT to local and state governments modify fiscal transfer schemes by considering PA as an additional indicator for distributing public money across governmental levels. In this way EFT change the nature of the incentives inherent in fiscal transfer schemes and help to create among public actors a mind-set more favourable to biodiversity conservation (Santos *et al.*, 2015). EFT in Brazil and Portugal compensate decentralized governments for management and/or opportunity costs entailed by hosting PA. Thus, EFT acknowledge fiscal needs for existing PA and provide incentives to designate additional PA (Droste *et al.*, 2017, 2016a; Ring, 2008c; Grieg-Gran, 2000, Loureiro, 2002; May *et al.*, 2002) and may improve the management of existing PA (Loureiro *et al.*, 2008). This is particularly important in view of the severe biodiversity conservation funding shortfalls in relation to politically set targets (McCarthy *et al.*, 2012). Scaling up the finance mechanism for biodiversity is gaining increasing momentum and EFT schemes have more recently been considered as one of the necessary ingredients of environmental fiscal reforms around the globe (OECD, 2013). Internalizing intergovernmental spillover benefits from conservation at local levels (Ring, 2008b) may help reach the above-mentioned political standards for biodiversity conservation, since external effects are – at least partly – reduced (see Baumol and Oates, 1971, for a similar argument regarding the internalization of environmental damage costs).

Proposals for EFT have been put forward for Switzerland (Köllner *et al.*, 2002), Poland (Schröter-Schlaack *et al.*, 2014), Indonesia (Irawan *et al.*, 2014; Mumbunan, 2011), India (Kumar and Managi, 2009) and the state of Saxony in Germany (Ring, 2008a). Moreover, Farley *et al.* (2010) discuss the possibility of upscaling the transfer mechanism to the global level (as so-called International Payments for Ecosystem Services). In practice, only 'national or state to *municipal* level' EFT have been implemented. In federalist countries such as Brazil and Germany, or countries with more than two government levels, intergovernmental fiscal transfers exist between the federal (i.e. national) and the *state* (or regional) level, providing the states (or regions) with financial resources to fulfil their respective public functions. Very often, such state governments play an important role in nature conservation and the designation and/or management of protected areas. It therefore follows that EFT also need to be considered in federal–state (or nation–region) fiscal relations. So far, few concrete proposals for incorporating EFT policy into federal–state fiscal relations have been put forward, for example, for Brazil. Building on the so-called FPE Verde, Cassola (2011, 2014) has modeled and presented EFT policy options that integrate PA-related indicators into the State Participation Fund (Fundo de Participação dos Estados – FPE), a major fund for tax revenue distribution between the federal and the state level in Brazil.

Against this background, we seek to elaborate on the possibility of integrating ecological indicators into federal–state fiscal relations and use the German fiscal transfer system as an example. Our analysis proceeds in the following way: after elucidating the general rationale of (ecological) fiscal transfers in the following section, we implement a three-step approach to policy analysis that was developed especially to take account of the institutional embedding of policy instruments as well as their interplay (Ring and Schröter-Schlaack, 2015, pp. 148 ff.). The *first step* is to identify the institutional context (third section). Here, we elaborate on both the German institutional context of nature conservation, in particular the importance of state governments for nature conservation, and the (potential) role of (ecological) fiscal transfers. The *second step* is to identify knowledge gaps and choose methods for analysing them (fourth section): we develop empirical arguments to justify the integration of conservation-related indicators into the German fiscal transfer system at federal level. The *third step* is to evaluate policy instrument design options (fifth section). Here, we employ a quantitative benchmark factor model based on different PA-related ecological indicators (see Schröter-Schlaack *et al.*, 2013). In the sixth section, we broaden the scope beyond these case specifics, discussing EFT design options and their implications, which are also of general relevance for other institutional contexts. The seventh section concludes with a brief reflection of lessons learnt for federal–state fiscal relations regarding EFT.



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## Rationales for Fiscal Transfers and the Integration of Ecological Indicators

Generally, *intergovernmental fiscal transfers* redistribute public revenue among different governmental levels. In the language of public finance, a key purpose of fiscal transfer schemes is to address fiscal imbalances, or budget gaps (cf. Sharma, 2012, for a discussion of the issue). These imbalances are addressed by (partially) closing the gap between fiscal capacity and fiscal need so that the relevant jurisdictions at all governmental levels can fulfil their public functions (Boadway and Shah, 2009). In addition to this, however, there are efficiency considerations: the theory of fiscal federalism (Boadway and Shah, 2009; Musgrave, 1959; Oates, 2005, 1999, 1972) argues for an efficient assignment of public functions and concomitant allocation of revenues to different levels of government. Generalizing this idea, the 'principle of fiscal equivalence' has been defined as achieving a 'match between those who receive the benefits of a collective good and those who pay for it' (Olson, 1969, p. 483). In the case of regional spillover effects from one administration to the other (or economies of scale in the provision of public goods), there are two ways of internalizing these external effects: (i) centralized government provision or (ii) fiscal transfers (either horizontally at the same level of government or vertically via central government grants to lower levels).

These general principles also apply to EFT. Conservation entails both administrative and opportunity costs; the related 'ecological public functions' (Ring, 2002) involve interjurisdictional spillovers. Goods and (ecosystem) services with a large geographic range, such as biodiversity conservation and climate change mitigation, and medium-range cultural and other services, benefit parties beyond those involved in conservation efforts (ten Brink *et al.*, 2013). Such interjurisdictional spillovers constitute positive external effects. Costs and benefits are therefore distributed unequally, leading to a suboptimal level of supply. Compensatory mechanisms that address nature conservation activities supplied by decentralized government agencies could hence increase efficiency and social welfare (Ring, 2008b).

