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Integrating local ecological services into intergovernmental fiscal transfers: The case of the ecological ICMS in Brazil

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Abstract

Local conservation efforts are often related to benefits at higher governmental levels. On the one hand, these efforts are strongly connected to local land-use decisions. On the other hand, activities such as sustainable water management or biodiversity conservation are associated with regional, national or even global public goods. Therefore, spatial externalities or spillovers exist, which—if not adequately compensated for—lead to an underprovision of the public goods and services concerned. This article investigates intergovernmental fiscal transfers as an innovative instrument for compensating local jurisdictions for the ecological goods and services they provide across local boundaries. From a public finance perspective, fiscal transfers are a suitable instrument for internalising spatial externalities. However, most federal states use this instrument predominantly for social and economic public sector functions rather than for ecological ones. This article investigates the case of the ecological "ICMS" that was first introduced by a few states in Brazil during the 1990s. Part of the revenue from this value-added tax is redistributed to the local level on the basis of ecological indicators. In this way, the state level uses fiscal transfers to compensate municipalities for the existence of protected areas and other ecological services provided within their territories. The Brazilian experience illustrates that such fiscal transfers can represent both a compensation for land-use restrictions and an incentive to value and engage in more conservation activities at the local level.

Keywords: Fiscal transfers; Environmental federalism; Conservation benefits; Spillover effects; Local ecological services; Brazil

Introduction

Sustainable land use requires a variety of conservation efforts and services, not least at the local level. There is a close link between the environmental quality of a landscape, its land-use pattern and the type of management performed by public jurisdictions and private land users. However, local communities can often obtain greater benefits from activities that contribute to the loss of biodiversity and ecosystem services. Providing incentives for conservation efforts in the form of benefits for local people has proven to be very difficult (Millennium Ecosystem Assessment, 2005a, p. 92ff). There are few incentives for local actors to engage in conservation activities, especially when ecological benefits cross local boundaries (Perrings and Gadgil, 2003). In Europe, compensation payments for ecological services provided by private land users are being introduced more and more widely, mainly in the context of co-funded EU agri-environmental programmes. What is largely lacking in European member states, however, are economic instruments that explicitly address local public actors in their role as providers of ecosystem services over the long term. Local governments usually seek to achieve socio-economic development by attracting both industries and residents as tax payers. Municipalities are rarely able to generate income from the provision of ecological services; on the contrary, they are often restricted in their sovereignty, e.g. regarding land-use planning. This is the case with a number of services, such as water protection or nature reserves. Decisions on the designation of the protected areas concerned are often taken by institutions above the local level, whereas the concrete consequences in terms of restrictions in land use are borne by local actors, often without any (or adequate) compensation.

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This article describes an innovative instrument that is able to address this basic problem. Intergovernmental fiscal transfers are analysed with regard to their potential within federal systems for compensating for ecological services provided by local governments. From a public finance perspective, it is the 'value added' of local ecological services, i.e. the benefits that cross the boundaries of local jurisdictions, which are of special interest. The first part of this article gives a brief introduction to public finance principles as they relate to ecological goods and services.[1] The main part presents a case study from Brazil, focusing on the status quo and the incentive effects of integrating ecological public sector functions into intergovernmental fiscal transfers. Since the 1990s, several states in Brazil have introduced fiscal transfers that explicitly compensate municipalities for certain ecological services, such as watershed protection and conservation areas (Bernardes, 1999; Grieg-Gran, 2000; Loureiro, 2002; May et al., 2002). The various ways of introducing ecological indicators into the Brazilian system of intergovernmental fiscal transfers, as well as the experiences gained so far, are analysed and important criteria for success elaborated. Finally, the prospects for transferring this instrument to other federal systems are explored.

Compensating for the value added of local ecological services

Principles of fiscal federalism

Fiscal federalism is a sub-field of public finances that explores the roles of the different levels of government and their interrelationships through fiscal instruments. Its major task is one of effectively and efficiently allocating public sector functions, expenditures and revenues to the central, state and local governmental levels in federal systems. As Oates (1999, p. 1120) puts it, "... we need to understand which functions and instruments are best centralised and which are best placed in the sphere of decentralised levels of government". Regarding the allocation function of the public sector, the principle of fiscal decentralisation has been advanced (Musgrave, 1959; Oates, 1972). Most public goods and services are provided more efficiently when production and consumption are limited to the lowest governmental level possible. This makes it possible to respond more appropriately to the regionally differing preferences of the population (Tiebout, 1956).

The decentralisation rule for allocating public goods and services applies in the absence of economies of scale. Given economies of scale, the provision of the public goods and services concerned should be moved to the cost-efficient centralised level (Postlep and Döring, 1996). Due to the characteristics of non-rivalry and non-excludability of many public goods, spatial externalities or spillovers may exist between jurisdictions. In this case, the principle of fiscal equivalence comes into play, which advocates achieving a match between those who decide about a collective good, those who pay for it and those who receive its benefits (Buchanan, 1950; Olson, 1969). Social welfare is increased through the differentiation of public services in accordance with costs and preferences at the appropriate governmental level. The realisation of fiscal equivalence may require competencies to be shifted to a more centralised level of government. Regional cooperation, e.g. by way of negotiations between the relevant parties, can also lead to an efficient Coasian type of resolution of jurisdictional spillovers (Bergmann, 1999; Oates, 2001). A third option has been mentioned by Olson (1969). Provided diseconomies of large-scale operations require local provision, spillovers can be internalised through fiscal transfers from more centralised levels to the local level. In this way, the local government is compensated for the external benefits of its expenditures. We focus on this potential of fiscal transfers to internalise spillover benefits to other jurisdictions. In the next section, we discuss how the principles of fiscal federalism apply to ecological goods and services.

Environmental federalism and spatial externalities

What are the consequences of the decentralisation rule and the principle of fiscal equivalence for environmental issues? The decentralisation rule implies that the provision of ecological goods and services should be assigned to lower levels of government where appropriate. However, the execution of this rule calls for a differentiated approach. Appropriate solutions have to be sought according to the specific characteristics of the various natural resources and environmental compartments. This is reflected in ongoing discussions regarding the competencies of the national or even supranational governmental level versus the state or local level in environmental standard setting (Döring, 1997; Oates, 1998, 1999).

Public goods that tend to be underprovided at decentralised levels are basic and applied research, including that concerning the development of environmental policy instruments, but also the dissemination of information on harmful environmental impacts or the development of pollution control techniques. These issues need to be assigned to a more centralised level of government (Oates, 2001). Global change problems such as climate change or biodiversity loss also point to the need for a fundamental role of central levels of government (Ring, 2004). Highly mobile environmental compartments and associated pollutants that easily cross administrative boundaries create far-reaching spatial externalities. The emissions of carbon dioxide and other air pollutants associated with climate change and the depletion of the ozone layer require more centralised, if not global, emission policies (Hansjürgens, 1996).

[1] For a more detailed interpretation of public finance principles with respect to ecological public sector functions and their relevance to European countries, see Ring (2002).

In contrast, environmental policy associated with less mobile environmental compartments and spatially restricted problems is better suited for assignment to decentralised levels of government (Ring, 2002). This is due to the lower probability of causing spatial externalities. Tasks relating to land use and soil conservation, as well as public functions associated with inland waters, can usually be solved within national boundaries. Despite the general suitability of many land-use issues for being assigned to lower governmental levels, spatial externalities may require different, more appropriate solutions.

Regarding water resources, such solutions may be necessary in relation to public policies for pollution control related to transboundary spillovers. In the context of water pollution in the US, for example, Sigman (2005) estimates the environmental costs generated downstream due to free riding states when rivers cross state boundaries. Whereas transboundary water pollution is associated with negative spillovers, priority areas for water protection can involve positive spillovers. In contrast to certain local costs, be it in terms of land-use restrictions or measures for keeping up and improving the quality of the respective reserves, the benefits from some of these activities cross local boundaries. For example, water protection zones are often located in rural areas, mostly providing drinking water far beyond local demand. Urban agglomerations and capital cities with high population densities and industrial activities rely especially heavily on water resources lying outside their own municipal boundaries. In the case of water resources, an important task consists in properly valuing these resources and their functions which should then, as far as possible, be reflected in water prices. In the European Union, the Water Framework Directive now obliges member states both to develop management regimes across state and national boundaries according to the spatial dimensions of river basins and to find solutions to fully reflect resource costs in water prices (Hansjürgens and Messner, 2002; Unnerstall, 2006). However, for various reasons, resource costs are not yet fully reflected in prices; indeed, with regard to certain tasks related to long-term resource protection, this may not even be a feasible solution.

The conservation and sustainable use of biodiversity is another example of the widespread existence of spatial externalities (Perrings and Gadgil, 2003; Ring, 2004). The loss of biodiversity and the threat to services provided by ecosystems for human well-being are among the serious global change problems, demanding in many cases centralised standard setting and policies. This is reflected in numerous international conventions regarding biological diversity and species protection. In the European Union, the Habitats and Birds Directives set strict standards to be implemented by member states at national and state levels (Similä et al., 2006). Despite centralised standards, decentralised activities related to local land use—seen cumulatively—have a tremendous influence on the state of biodiversity worldwide. Compared to water resources, ensuring that the value of ecological services is reflected in market prices is even more difficult, if not impossible, for many areas of biodiversity conservation (Gowdy, 1997; Millennium Ecosystem Assessment, 2005b). This is especially true for benefits related to non-use values, such as existence and option values that may accrue to people everywhere. For example, Horton et al. (2003) attempted to estimate the non-use values for a programme of protected areas in the Brazilian Amazon by eliciting individual preferences in Italy and the UK. Although the contingent valuation study exemplified the difficulties and uncertainties of such a global approach, it clearly indicated that the majority of households in Italy and the UK were willing to pay to support large-scale tropical forest preservation efforts. Hence, large-scale positive spillovers exist at least for certain public goods of global relevance. The practical consequences of spatial externalities related to species protection are illustrated by an empirical study by List et al. (2002). In their study of federal and state spending under the Endangered Species Act in the US, they identified the phenomenon of free riding on the part of the states. States tend to spend less (relative to the federal government) on those species that demand a large habitat area and whose preservation causes conflicts with economic development. Perrings and Gadgil (2003) address a number of reforms necessary to reconcile both local and global public benefits of biodiversity conservation. One of them is adjusting incentives to allow local communities to be rewarded and paid for their conservation efforts (Ring, 2002; Unnerstall, 2004; Millennium Ecosystem Assessment, 2005b).

In the following case study, the focus for solving such discrepancies will be on fiscal transfers. Spillovers associated with the provision of public goods and services at the local level can be internalised through intergovernmental fiscal transfers from more centralised levels to the local level. These transfers may compensate municipalities for the external benefits of their conservation expenditure, as well as for their opportunity costs related to land-use restrictions to be borne. This is especially necessary in relation to social benefits that accrue in the long term, where public actors are bearing the costs arising in the present. In this way, the 'value added' of local ecological goods and services is acknowledged socially, which at the same time can provide an incentive for local actors to engage in more conservation activities.

Fiscal transfers for local ecological services in Brazil

Brazil has 27 states, each with an elected government which has revenue-raising powers. The ICMS tax (*Imposto sobre Circulação de Mercadorias e Serviços*) represents the largest source of state revenue in Brazil, constituting approximately 90% of overall state tax revenues (Loureiro, 2002). It is also an important source of revenue for local governments. The ICMS is a tax on goods and services, similar to the value-added taxes in other countries. It is

collected on commercial transactions and exchanges of goods and services, such as energy, transportation and communication (May et al., 2002). The Federal Constitution of Brazil as adopted in 1988 decrees that 25% of the revenues raised by this tax are to be allocated by the state to the local level of government. Constitutional law further stipulates that 75% of the total amount passed on to the municipalities is to be distributed in accordance with the share of the state ICMS that has been collected within that municipality. The state governments determine the indicators to be used for allocating the remaining 25%. Typical indicators are based on population, geographical area and primary production (Grieg-Gran, 2000). Since the 1990s, the states began to introduce ecological indicators.