Both existing and proposed EFT schemes most commonly integrate ecological indicators for conservation efforts into fiscal transfer schemes such that a portion of tax revenue is redistributed according to these indicators. There is a trade-off between the (ecological) accuracy of an indicator and the rather low level of complexity required to calculate transfers based on continually available data (Schröter-Schlaack *et al.*, 2014). Hence, all existing EFT schemes in Brazil, Portugal and, to some extent, France use the coverage and category of PA as their main ecological indicator (Borie *et al.*, 2014; Grieg-Gran, 2000; Loureiro, 2002; May *et al.*, 2002; Ring, 2008c; Santos *et al.*, 2012; Sauquet *et al.*, 2014; Schröter-Schlaack *et al.*, 2014). This compensates the hosting administration for the costs incurred and creates incentives for designating additional PA (Sauquet *et al.*, 2014; Droste *et al.*, 2017).

## Institutional Context of Nature Conservation and Ecological Fiscal Transfers in Germany

In line with the *first step of the policy analysis*, we begin by analysing the institutional context. Germany is a federalist state comprising 16 states including three city states (Berlin, Hamburg and Bremen), the so-called *Länder* (Preamble and Art. 20 I German Constitution, also called Basic Law). According to Article 72 *et seq.* of the Basic Law the federal level of government has comprehensive legislative powers by which it can create a unified legal framework in many fields of law. The *Länder* are responsible for the execution and implementation of federal laws (Art. 83 Basic Law). This holds true for the designation and management of most PA categories in Germany, including Natura 2000 sites. The *Länder* thus have a key role in financing and implementing nature conservation, as they need to provide the necessary administrative capacity and funding to (at least partially) endow support programmes for private landholders. Annual costs for implementing and managing the Natura 2000 network alone have been estimated to be around €620 million for Germany (Gantioler *et al.*, 2010). Fiscal transfers are an important source of income for the *Länder*, as they provide up to 28% of the total state budget per capita (see Table 3 later). An uneven distribution of PA (and hence an unequal distribution of conservation costs) would therefore justify compensating those states that provide above-average PA within the fiscal transfer scheme.



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The German system of fiscal transfers between the federation and the 16 states (*Länder*) redistributes tax revenue both vertically (i.e. between federal and state level) and horizontally (i.e. balancing unequal fiscal capacities among different states) (Federal Ministry of Finance (BMF), 2015). Its aim is to enable the administrative authorities to fulfil their public functions in order to 'ensure uniform living standards' throughout the country (Basic Law, Art. 106; see also BMF, 2015).[1]There are several stages of tax revenue distribution, including one of horizontal financial equalization between the German *Länder*, where poor states receive adjustment payments funded by the wealthier states to match fiscal capacity (i.e. mainly the states' tax income) with fiscal needs (BMF, 2015). As per capita fiscal needs are assumed to be the same among all the states, population numbers serve as the main indicator to calculate fiscal needs. There are, however, two important modifications in place: for both the densely populated city states and the three parsely populated states, population numbers are increased calculatorily to account for population density-dependent above-average fiscal needs. Hence, the horizontal fiscal transfers are modified according to a U-shaped function in order to ensure there is sufficient fiscal capacity per capita. As a consequence, both the densely populated city states Berlin (BE), Hamburg (HH) and Bremen (HB) and the most sparsely populated states of Mecklenburg-Western Pomerania (MV), Brandenburg (BB) and Saxony-Anhalt (ST) are ascribed a calculatory increase in their actual population,[2] the so-called *Einwohnerveredelung* (Lenk, 2004). The Standards Act (MaßstG, 2009: §8) defines that the above-average needs of these states have to be determined by objective indicators showing an abstract higher need. That is to say, it cannot be public spending *per se* that determines higher fiscal need, not least because higher spending might be determined rather by higher fiscal capacity than by higher fiscal need.

Several public finance studies have analysed the relationship between fiscal needs and fiscal capacity in the context of the German federal system structure in order to demonstrate that the assumed above-average fiscal needs per capita are indeed an empirical pattern. By comparing city states[3] with similarly large cities that have surrounding areas under their administration, Hummel and Leibfritz (1987) show that city states are entitled to receive compensation because they provide public goods with positive spillover effects to the states surrounding them (Hummel and Leibfritz, 1987). Such above-average fiscal needs have further been substantiated by Eltges *et al.* (2001), who find above-average fiscal needs in city states due to social services provision and higher unemployment and crime rates. Additionally, they demonstrate slightly above-average fiscal needs per capita in sparsely populated states that provide road infrastructure and execute public responsibilities related to agriculture and forestry, among other things. Similar findings with regard to sparsely populated states have been presented by Seitz (2002), who finds a negative correlation between per capita infrastructure requirements and population density due to the lack of returns to scale from industrial or service agglomerations. Seitz therefore concludes that there is a substantiated above-average fiscal need per capita in sparsely populated states and that this fact should be accounted for within the fiscal equalization scheme.

All these studies have provided objective indications, backed up by empirical evidence, that above-average fiscal needs in both sparsely and densely populated states are a structural condition within the German federation. Legal judgements related to the issue acknowledge, furthermore, that calculatory modifications of inhabitant numbers to reflect above-average fiscal needs are in accordance with German Basic Law and its principle of solidarity (BVerfG, 1999, 1992, 1986). Based on this, we now proceed with the *second step* of our policy analysis: in analogy to previous studies, we apply an econometric analysis of the relation between PA distribution and public spending for nature conservation among German states in order to demonstrate whether the coverage and category of PA also constitute a structural condition eligible for recognition in the German fiscal equalization system.