Paraná was the first state to introduce the ICMS Ecológico (ICMS-E) (May et al., 2002), meaning the ICMS along with an allocation of tax revenues based on environmental indicators.[2] In 1990 and 1991, the relevant laws and implementing regulations were adopted that allowed for consideration of ecological indicators in the ICMS (Loureiro, 2002). Drawing on the experience of Paraná, which started using ecological indicators in 1992, the states of Minas Gerais (1996), São Paulo (1996), Rondônia (1997), Mato Grosso do Sul (2002), Tocantins and Pernambuco (2003) started operating a similar system a few years later (Grieg-Gran, 2000; Loureiro, 2002; May et al., 2002; CPRH, 2003). The state of Rio Grande do Sul passed an ICMS-E Law in 1993, followed by implementing laws and regulations in 1997 and final adoption in 1999 (Freitas, 1999). ICMS-E legislation also exists in the states of Amapá (1996), Mato Grosso (2001) and, very recently, Rio de Janeiro (2007). Other Brazilian states, namely Santa Catarina, Espírito Santo and Goiás, drafted ICMS-E legislation; Amazonas, Bahia and Ceará submitted ICMS-E legislation to their respective state legislatures (Bernardes, 1999; Freitas, 1999; Leite, 2001; Loureiro, 2002; MMA, 2002; Arantes, 2006). Discussions are being conducted in the latter states, but so far ecological ICMS legislation has been met with opposition, mostly due to fiscal competition between municipalities for scarce revenues.

Paraná: valuing watershed protection areas and conservation units

Following the implementation of more strict environmental legislation in the early 1980s, a number of municipalities in Paraná that had protected areas on their territory exerted pressure on the state legislature and government agencies (Loureiro, 1998). The land-use restrictions associated with large conservation and watershed protection areas were preventing the municipalities from developing productive activities and thereby generating value added. The municipality of Piraquara is a typical example of this situation: 90% of municipal territory consists of designated protected areas for conserving a major watershed to supply the Curitiba metropolitan region (1.5 million inhabitants) with drinking water, and the remaining 10% occupies protected areas for biodiversity conservation (May et al., 2002).

The ICMS Ecológico was introduced in response to these concerns, as an instrument to compensate municipalities with large protected areas for the land-use restrictions they faced, while providing incentives for conservation (Loureiro, 2002). In the case of Paraná, state decision-makers considered the long-term costs of water treatment needed due to uncontrolled development around water sources. They also were worried about the serious deterioration of the state's land cover with respect to biodiversity protection (Loureiro, cited in Echavarría, 2000). Following the adoption of the Ecological ICMS Law in 1991, 5% of the total amount distributed to the local level has been based on ecological indicators since 1992. Half of this (2.5%) is distributed to municipalities that have watershed protection areas on their territories which partly or completely provide services for public drinking water systems in neighbouring municipalities. The other half is for those municipalities that have "conservation units" (Loureiro, 2002). Conservation units (*CUs*) are conservation areas that consist of completely protected and restricted sustainable use areas that can be publicly managed (federal, state or municipal level), privately owned or managed by public–private partnerships. The ICMS-E revenue accrues to the municipality and not to the owner of the land. Therefore, the incentive effect primarily addresses local public authorities. However, as we will see later, there is also an incentive effect to encourage public–private partnerships in terms of more environmentally sound land uses. The protected areas may be used indirectly (biological reserves, ecological stations and parks) or directly (indigenous areas, extractive reserves and sustainably managed forests). In either case, they have to be registered and legally defined in order to be considered for ICMS-E allocation (Grieg-Gran, 2000). In Paraná, the ICMS-E programme is administered by the Paraná State Environmental Institute (*Instituto Ambiental do Paraná, IAP*).

Synopsis of existing approaches

The states of Paraná, Minas Gerais, Rondônia and São Paulo have now been operating the ICMS-E for several years. Mato Grosso do Sul, Pernambuco and Tocantins introduced the new system only recently. Each state is free to decide upon the indicators for distributing 25% of the ICMS to the local level, and therefore, different operating

[2]The ICMS Ecológico is also known as the "ecological value-added tax". This holds both for scientific literature and common language use in Brazil. From a public finance perspective, however, this term is misleading. An ecological tax would be a tax whose assessment base is related to ecological indicators. The ICMS Ecológico, by contrast, uses ecological indicators for the allocation of its revenues. Therefore, economically speaking, the term ecological fiscal transfer is more appropriate and will be used henceforth in this article.

systems are in place. This is important to bear in mind when comparing various effects among the states. The indicator "conservation units" has been introduced by all states with ICMS-E legislation. Although the states use slightly different methods to calculate the ecological index of a municipality, the basic procedure is the following:

The revenues allocated are based on the ecological index EI_i of municipality i multiplied by the total amount of ICMS-E revenues dedicated to conservation units. The ecological index EI_i is calculated by dividing the municipal conservation factor MCF_i by the state conservation factor SCF. For each municipality i $(i = 1,\ldots,z)$ the ecological index EI_i can be written as

$$EI_i = \frac{MCF_i}{SCF}. \quad (1)$$

EI_i is the ecological index of municipality i, MCF_i the municipal conservation factor of municipality i, SCF the state conservation factor, and z the total number of municipalities in the state.

The municipal conservation factor MCF_i is based on the total area set aside for protection in terms of conservation units CU in relation to the total area of the municipality:

$$MCF_i = \frac{Area\ CU_i}{Area\ M_i}. \quad (2)$$

$Area\ CU_i$ is the total area of conservation units in municipality i and $Area\ M_i$ the total area of municipality i.

The CUs of a municipality are calculated according to Eq. (3) where the protected areas are weighted according to the different categories of management. Table 1 shows the conservation weights CW_n for different types of protected areas in Paraná.

If n denotes the different categories of management,

$$Area\ CU_i = \sum_n protected\ area_n \times CW_n. \quad (3)$$

CW_n is the conservation weight for management category n.

Table 1
Conservation weights CW_n for different management categories n of protected areas in Paraná

Management category	Conservation weight
Ecological research station	1.0
Biological reserve	1.0
Park	0.9
Private natural heritage reserve	0.8
National, state or municipal forest	0.7
Indigenous area	0.5
Environmental protection area I	0.1
Area of relevant ecological interest	0.1
Special, local areas of tourist interest	0.1
Buffer zones	0.1

Source: Adapted from Grieg-Gran (2000).

The state conservation factor SCF is given by the sum of all municipal conservation factors in the state:

$$SCF = \sum_{i=1}^{z} MCF_i. \quad (4)$$

Paraná was also the first state to evaluate the quality of protected areas and to include this in the calculation of the ecological index (Grieg-Gran, 2000; Loureiro, 2002; May et al., 2002). The additional quality index of each protected area is assessed by regional officers of the state environmental agency on the basis of variables such as physical quality, biological quality (fauna and flora), quality of water resources (within the CU and in its surroundings), physical representativeness, and quality of planning, implementation and maintenance.[3] Minas Gerais (2005) planned for a quality factor early on, but only introduced the respective regulation in 2005. Although more states with ICMS-E legislation call for a quality index, in most cases they are only partially implemented, if at all.

Table 2 illustrates the types and shares of all ecological indicators adopted so far for ICMS-E allocation by the respective states. With regard to the waste management indicator in Minas Gerais, funds are allocated to those municipalities operating solid and liquid waste management systems duly licensed by the State Environmental Policy Council (Bernardes, 1999).

Differences can be noted in the way the states introduced ecological indicators into the ICMS allocation system. In Rondônia, the allocation of ICMS based on value added (75%), population (0.5%), area (0.5%) and agricultural production (5%) did not change (Freitas, 1999). It was the "equal share" indicator being reduced from 19% to 14% that allowed for the introduction of the ecological indicator, which was allocated a share of 5% (Grieg-Gran, 2000).

Whereas Rondônia changed its allocation system within one year (between 1996 and 1997), Minas Gerais introduced its new allocation system step-wise, starting to apply new indicators in 1996 and achieving full operation of the new system in 1998. In Minas Gerais, the introduction of the ICMS-E was part of a substantial change of the whole ICMS allocation system, popularly known as the "Robin Hood Law" (Bernardes, 1999). The allocation based on value added was gradually reduced from about 94% (1995) to 80% (1998) to allow for the consideration of other indicators. Apart from the introduction of ecological indicators, eight further indicators were implemented: geographical area (1%), population (2.71%), 50 municipalities with the biggest population (2%), education (2%), area cultivated (1%), cultural heritage (1%), health expenditure (2%) and the municipalities' own revenue generation (2%). Here, the reform of the ICMS system covered not only ecological aspects, it also included the redistribution of resources for social reasons, aimed at

[3] A more detailed description is provided by Loureiro (2002, p. 79ff) and May et al. (2002, p. 195).

Table 2
ICMS allocation for ecological indicators in the states operating the ICMS Ecológico

State	ICMS-E legislation adopted	Ecological share of total ICMS (%)	Allocation to resp. indicators (%)	Ecological indicators
Paraná	1991	5	2.5 2.5	Watershed protection areas Conservation units
São Paulo	1993	0.5	0.5	Conservation units
Minas Gerais	1995	1	0.5 0.5	Conservation units Solid waste disposal and sanitation systems
Rondônia	1996	5	5	Conservation units
Amapá	1996	1.4	1.4	Conservation units
Rio Grande do Sul	1998	7	7	Conservation units
Mato Grosso	2001	7	5 2	Conservation units Waste disposal and sanitation systems
Mato Grosso do Sul	2001	5	5	Conservation units
Pernambuco	2001	6	1 5	Conservation units Waste management
Tocantins[a]	2002	13	3.5 3.5 2 2 2	Conservation units Solid waste disposal and sanitation systems; water protection Slash and burn control Local environmental policy Soil protection
Rio de Janeiro[b]	2007	2.5	1.1 0.8 0.6	Conservation units Water resources Solid waste management

Sources: Bernardes (1999), Grieg-Gran (2000), Loureiro (2002), CPRH (2003), SEPLAN (2003), Rio de Janeiro (2007), and Domingues (personal communication).
[a]Final implementation state in 2007.
[b]Final implementation state in 2011.

making poorer municipalities better off. For this reason, it is much more difficult to illustrate clearly the effects of the introduction of ecological indicators in Minas Gerais compared to Rondônia (Grieg-Gran, 2000).

The state of Tocantins also decided to introduce the ICMS-E in a gradual manner. Having started in 2003 with an overall percentage of 3.5% for ecological indicators, Tocantins is to allocate a total of 13% in 2007 for conservation units and indigenous areas, local environmental policy, slash and burn control, water and soil protection, as well as waste and sewage disposal (SEPLAN, 2003).

A similar step-wise implementation is foreseen in the state of Rio de Janeiro, which passed its law on the ecological ICMS in October 2007 (Rio de Janeiro, 2007). Starting with just 1% in 2009, in its final implementation stage in the year 2011 a total of 2.5% will be allocated to municipalities according to conservation units, the quality of water resources and solid waste management (see Table 2).

Before investigating the specific effects of the ICMS-E, a brief overview is presented regarding the existence and respective categories of protected areas for the states of Paraná, Rondônia and Minas Gerais. Table 3 shows the jurisdiction of protected areas in these states in 1997, differentiated according to federal, state and municipal levels. All states have in common a very low percentage of protected areas under municipal jurisdiction. In Paraná, more than 95% of areas are protected under a jurisdiction higher than the municipal level; in Minas Gerais and Rondônia the figure is more than 99%.