[1]The legal basis for implementation is the Financial Equalization Act (Finanzausgleichsgesetz – FAG) and the Standards Act (Maßstäbegesetz – MaßstG).
[2]A factor of 1.35 for the city states of Bremen (HB), Hamburg (HH) and Berlin (BE) and, for the sparsely populated states, 1.05 for Mecklenburg-Western Pomerania (MV), 1.03 for Brandenburg (BB) and 1.02 for Saxony-Anhalt (ST). See Appendix A.2 for a formal description of the equalization scheme.
[3]City states are a peculiar characteristic of the German federal system. Bremen, Hamburg and Berlin are states that consist solely of the cities' territory, with no surrounding administrative areas.



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## Empirical Approach: The Distribution of Protected Areas and Spending on Nature Conservation among German States

Although a systematic integration of environmental considerations into intergovernmental fiscal schemes has already been proposed for Germany (Czybulka and Luttmann, 2005; Möckel, 2013; Perner and Thöne, 2007; Ring, 2008a, 2002; Schröter-Schlaack *et al.*, 2013; SRU, 1996, 2002) there is only limited empirical information available to date about fiscal needs for ecological public functions and their financial consideration within intergovernmental fiscal relations. Especially regarding the integration of conservation-related ecological public functions, there is not yet conclusive evidence for an objective indicator of above-average fiscal need per capita for federal states with above-average PA. Focussing on aspects of the states' legal obligations and competencies for conservation, Czybulka and Luttmann (2005) argue that there are substantiated reasons to assume an above-average fiscal need for conservation and the provision of related ecological public functions in sparsely populated states, but they do not provide quantitative evidence for this claim. Seitz (2001) provides quantitative evidence that European Natura 2000 sites are not strongly correlated with population density, but does not consider other (i.e. national and regional) PA categories. Our contribution to the literature is to provide an empirical analysis of the spatial distribution of PA in German states: is there a significant correlation between population density and PA coverage in Germany, considering all PA categories? Since fiscal need is calculated on a per capita basis, a significant, negative correlation would provide (i) evidence of above-average fiscal needs per capita relative to the provision of conservation-related public goods and (ii) a justification for modifying the German federal financial equalization system by considering conservation-related indicators, as has been suggested previously (Czybulka and Luttmann, 2005; Möckel, 2013; Schröter-Schlaack *et al.*, 2013).

### Data

The Leibniz Institute of Ecological Urban and Regional Development (IOER) monitors data on spatial development such as PA coverage at state level (IOER, 2015; Walz and Schumacher, 2010). The so-called IOER Monitor includes two terrestrial PA categories relating to landscape and nature protection: (1) 'nature and species conservation', referring to the stricter German PA categories of national park, nature reserve and Natura 2000 site as well as the core areas of biosphere reserves, and (2) 'landscape protection', referring to nature parks and landscape reserves as well as buffer zones and transition areas in biosphere reserves with fewer land-use restrictions. Spatial overlaps are dealt with by taking only the PA category with stricter land-use restrictions into account. PA data is measured biannually. The IOER Monitor also provides data on population density. The IOER data set does not include any marine PA. The Federal Statistical Office provides data on GDP per capita, value added per sector, and the states' net public spending on environmental protection and nature conservation (Statistisches Bundesamt, 2015, and personal communication).

### Graphical Illustration

Figure 1 maps the distribution of three different PA indicators ('nature and species conservation', 'landscape protection' and 'total protected area') per capita for 2010 across the German *Länder*. As can be seen, the variation of 'nature and species conservation' is stronger than that of 'landscape protection', which is to say the latter is more equally distributed. Furthermore, there is a clear pattern that the least populated north-eastern region (i.e. the states of Mecklenburg-Western Pomerania and Brandenburg) provides most 'nature and species conservation' area as well as total PA per capita.

Figure 2 relates 2010 PA per capita to per capita public expenditure on nature conservation and environmental protection for the German *Länder*. It shows an unequally distributed share of PA between the *Länder* on the one hand (for strictly protected PA categories and for total PA) and public spending on the other. It illustrates that there is an exponentially declining relation between PA per capita and population density on the one hand and a more or less U-shaped relation between net public environmental and conservation expenditure per capita and population density on the other (see the second degree polynomial trend line). This illustrates our argument graphically: sparsely populated states provide a public good (with positive spillover effects) and have higher expenditures in



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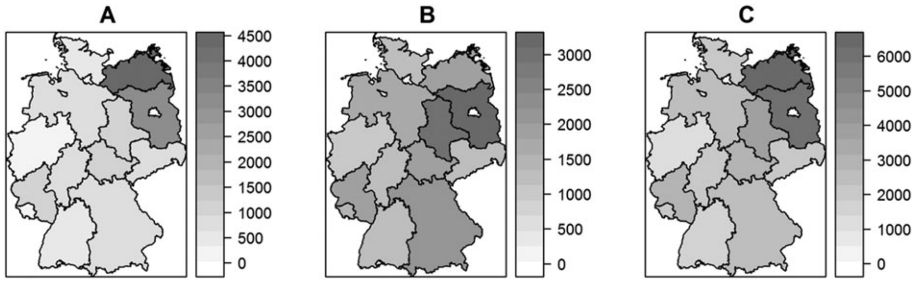


***Figure 1.*** Spatial distribution of PA indicators for 2010 in Germany. (A) nature and species conservation, (B) landscape protection, (C) total PA. Units: $m^2$ per capita. Sources: authors' elaboration based on IOER (2015)

the environmental and conservation sector – while densely populated states have high per capita environmental expenditure but do not provide much conservation. Therefore, we see PA as a suitable and objective indicator for above-average fiscal needs. However, this does not yet constitute an empirical proof of a significant correlation between PA per capita and population density. To this end, we next employ an econometric panel data analysis to test the null hypothesis that there is no significant correlation between PA and population density (Seitz, 2001).