Rondônia represents a very special situation. This state has an extraordinarily high percentage of protected areas (36%), with more than 50% of all its municipalities containing protected areas (total number of municipalities in 1998: 52). Rondônia began to be settled through officially induced colonisation by people of European ancestry only in the late 20th century, starting in the early 1970s. A substantial part of this state consists of Indian reserves, extractive reserves, federal parks and other reserves, most of which are threatened by illegal logging, mining and other economic activities. In contrast, Paraná and Minas Gerais are in the Atlantic Forest, where

Table 3
Jurisdiction of protected areas in Paraná, Rondônia and Minas Gerais (1997)

	Federal	State	Municipal	Total
Paraná				
Area protected (ha)	502,471	1,013,421	69,699	1,585,590
Percentage of total protected area	32	64	4	100
Protected areas as % of total state area				2
Minas Gerais				
Area protected (ha)	830,269	331,078	2772	1,164,119
Percentage of total protected area	71	28	0.24	100
Protected areas as % of total state area				2
Rondônia				
Area protected (ha)	6,637,462	2,406,018	1150	9,044,630
Percentage of total protected area	73	27	0.01	100
Protected areas as % of total state area				36

Source: Grieg-Gran (2000, p. 7).

settlement has taken place ever since colonisation in the 16th century, leading to substantial deforestation. Only 1% of the original Atlantic Forest is left, of which 75% is severely endangered. Protected areas in Minas Gerais account for 2% of its total state area, with only about 16% of its municipalities including protected areas as part of their municipal area (total number of municipalities in 1998: 853) (Grieg-Gran, 2000). Paraná's protected areas also account for about 2% of the total state area (total number of municipalities in 1999: 400).

Participation in the programme

In the states in which ICMS-E legislation exists, ecological fiscal transfers are automatically distributed to all municipalities that qualify, i.e. that hold officially registered conservation units within their territories. Therefore, an important prerequisite for the success of the programme is a good information policy. Municipalities need to know about the programme and they also need to expect benefits from participation for actually making an effort to create new conservation units or to use the ICMS-E revenues for additional conservation benefits. In Minas Gerais, for example, the decentralised structure of the State Forest Institute, which is responsible for monitoring all information related to ICMS-E transfers based on conservation units, turned out to be extremely helpful in terms of publicising the new law. With its 150 local and 14 regional offices, it acted as an important source of information for municipalities with an interest in participation (Bernardes, 1999).

May et al. (2002) indicate that since the programme's inception, Minas Gerais showed a 100% increase in the number of municipalities benefiting from ICMS-E revenues. Currently, about 30% of all municipalities in Minas Gerais participate in the programme. In Paraná, the ICMS-E programme began with the participation of 112 municipalities in 1992. In the year 2000, 221 municipalities benefited from the ICMS-E, either for conservation units or watershed protection or for having both types of protected areas. Over 50% of all municipalities in Paraná are now participating in the programme. With regard to the biodiversity part of the ICMS-E programme, the number of participating municipalities grew from 63 in 1992 to 176 in the year 2000, representing an increase of 179% (Loureiro, 2002). This means that since its inception in Paraná, 113 municipalities qualified for the programme for the first time, due to the designation of new conservation units.

The ICMS-E has greatly improved relations between protected areas and the surrounding inhabitants (Bernardes, 1999). Instead of perceiving protected areas as an obstacle to development, they are starting to see them as an opportunity to generate revenue. More municipalities are now aware of the existence of protected areas within their territory and are beginning to change their attitude towards them. They are more open to creating new reserves and, depending on the design of ecological indicators, also care about the quality of these areas. During the first year of operating the ICMS-E in Minas Gerais, only federal and state protected areas were considered; protected areas at municipal level were excluded because they lacked formal registration. The following year saw the official registration of existing municipal protected areas, and these were then included in the ICMS-E programme (Grieg-Gran, 2000).

Increase in protected areas

Young (2005) stresses the effectiveness of the ICMS-E in encouraging the creation of new protected areas. Existing empirical studies concentrate on the states of Paraná and Minas Gerais, which were among the first states to introduce this economic instrument. Here, a clear incentive effect can be seen in the way new protected areas have been created, predominantly at local and state level. In relation to public protected areas in particular, the ICMS-E has

become an important stimulus for the creation of new conservation units and for improved environmental management and quality of these areas.

In Paraná, the total area measured in conservation units grew by over 1,000,000 ha in the year 2000, representing an overall increase of 165% during the 9 years since the programme's inception in 1992 (May et al., 2002). Table 4 shows that municipalities developed a strong interest in designating new public protected areas at the local level. The introduction of quality evaluation for conservation units had a positive effect on the interest of municipalities in improving their management (Grieg-Gran, 2000, p. 21). Some municipalities and their mayors also started supporting private land users in managing conservation units, including provision of staff, equipment and vehicles for managing the areas.

In Minas Gerais, conservation units grew by slightly over 1,000,000 ha in 5 years, representing a 62% increase (see Table 5, May et al., 2002). As for public protected areas, the designation of new protected areas was carried out exclusively at the state and municipal level of government. In Minas Gerais, however, the ICMS-E is not the only reason for the increase in protected areas: part of the initial growth was due to the efforts by local governments to register existing units that had not been regulated previously by the state.

In Paraná and Minas Gerais, intra-state allocations favour municipalities with large areas dedicated to 'indirect use' conservation units, which are designated at state and federal levels. Relatively high conservation weights are assigned to parks, reserves and forests (cf. Table 1), and a significant increase in protected areas can be noted for these management categories, at both state and municipal governmental levels (May et al., 2002). Nevertheless, a substantial volume of financial resources has been allocated to municipalities with Environmental Protection Areas (Área de Proteção Ambiental, APAs). APAs alone account for 86% (Paraná) and 78% (Minas Gerais) of the incremental increase in total new conservation units in these states, the vast majority being dedicated to state and municipal APAs. APAs are easily created, and a relatively low level of control is practised within them. They may cover large areas within a municipality with restricted zoning, in spite of far less rigorous enforcement than other conservation units, which is reflected by rather low conservation weights.