### Econometric Model

To estimate the relation between variables, regressions are computed in the **R** environment (R Development Core Team, 2015). The **plm** package (Croissant and Millo, 2008) is employed to deal with unobserved heterogeneity among German *Länder* using individual specific fixed effects regressions. The dependent variable is protected area in square metres per capita, PA.cap (using different PA categories such as nat.cap for nature and species conservation, land.cap for landscape protection or tot.cap for total PA). Independent variables are population density (pop.dens), GDP per capita (GDP.cap), the share of value added by agriculture (VA.agr) and industry (VA.ind) as a percentage of total value added by these two sectors, and public expenditure on environmental protection and nature conservation per capita in constant €2005 prices (spend.cap). A continuous year variable is used to detrend the data. A log–log transformation is employed. Furthermore, an integer year variable is used to detrend the data. This gives the general model structure:

$$\ln(\text{PA.cap}_{it}) = \beta_1 \ln(\text{pop.dens}_{it}) + \beta_2 \ln(\text{GDP.cap}_{it}) + \beta_3 \ln\left(\text{VA.agr}_{it}\right) + \beta_4 \ln(\text{VA.ind}_{it}) + \beta_5 \ln(\text{spend.cap}_{it}) + \beta_6 \text{year} + \mu_i + \epsilon_{it} \quad (1)$$

with $i = 1, \ldots, 16$ entities (*Länder*), $t = 2006, 2008, 2010$ as the time index, the individual error component $\mu_i$ and an idiosyncratic error term $\epsilon_{it}$, which is assumed to be normally distributed around mean zero and to be independent from regressors. Standard errors are computed with robust covariance matrix estimators à la Driscoll and Kraay (1998) with a maximum lag window of $m(T) = 1$ and estimation type HC3 (Millo, 2014; Zeileis, 2004) to account for heteroscedasticity, serial and spatial correlation.[4]

## Results

Regressions for different dependent variables ('nature and species conservation', 'landscape protection' and 'total PA') are reported in Table 1. Summary statistics can be found in the appendix. Controlling for socio-economic variables we find a significant, negative correlation between the logarithm of total PA in square metres per capita and population density (Model 6). This correlation provides sufficient evidence for a structural condition of the federation, namely, sparsely populated states providing more PA per capita. We also find a significant,

[4]The data, R code and files used for analysis and plotting can be found at https://github.com/NilsDroste/EFT-DE



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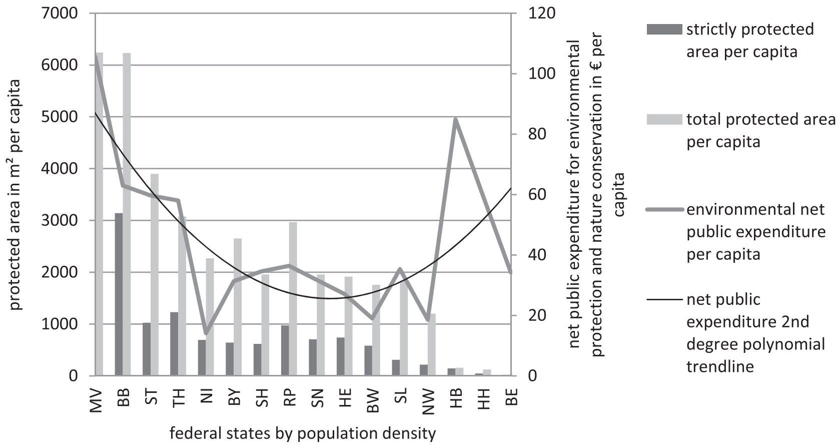


***Figure 2.*** PA and respective public expenditure per capita for 2010 in Germany. Sources: IOER (2015) and Federal Statistical Office (personal communication), figure adapted from Droste (2013)[5]

negative correlation between GDP per capita and PA per capita (i.e. for nature and species conservation and total PA). This indicates that on average more PA are designated in relatively poorer states. For total PA, the value added by the agricultural and industry sectors is positively correlated. While public expenditure for environmental protection and nature conservation is significantly and positively correlated with nature and species conservation per capita, it is significant and negative for landscape protection and total PA – which may indicate that it is a poor indicator for conservation performance due to its composite aggregate of both environmental protection and conservation expenditure. The adjusted $R^2$ indicates that Models 1 to 4 have a really poor fit, taking the variable-to-sample size ratio into account. Looking at the overall picture – taking all PA categories into account – the adjusted $R^2$ values suggest that Model 5 is preferable to Model 6.

Previous reforms of the fiscal transfer system in Germany have acknowledged the fact that both densely and sparsely populated states have additional fiscal needs when it comes to fulfilling their public functions (Eltges *et al.*, 2001; Hummel and Leibfritz, 1987; Seitz, 2002). Regarding nature conservation, there have been legal arguments in favour of EFT in Germany (Czybulka and Luttmann, 2005) but no empirical analysis beyond Natura 2000 sites (Seitz, 2001). The overall negative correlation of total PA per capita with population density (Model 5) provides evidence for a structural condition within the federation, namely, that sparsely populated states on average provide more PA per capita, most likely due to a higher propensity to designate PA in regions with great natural endowments. Considering that nature conservation efforts impose management costs, we have thus provided evidence that PA per capita is an objective indicator of an above-average fiscal need for conservation in sparsely populated states in Germany, and we now proceed by proposing policy options for including suitable indicators in the fiscal transfer system in Germany.

## Assessment of Policy Options: Modelling Ecological Fiscal Transfers in Germany

Having established that there is indeed a structural condition for the distribution of PA in Germany, namely, higher provision where there is lower population density, we proceed to *step three in our policy analysis* by evaluating the fiscal effects of different EFT design options.[6]

[5]German Länder: MV: Mecklenburg-Western Pomerania, BB: Brandenburg, ST: Saxony-Anhalt, TH: Thuringia, NI: Lower Saxony, BY: Bavaria, SH: Schleswig-Holstein, RP: Rhineland-Palatinate, SN: Saxony, HE: Hesse, BW: Baden-Württemberg, SL: Saarland, NW: North Rhine-Westphalia, HB: Bremen, HH: Hamburg, BE: Berlin.
[6]For more detail and further design options, see Schröter-Schlaack *et al.*, (2013) and Droste (2013).



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| | Dependent variable | | | | | |
|---|---|---|---|---|---|---|
| | ln(nat.cap) | | ln(land.cap) | | ln(tot.cap) | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| ln(pop.dens) | −0.292*** | 0.395 | −1.095*** | −1.211** | −1.162*** | −0.925*** |
| | (0.075) | (0.601) | (0.378) | (0.581) | (0.316) | (0.198) |
| ln(GDP.cap) | −0.995*** | −0.889*** | −0.296* | −0.365** | −0.651*** | −0.644*** |
| | (0.258) | (0.192) | (0.146) | (0.171) | (0.066) | (0.038) |
| ln(VA.agr) | | −0.032 | | 0.097*** | | 0.043*** |
| | | (0.019) | | (0.021) | | (0.013) |
| ln(VA.ind) | | 0.701 | | 0.058 | | 0.349* |
| | | (0.543) | | (0.153) | | (0.197) |
| ln(spend.cap) | | 0.040** | | −0.075*** | | −0.027*** |
| | | (0.017) | | (0.023) | | (0.010) |
| year | 0.025*** | 0.032*** | 0.010 | 0.003 | 0.015*** | 0.014*** |
| | (0.002) | (0.004) | (0.006) | (0.006) | (0.005) | (0.002) |
| Observations | 48 | 48 | 48 | 48 | 48 | 48 |
| $R^2$ | 0.356 | 0.404 | 0.198 | 0.297 | 0.561 | 0.604 |
| Adjusted $R^2$ | −0.043 | −0.077 | −0.300 | −0.271 | 0.288 | 0.283 |
| *F* statistic | 5.354*** | 2.937** | 2.380* | 1.832 | 12.335*** | 6.598*** |

***Table 1.*** State-level regressions
The panel data sample is balanced with $n = 16$, $T = 3$, $N = nT = 48$. Robust standard errors are reported in parentheses below the estimated coefficients. Individual coefficients are indicated by a *10%, **5% or ***1% significance level. The models use an individual fixed effects specification.

## Ecological Fiscal Transfer Model

In the existing German fiscal equalization scheme, tax revenue is transferred from wealthier to poorer states. In this way, differences in fiscal budget per capita among federal states are substantially equalized (Lenk *et al.*, 2015; Lenk and Kuntze, 2012). The respective formulae can be found in appendix A.2.

Although different options are discussed elsewhere (see Schröter-Schlaack *et al.*, 2013), we restrict the analysis here to a relatively simple approach of accounting for above-average fiscal needs per capita. Building on the modification of population numbers for sparsely and densely populated states, we suggest increasing the population numbers by a factor $\text{eco}_i$ to account for conservation-related above-avarage fiscal needs of states. Equation 2 gives the ecological benchmark assessment for the conservation factor $\text{eco}_i$.

$$\text{eco}_i = 1 + f_{\text{eco}}\left(\frac{\text{PA}_i}{\text{PA}_{\text{DE}}} - 1\right) \tag{2}$$

where $\text{PA}_i$ is the PA per capita in state $i$. The benchmarking consists in a ratio of state provision of PA and federal average of PA per capita $\text{PA}_{\text{DE}}$ minus 1. The benchmark factor $\text{eco}_i$ will be $f_{\text{eco}}$ times larger than 1 if PA coverage in state $i$ is above average and $f_{\text{eco}}$ times smaller than 1 if it is below average.[7] To account for the state's relative conservation performance, we suggest integrating the factor $\text{eco}_i$ into the fiscal need formula in analogy to previous decisions to take account of above-average fiscal needs for sparsely populated states (see Appendix A.2, Equation (A.2)). In order to provide various policy options for a political process that is ultimately based upon negotiations between

[7]Factor $f_{eco}$ is a weighting factor that reflects the extent to which differences in PA coverage are taken into account. It is set to 0.1 to yield reasonable marginal fiscal transfer changes (Schröter-Schlaack *et al.*, 2013).



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the German central government and the *Länder*, we show results for three different benchmark conservation factors $eco_i$. The first, $eco_{NCA, i}$, is formed using 'nature and species conservation' area per capita. The second is a weighted per capita sum of 'nature and species conservation' (weight = 0.8) and 'landscape protection' $eco_{LPA, i}$ (weight = 0.2), since there are different conservation benefits provided by different PA categories and the spatial distribution of both categories differs among states (see also later for a discussion of the issue). The third indicator $eco_{TPA}$, is based on an unweighted total PA per capita (see Table 2).

#### Marginal Fiscal Transfer Changes upon Integration of Ecological Indicators

The integration of ecological indicators changes fiscal transfers compared with the current distribution. We quantify the marginal changes in transfers for the three different conservation factor scenarios (see previous subsection). Table 3 gives marginal transfer changes as of 2010 for each of the *Länder* if three different ecological indicators were integrated into the current German financial equalization system, comparing them to the status quo. As can be seen in Table 3, tax revenue per capita is equalized through fiscal transfers among German states (status quo scenario). When ecological indicators are introduced they cause a deviation from the status quo fiscal transfers and we indicate using grey shading where states suffer a loss compared with the status quo. It becomes clear that, regardless of the specific ecological indicator $eco_i$ chosen, winners and losers stay more or less the same over the three scenarios (except BY, NI and SN). However, the magnitude of transfers changes drastically in some cases (e.g. for MV and SL) across different indicators due to the different spatial distribution patterns of different PA categories.