Following the introduction of the ICMS-E, new state legislation in Paraná and Minas Gerais has enabled the

Table 4
Public and private protected areas in Paraná before and after the ICMS-E

Protected areas	Until 1991 (ha)	Created after 1991 (ha)	Total by 2000 (ha)	Increase (%)
Public				
Federal	289,582	50,846	340,428	18
State	39,859	13,804	53,663	35
Municipal	1429	2740	4169	192
Private/mixed				
APA	306,693	905,631	1,212,324	295
RPPN	0	26,124	26,124	
Other	0	53,607	53,607	
Total	637,563	1,052,752	1,690,315	165

Source: Adapted from May et al. (2002). APAs (Environmental Protection Areas) can be designated at federal, state or municipal level. RPPNs (Private Natural Patrimony Reserves) can be designated at federal or state level.

Table 5
Public and private protected areas in Minas Gerais before and after the ICMS-E

Protected areas	Until 1995 (ha)	Created after 1995 (ha)	Total by 2000 (ha)	Increase (%)
Public				
Federal	268,147	0	268,147	0
State	295,151	196,436	491,587	67
Municipal	3851	9076	12,927	236
Private/mixed				
APA	1,023,566	785,894	1,809,460	77
RPPN	20,261	13,808	34,069	68
Total	1,610,976	1,005,214	2,616,190	62

Source: Adapted from May et al. (2002). APAs (Environmental Protection Areas) can be designated at federal, state or municipal level. RPPNs (Private Natural Patrimony Reserves) can be designated at federal or state level.

Table 6
Protected areas in Minas Gerais before and after the ICMS-E, according to governmental levels

Protected areas	Up to 1995 (ha)	Created after 1995 (ha)	Total by June 1999 (ha)	Increase (%)
Federal	909,467	5710	915,177	0.6
State	695,610	552,976	1,248,586	79.5
Municipal	6997	113,297	120,294	1619.2
Total	1,612,074	671,983	2,284,057	41.7

Source: Adapted from Bernardes (1999). In this table, public and private/mixed protected areas, such as APAs and RPPNs, are already included in the figures presented according to their governmental level of designation.

generation of a wider range of conservation units, including areas established under municipal jurisdiction as well as the Private Natural Patrimony Reserves (Reserva Particular do Patrimônio Natural, RPPN). RPPNs are owned and administered by a wide range of institutions, including NGOs, industry or private landowners. These private reserves are established and run by their owners. Owners are fully responsible for maintenance and management, yet they may benefit indirectly from the revenues municipalities receive based on the ICMS-E.

Originally, RPPNs represented a category of protected areas that was to be designated and handled at the national level by IBAMA (*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis*), involving a very slow and difficult process. Paraná and Minas Gerais established state legislation in the 1990s, allowing a less bureaucratic way of designating and handling the private reserves at state level. Together with the financial incentive effect of the ICMS-E, this step contributed to a significant increase in the number and size of RPPNs. By the year 2000, some 26,124 ha were designated in Paraná and 34,069 ha in Minas Gerais. Both states are promoting RPPNs as part of an integrated public–private partnership in buffer zones surrounding public protected areas (Bernardes, 1999). Particularly in Paraná, state environmental agencies play a very active role in promoting private reserves, and the state now holds the largest number and area of RPPNs (183 reserves with 36,928 ha) protecting the remaining Atlantic Forest, one of the global hotspots of biodiversity (Mesquita, 2004). The positive experience with these reserves was triggered by the ecological fiscal transfers that motivated local governments to assist landowners in measures to protect and maintain the environmental quality of their areas, as well as helping them to prepare the necessary registration documentation (Bernardes, 1999). A number of local governments have now begun to share additional revenues from RPPNs with landowners, whether in cash or in kind. This is done through agreements with the state association of RPPNs, since there is no leeway in the state laws for direct payment of municipal budgetary resources to private landowners for environmental services. May et al. (2002) mention in the case of Paraná that mainly large farmers were prioritised for RPPN creation, due to the size of their property and the volume of resources generated from it. Although small farmers may also be interested in RPPN creation, their land is not usually eligible due to its small size and the high transaction costs associated with it.

Bernardes (1999) presents figures for protected areas in Minas Gerais up to June 1999 that further break down the categories of APA and RPPN according to their governmental levels (Table 6).[4] These figures clearly show how strong an incentive effect the ICMS-E exercised on the initiative at state and local levels to create new protected areas. The largest absolute increase (552,976 ha) in protected areas up to June 1999 was due to new conservation units at state level. However, the largest relative increase of 1619% took place at municipal level, where 120,294 ha of protected areas existed in June 1999 compared to only 6997 ha before the introduction of the ICMS-E.

Changing municipal revenues

The total amounts passed through to municipalities are appreciable. In the state of São Paulo, the sums distributed from the ICMS-E amounted to 70,241 million Brazilian Real (R$) between 1994 and 1996, averaging over R$ 23.4 million annually. It is estimated that participating municipalities in São Paulo received about R$ 2.45 per hectare of protected area per month (Bernardes, 1999). Azzoni and Isai (1994) provide an estimate of the opportunity costs associated with protected areas for the state of São Paulo. They relate the value of production lost (in terms of state GDP) to state and county losses in terms of fiscal transfers and revenues from the value-added tax. They show for two extreme scenarios that—based on existing protected areas—the cost of environmental protection is likely to be between 0.05% and 0.03% of the state's GDP, depending on the location of the protected areas.

In Paraná, the amounts averaged over R$ 50 million annually between 1994 and 2000[5] (May et al., 2002). Individual municipalities, such as Piraquara in Paraná, saw their revenues increase considerably. Ninety percent of Piraquara's municipal territory is designated as a protected

[4]Bernardes (1999) and May et al. (2002) differ slightly in their base figure of protected areas in Minas Gerais up to 1995. Since the difference of less than 1% is minimal, this is not considered any further here.

[5]In June 2001: Brazilian Real R$ 1.00 = US$ 0.41.

area for water conservation, while the remaining 10% consists of protected areas for biodiversity conservation. This municipality increased its earnings by 84% in 1995 (Loureiro, cited in Echavarría, 2000).

May et al. (2002) investigated municipal revenues in the Paraná floodplain, the so-called "Varjão". Located in the northwestern part of the state, it lies within the Paraná, Paranapanema and Piquiri watersheds. Here, the ICMS-E constitutes a high percentage of overall municipal revenues and became a solution to the financial problems of the municipalities. The impacts of ICMS-E resources are especially significant, for example, in the municipality of São Jorge do Patrocínio, which has 52% of its total area in conservation units (May et al., 2002, p. 185). In 1998, ICMS-E transfers represented 17.6% of the overall municipal budget and in 2000, ICMS-E revenue amounted to 71% of total ICMS transfers for that year. Conservation began to become an important part of the municipal agenda—for neighbouring municipalities as well. It led to the creation of Brazil's first municipal consortium for biodiversity protection in 1995 and, two years later, of the Ilha Grande National Park. Differences in ICMS-E pass-throughs are mainly due to the proportion of Park area within the total area of the municipality. The local population is aware of the financial importance of the ICMS-E for revenue generation, and the behaviour of the community towards the environment has changed. ICMS-E resources nowadays are used for numerous environmental activities, such as well drilling to provide drinking water, cleaning and landscaping of the urban area, rubbish collection, landfills, environmental education and the enforcement of land-use controls in parks and APAs. They are also used for other activities, such as the acquisition of tractors or the construction of industrial facilities. "All these benefits, provided by ICMS-E revenues, are disclosed to the community to make the public aware of the link between environmental protection and day-to-day-problems" (May et al., 2002, p. 185).

Grieg-Gran (2000) investigated the detailed financial effects of the ICMS-E for the states of Rondônia and Minas Gerais. Due to the relatively low number of municipalities in Rondônia, a full picture for the whole state is available. Here, the 5% ecological share of total ICMS was introduced between 1996 and 1998 in combination with the equivalent reduction in the equal shares indicator. As a consequence, municipalities must have at least a 25% share of protected area within their territory to outweigh the reduction in the equal shares indicator. Municipalities with more than a 25% share of protected area can benefit significantly from the new type of transfers. In Rondônia, roughly 60% of municipalities with protected areas benefited from the introduction of the ICMS-E: 7 municipalities with more than 50% protected area, three municipalities with 40–50%, six municipalities with 30–40% protected area, and one municipality with 25–30%. The remaining 40% of municipalities experienced a negative impact due to the reduction in weighting accorded to the equal shares indicator.

In Minas Gerais, the values allocated through the ICMS-E reached about R$ 15 million annually between 1998 and 2000 (May et al., 2002). In 1998, 86 municipalities with protected areas benefited from the increase in their consolidated index for ICMS allocation thanks to the ecological indicator (Grieg-Gran, 2000). Thirty-eight municipalities with protected areas experienced a reduction in their overall index. This reduction in revenues resulted not so much from having too few protected areas, but rather from other factors. In part, it was due to the reduction in weighting accorded to value added; and in part it was to do with the introduction of other new indicators, such as health and education. In the case of Minas Gerais, it is important to distinguish between the effects of the ecological indicator and those of the others. For some municipalities, however, the introduction of the ecological indicator turned out to be extremely important. In 1998, the ecological index accounted for more than 20% of the consolidated index in some 20 municipalities. The municipality of Marliéria, for example, has 55% of its territory within the Rio Doce State Park, the largest contiguous area of Atlantic Forest in Minas Gerais. Here, the ecological index accounts for 70% of the overall index for ICMS allocation (Grieg-Gran, 2000), and in the first year after the ICMS-E was introduced, revenues from it accounted for around 68% of total municipal ICMS revenues, increasing from R$ 36,648 in 1995 to R$ 811,335 in 1996 (Bernardes, 1999).

One generic feature of the ICMS Ecológico in particular deserves to be highlighted: the amount of money available for distribution for ecological purposes in any one year depends on the state revenues of value-added tax in this year. Thus, municipalities are competing for the same pool of money. Given certain finite tax revenues, the creation of additional conservation units will inescapably lead to a gradual decrease in payments for environmental services per unit. Municipalities compete to provide more ecosystem services at lower and lower costs. Therefore, it is important to design the ICMS Ecológico not just around the quantity of conservation units, but also around their quality. In Paraná, the growing quality of conservation units over the years has demonstrated just how much of an incentive effect the criterion of quality is capable of generating (Loureiro, 2002). If municipalities are aware of this feature, it may also motivate them to consider carefully the opportunity costs of different land uses.

Grieg-Gran (2000) presents calculations for Rondônia and Minas Gerais in order to identify the potential benefits that municipalities can expect to accrue when they set aside a further 1000 ha of protected area.[6] For municipalities with very low average levels of value added and primary production, the conservation option would turn out to be highly beneficial. In the case of Rondônia, 28 municipa-

[6] Grieg-Gran (2000) assumes that the municipality concerned is the only one in the whole state to designate an extra 1000 ha of its territory as a protected area.

lities would benefit from creating protected areas. Of these, only 12 already have protected areas, 16 have none and could be financially better off with protected areas. Comparative calculations for Minas Gerais are more complicated due to complex changes in overall ICMS-E allocations. Still, there are municipalities with low levels of value added where the creation of protected areas would be extremely financially attractive. São Sebastião do Rio Preto, which has no conservation units, would have to generate at least 226 times the average value added per hectare in the municipality for it to be more beneficial in terms of ICMS revenues than the creation of 1000 ha of protected area (Grieg-Gran, 2000, p. 24).