## Discussion: Federal-State Level EFT Design Options and their Implications

In many federalist states such as Germany, (regional) state governments are lacking in adequate financial resources for nature conservation, while often being responsible for the designation and management of PA. Furthermore, the existing incentive structure of fiscal transfers is not conducive to taking conservation benefits into account when deciding about allocating state budget among different public responsibilities. Thus, given tight (public) budgets in general and a severe lack of conservation financing more specifically (McCarthy *et al.*, 2012), EFT constitute an innovative and complementary financing instrument in the conservation policy mix.

EFT schemes based on PA indicators that have been implemented to date usually involve general purpose transfers, meaning that these are not earmarked for spending on nature conservation. However, conservation-related indicators serve to bind the distribution of intergovernmental fiscal transfers to the existence of conservation efforts displayed in the ecological indicators applied. EFT thus create an incentive to conserve nature in order to access this part of the budget. The costs of providing conservation would be compensated (at least partly) by acknowledging PA indicators for fiscal transfers, thereby internalizing conservation spillover benefits. In this sense, EFT share some characteristics with PES as they incentivize decision makers to change their behaviour in an environmentally friendly way. Since neither implemented EFT schemes in Brazil or Portugal, nor our design proposal, are based on actual marginal costs and benefits, we do not claim that the internalization achieved is optimal in an economic sense. However, we argue that a (partial) internalization of PA spillovers would still increase incentives to comply with predefined political conservation standards, such as a certain share of PA on total state area (BNatSchG, 2009). Rather than aiming at optimal solutions, standard-price approaches (Baumol and Oates, 1971) as well as evolutionary strategies in environmental policy (Ring, 1997) provide signals in the right direction.

Our proposed approach is based on an assessment of how much PA is actually provided by individual states compared with the average; as such, it is performance based (see Table 2). It requires no additional budget from the (national) federal government but creates conservation incentives by greening the indicators for tax revenue allocation (Droste *et al.*, 2017). Hence, there is no increase in the overall amount of money available, and some states will receive less with EFT than under the status quo (see Table 3). This is due to the fact that these states underperform or are below average in relevant nature conservation activities. While this may be seen as a dynamic incentive for conservation, which introduces elements of competitive federalism by virtue of its performance-based design (Oates and Schwab, 1988), the annual amount of fiscal transfers (and thus a share of state total budget) would depend



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| Federal state | Population | 'Nature and species conservation' area (NCA) in km² | NCA area in m² per capita | NCA conservation factor $eco_{NCA,\ i}$ | 'Landscape protection' area (LPA) in km² | LPA area in m² per capita | LPA conservation factor $eco_{LPA,\ i}$ | Weighted factor 0.8 $eco_{NSA}$ + 0.2 $eco_{LPA,\ i}$ | 'Total protected area' (TPA) in km² | TPA in m² per capita | TPA conservation factor $eco_{TPA,\ i}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BW | 10 753 880 | 6 256.50 | 582.00 | **0.98** | 12 620.30 | 1 174.00 | **0.98** | **0.98** | 18 876.77 | 1 755.00 | **0.98** |
| BY | 12 538 696 | 8 042.70 | 641.00 | **0.99** | 25 115.80 | 2 003.00 | **1.04** | **1.00** | 33 158.49 | 2 644.00 | **1.03** |
| BE | 3 460 725 | 68.60 | 20.00 | **0.90** | 95.40 | 28.00 | **0.90** | **0.90** | 164.04 | 47.00 | **0.90** |
| BB | 2 503 273 | 7 812.70 | 3 121.00 | **1.35** | 7 724.30 | 3 086.00 | **1.12** | **1.30** | 15 536.99 | 6 207.00 | **1.19** |
| HB | 660 706 | 74.40 | 113.00 | **0.92** | 27.90 | 42.00 | **0.90** | **0.91** | 102.69 | 155.00 | **0.91** |
| HH | 1 786 448 | 80.00 | 45.00 | **0.91** | 138.90 | 78.00 | **0.91** | **0.91** | 219.00 | 123.00 | **0.91** |
| HE | 6 067 021 | 4 476.40 | 738.00 | **1.01** | 7 136.80 | 1 176.00 | **0.98** | **1.00** | 11 613.20 | 1 914.00 | **0.99** |
| MV | 1 642 327 | 6 979.90 | 4 250.00 | **1.51** | 3 246.50 | 1 977.00 | **1.04** | **1.42** | 10 249.53 | 6 241.00 | **1.20** |
| NI | 7 918 293 | 5 478.00 | 692.00 | **1.00** | 12 432.70 | 1 570.00 | **1.01** | **1.00** | 17 958.39 | 2 268.00 | **1.01** |
| NW | 17 845 154 | 3 817.90 | 214.00 | **0.93** | 17 589.40 | 986.00 | **0.97** | **0.94** | 21 407.27 | 1 200.00 | **0.96** |
| RP | 4 003 745 | 3 891.30 | 972.00 | **1.04** | 7 981.10 | 1 993.00 | **1.04** | **1.04** | 11 892.29 | 2 970.00 | **1.04** |
| SL | 1 017 567 | 315.90 | 310.00 | **0.94** | 1 559.20 | 1 532.00 | **1.01** | **0.96** | 1 875.12 | 1 843.00 | **0.99** |
| SN | 4 149 477 | 2 928.70 | 706.00 | **1.00** | 5 194.40 | 1 252.00 | **0.99** | **1.00** | 8 123.09 | 1 958.00 | **0.99** |
| ST | 2 335 006 | 2 392.50 | 1 025.00 | **1.05** | 6 707.20 | 2 872.00 | **1.10** | **1.06** | 9 099.74 | 3 897.00 | **1.08** |
| SH | 2 834 259 | 1 737.90 | 613.00 | **0.99** | 3 807.60 | 1 343.00 | **1.00** | **0.99** | 5 545.47 | 1 957.00 | **0.99** |
| TH | 2 235 025 | 2 749.30 | 1 230.00 | **1.08** | 4 140.10 | 1 852.00 | **1.03** | **1.07** | 6 889.45 | 3 082.00 | **1.05** |
| **Federation** | **81 751 602** | **57 102.80** | **698.00** | | **115 517.60** | **1 413.00** | | | **172 711.50** | **2 113.00** | |

***Table 2.*** Conservation factors by different nature conservation area categories for 2010
Source: authors' calculation based on IOER (2015), Schröter-Schlaack *et al.* (2013) and we (2013).



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| Scenarios | Status quo | | | Nature and species conservation | | Nature and species conservation (0.8) + landscape protection (0.2) | | Total PA | |
|---|---|---|---|---|---|---|---|---|---|
| **Federal states** | Tax revenue **before** fiscal transfers in € per capita | Tax revenue **after** fiscal transfers in € per capita | Fiscal transfers in € per capita | EFT in € per capita | Relative change per capita transfers to status quo in per cent | EFT in € per capita | Relative change per capita transfers to status quo in per cent | EFT in € per capita | Relative change per capita transfers to status quo in per cent |
| BW | 3441 | 3282 | −159 | −170 | −6.7 | −169 | −6.4 | −168 | −5.7 |
| BY | 3611 | 3331 | −280 | −291 | −3.7 | −286 | −1.9 | −274 | 2.3 |
| BE | 2835 | 3942 | 1107 | 1056 | −4.5 | 1056 | −4.5 | 1056 | −4.6 |
| BB | 2777 | 3007 | 230 | 408 | 77.4 | 385 | 67.1 | 329 | 43.2 |
| HB | 3152 | 4048 | 896 | 852 | −4.8 | 851 | −5 | 848 | −5.3 |
| HH | 4377 | 4340 | −37 | −67 | −79.2 | −67 | −78.8 | −66 | −77.8 |
| HE | 3643 | 3354 | −289 | −294 | −1.7 | −295 | −2 | −297 | −2.8 |
| MV | 2622 | 2960 | 338 | 600 | 77.5 | 552 | 63.2 | 438 | 29.7 |
| NI | 3018 | 3067 | 49 | 48 | −1 | 49 | 1.4 | 52 | 7.4 |
| NW | 3077 | 3103 | 26 | 2 | −93.2 | 4 | −85.9 | 8 | −68.4 |
| RP | 2953 | 3055 | 102 | 122 | 19.1 | 122 | 19.3 | 123 | 19.9 |
| SL | 2908 | 3041 | 133 | 105 | −21 | 112 | −16.2 | 127 | −4.9 |
| SN | 2664 | 2954 | 290 | 290 | 0.2 | 289 | −0.3 | 286 | −1.3 |
| ST | 2663 | 2961 | 298 | 322 | 8 | 328 | 10 | 342 | 14.5 |
| SH | 3022 | 3076 | 54 | 105 | −21 | 112 | −16.2 | 127 | −4.9 |
| TH | 2647 | 2944 | 297 | 336 | 13.2 | 331 | 11.6 | 320 | 7.9 |

***Table 3.*** Marginal fiscal transfer changes as of 2010 for three different scenarios involving the integration of different PA-based ecological indicators into the German financial equalization system. Source: authors' calculation based on Droste (2013) and Schröter-Schlaack *et al.* (2013); PA data for 2010 from IOER (2015).



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on yearly conservation performance in terms of PA designated by the jurisdiction compared with other jurisdictions. That is to say, the incentive element of EFT alone cannot ensure that there is sufficient conservation financing available, but it can act as a complement to general conservation financing by providing a fiscal incentive for public administrations to perform well in terms of conservation benchmarks.

Based on the foregoing remarks, a critical aspect is the choice of indicator. In Germany, the 16 states' fiscal needs are calculated on the basis of weighted population numbers, the weightings being derived from abstract and objective indicators for above-average fiscal needs. We have therefore developed an approach tailored to the German system that includes an additional population weighting for providing conservation (see Table 2). Different distributional effects occur depending on the different indicators we have used to compute EFT. As can be seen from Table 3, there are substantial differences in transfers to individual states depending on the type of indicator chosen. Regarding the choice of indicators, we argue that stricter PA very likely provide greater benefits for biodiversity conservation and hence greater interjurisdictional spillover benefits. Nevertheless, landscape protection also provides spillover benefits in terms of recreational and amenity services. Thus, our proposed combined and weighted indicator for EFT takes these factors into account (see Table 2). How different PA categories perform in terms of biodiversity conservation and ecosystem service provision and what this would imply for designing EFT indicators is, however, a question for future research. While we cannot provide a generally applicable solution in this paper, it becomes clear that there is room for manoeuvre in terms of political negotiations to counterbalance unacceptable burdens for individual states.

## Conclusion

EFT close an important gap in the conservation policy mix. They explicitly address decentralized public actors such as state or municipal governments. Whereas there is a range of economic instruments directed towards private actors (such as tax reliefs, agri-environmental schemes or PES), there is no such variety aimed at public actors. Therefore, EFT provide a suitable instrument to address local, regional and state governments. PA provide conservation benefits that spill over the boundaries of the jurisdictions, providing them to other regions (ten Brink *et al.*, 2013). We have analysed the theoretical and empirical underpinnings of fiscal transfers and the rationales for including ecological indicators, and have presented design options for EFT in Germany that may internalize such positive external effects.

However, EFT cannot simply be transferred from one country to another. They need to be tailored according to the legal and institutional framework in place. This requires analysis of the institutional context, closing of knowledge gaps and derivation of an appropriate policy design from there (cf. Ring and Schröter-Schlaack, 2015, for the underlying policy analysis approach). Previous reforms of the German financial equalization system from the federal to the state level have been based on above-average fiscal needs in both densely and sparsely populated states and have led to a calculatory population increase for these states. We have shown econometrically that the same structural condition holds for the distribution of PA. There is a significant negative correlation between total PA coverage per capita and population density across the German *Länder*. This provides a structural argument for an integration of ecological indicators into the current fiscal transfer system. We have presented a potential performance-oriented model that assesses the designation of different PA categories using the national average as a benchmark. States with above-average PA coverage per capita would be entitled to receive increased fiscal transfers, whereas states below the average would lose out. Such an EFT scheme transforms above-average PA coverage into a source of state revenue and builds closely on the legal and institutional setting of intergovernmental fiscal relations in Germany. The idea of performance-oriented EFT may well be transferred to other states or even supra-national bodies (cf. Droste *et al.*, 2016b).

Looking beyond our particular policy design study, existing EFT schemes with PA-related indicators all focus on EFT to the local government level, regardless of whether the country is organized centrally (Portugal) (Santos *et al.*, 2012) or federally (Brazil) (Grieg-Gran, 2000; Ring, 2008c). Our proposal may provide useful insights for other federal systems where the financial constitution regulates fiscal relations between the federal and the state level. In fact, federal to state-level EFT make it possible to take the interstate spillover effects of nature conservation into account.



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This promises to be especially relevant to large federalist countries with heterogeneous natural endowments such as Brazil, which is a major hotspot of global biodiversity and yet has a noticeably unequal spatial distribution in relation to biomes, PA, population and socio-economic characteristics (Cassola, 2011; Droste *et al.*, 2017). While initial policy proposals for federal-to-state EFT schemes in Brazil (Cassola, 2011, 2014), Switzerland (Köllner *et al.*, 2002) and India (Kumar and Managi, 2009) have been put forward, our approach is the first to consider the integration of indicators on conservation performance at state level into fiscal equalization between states. This provides a complementary design option that could be adapted elsewhere.

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## Appendix A.1

Descriptive statistics

| Statistic | N | Mean | St. dev. | Min. | Max. |
|---|---|---|---|---|---|
| Nature and species conservation area per capita in m$^2$ (nat.cap) | 48 | 915.8 | 1046.0 | 19.7 | 4266.1 |
| Landscape protection area per capita in m$^2$ (land.cap) | 48 | 1402.1 | 856.1 | 24.5 | 3101.1 |
| Total protected area per capita in m$^2$ (tot.cap) | 48 | 2317.9 | 1737.4 | 44.6 | 6256.8 |
| Population density in persons/km$^2$ (pop.dens) | 48 | 670.8 | 1033.1 | 71 | 3884 |
| GDP in € per capita (GDP.cap) | 48 | 28 452.4 | 7842.7 | 19 610.3 | 50 691.0 |
| Valued added agriculture as a percentage of total value added (agr) | 48 | 1.1 | 0.9 | 0.01 | 3.7 |
| Valued added industry as a percentage of total value added (ind) | 48 | 28.6 | 6.5 | 15.9 | 39.0 |
| Public expenditure environmental protection and nature conservation in € per capita (spend.cap) | 48 | 41.5 | 22.7 | 10.0 | 100.4 |

Sources: authors' calculations based on IOER (2015) and Statistisches Bundesamt (2015, and personal communication); monetary values are in constant € 2005 prices.

## Appendix A.2

According to the Financial Equalization Act (FAG, 2013), fiscal capacity and fiscal need are defined as given in Equations (A1) and (A2). Adjustment payments result from comparing the fiscal capacity index $FC_i$ and the equalization index $FE_i$ of a state. If state *i*'s FC is larger than its FE, the state pays transfers, and vice versa.

Fiscal Capacity Index (FC).

$$FC_i = S_i + \sum_{j=1}^{m} 0.64 M_{ij}. \tag{A.1}$$

FC of state *i* is determined by the sum of state-level tax revenue *S* of state *i* and 64 per cent of the municipal-level tax revenue *M* of all municipalities *j* in state *i*.Fiscal Equalization Index (FE).

$$FE_i = \frac{\sum_{i=1}^{n} S_i}{\sum_{i=1}^{n} g_1 P_i} g_1 P_i + \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} 0.64 M_{ij}}{\sum_{i=1}^{n} g_2 P_i} g_2 P_i \tag{A.2}$$

In principle, the German system assumes that the fiscal need per inhabitant is the same for all states. Therefore, the FE of state *i* is determined by the average tax revenue per capita at state level *S* among all 16 states multiplied by the weighted population *P* of state *i* plus 64 per cent of the average municipal tax revenue *M* of municipalities *j*of state *i* multiplied by the weighted population *P*.[8] The fiscal transfers are then determined by a linear-progressive equalization function (FAG, 2013: §10) depending on the extent to which the relevant states diverge from the average. As can be seen from Equations A.1 and A.2, only 64 per cent of the local authorities' tax revenues are taken into account in determining the states' fiscal capacity. Since local authorities have relevant fiscal needs and capacities and their public functions differ between the states, Lenk *et al.* (2015) call for municipal tax revenues to be acknowledged fully in the financial equalization. However, our EFT model is based on the existing formulae.The ecological benchmark factor $eco_i$ (see Equation 2) would be integrated on the municipal level by replacing $g_2$ by $g_i = g_2 eco_i$, where above-average fiscal needs for sparsely populated states have also been integrated.

[8]The weight $g_1$ is 1.35 for the city states Bremen, Hamburg and Berlin and 1 for all other states. Weight $g_2$ is again 1.35 for the city states, while a factor of 1.05 applies to Mecklenburg-Western Pomerania, 1.03 to Brandenburg and 1.02 to Saxony-Anhalt. This means that fiscal need is basically the same for all states, with a factorial increment of the population of the three city states and the three most sparsely populated states. The factor compensating sparsely populated states for above-average fiscal needs is applied only at the municipal level.



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