The ecological ICMS: general reflections and transfer potential

The way forward in Brazil

Although the basic features of the ICMS-E are rather uniform across the various Brazilian states, the method of implementing it, its operation in practice and the reactions on the part of the municipalities can vary greatly. In-depth empirical studies show that ICMS-E allocations appear to have substantial impacts on conservation decisions in some areas, while in others only a limited impact can be observed (May et al., 2002). Municipalities with a high share of protected areas in particular can benefit substantially from the ecological fiscal transfers, and therefore appreciate the ecological services they provide across local boundaries. Many municipal governments—and depending on their information policy the public as well—are now aware of the natural assets they preserve and maintain. However, the type of indicator chosen also determines the incentive effect. The examples of Paraná and Minas Gerais show that not only the quantity but also the quality of the respective areas should be taken into consideration. In Paraná, there has not only been an increase in the number and surface area of conservation units, there have also been noted improvements in the quality of conservation units (Loureiro, 2002). A quality-based evaluation awaits implementation in other states, and this represents a major challenge due to the regular controls of the registered areas conducted by decentralised environmental institutions.

One prevalent point of critique relates to the way the ICMS-E revenues are currently allocated to municipalities. So far, they are given as lump-sum transfers, to be used in any way the recipient wishes. Some authors argue that earmarking for environmental purposes should be considered (Grieg-Gran, 2000; May et al., 2002). However, from a general public finance perspective, there are also a number of arguments in favour of lump-sum transfers, such as guaranteeing maximum financial autonomy to local jurisdictions.

Despite the pros and cons of how precisely to design the ICMS-E, this innovative instrument is in the ascendent in Brazil. One of the great advantages of the ICMS-E is that it is not an instrument that requires new institutions or a new bureaucracy. By simply introducing an ecological indicator into the existing fiscal transfer mechanism, it builds on existing institutions and administrative procedures, thereby entailing very low transaction costs. The ICMS Ecológico is strongly promoted by the Federal Environmental Ministry and many initiatives have been undertaken by a variety of actors to advance its implementation in those states that do not have it so far, such as Goías, Espírito Santo and Bahía (Arantes, 2006; Veiga Neto, 2006, personal communication).

A major challenge for Brazil will be to promote efforts for the design and implementation of economic incentives that are geared directly towards individual land users. The ICMS-E clearly has its focus on municipalities and on compensation for the land-use restrictions imposed on local public governments. However, a substantial proportion of the opportunity costs generated by protected areas accrues at the level of the individual land user. Therefore, further programmes need to be developed that focus on the individual land user, among them payments for environmental services, agricultural certification schemes, agri-environmental and forestry programmes, and so forth.

Transfer potential to other federal systems

Local governments rarely have substantial scope for influencing decisions made on the designation and maintenance of large-scale areas set aside for protective purposes. The "forced" provision of ecological goods and services in the form of protected areas, where there is no compensation for positive spillovers, is neither effective nor efficient. From an economic point of view, it is perfectly rational for local governments to be uninterested in—or even to be against—water and nature protection areas if the associated costs are to be borne locally, e.g. in terms of land-use restrictions, whereas many benefits cross local boundaries. Municipalities do not usually support the existence of protected areas within their territory, apart from a few exceptions where intrinsic motivation or a substantial potential for nature tourism comes into play. For most other local actors, protected areas reduce options for generating local income by attracting more inhabitants or promoting economic development. Even though protected areas might exist, a lack of enforcement, control or even simply information can easily lead to the deterioration of the quality of these areas. Therefore, one prerequisite for long-term sustainable land use consists in the integration of protected areas with positive spillovers into intergovernmental fiscal transfers to the local level. The internalisation of positive spatial externalities brings local interests in line with supra-local interests, thereby creating incentives for appropriate local public behaviour and contributing to economic efficiency.

One of the major problems associated with centralised provision of ecosystem services is that knowledge about the opportunity costs of protected areas is greater at the local

level. The ICMS Ecológico addresses this problem by combining centralised incentives with decentralised decisions. As with markets, it does not require any centralised source of information. Although this article presented a national case study from Brazil, the general message can be transferred to other federal systems. It goes without saying that the recommendations to be made depend on the type of federal system being looked at, the general role and functions of different jurisdictions within these systems, and the specific constitutional and environmental legislation in force. In Brazil, the present focus is on compensating municipalities, i.e. public institutions, based on environmental performance indicators. Due to the specific legal framework and societal conditions prevailing there (including the prevention of corruption), there are almost no instruments that directly support private land users in their substantial role as conservation actors (Loureiro, 2005, personal communication).

If we take the European Union and its many federally organised member states as a prominent example for comparison, the choice of instruments for compensating for local spillover benefits reflects the opposite strategy. Here, the focus is almost exclusively on the private land user, be it in agriculture, forestry or aquaculture. There are, for example, many different agri-environmental programmes in existence that are continuously being monitored and improved with the aim of increasing ecological effectiveness (e.g. Court of Auditors, 2000; Baldock et al., 2002). Ultimately, both sides—private land users and the municipality as the public representative of local communities—have to be considered in their specific role for long-term sustainable land use (Ring, 2004). However, in a few European countries there is a need for increased use of fiscal transfers to the local level for conservation purposes.

Köllner et al. (2002), for example, present a recent case study for integrating biodiversity into intergovernmental fiscal transfers in Switzerland. Portugal has recently set up a fiscal transfer scheme that explicitly rewards municipalities for having designated Natura 2000 sites and other protected areas within their territories (de Melo and Prates, 2007). In Germany, this topic has already been discussed among the research community, federal conservation agencies and expert councils. In its reports over the last 10 years the German Advisory Council on the Environment has called for the integration of ecological indicators into intergovernmental fiscal transfers to the local level (SRU, 1996; Ewers et al., 1997). A number of detailed studies and suggestions regarding implementation are available (e.g. Bergmann, 1999; Rose, 1999; Ring, 2001; Perner and Thöne, 2005), although the crucial step towards creating actual policy on this has not yet been taken. The Brazilian case showed that various mechanisms already exist for acknowledging ecological goods and services in intergovernmental fiscal transfers to the local level. In Germany, only very few states have implemented ecological aspects in their fiscal system, mostly concentrating on end-of-the-pipe and infrastructure-related public ecological functions (Ring, 2002). The special relevance of protected areas has not yet been recognised. As a result, the majority of German municipalities still perceive them as an obstacle to development (Bauer et al., 1996, p. 334; Stoll-Kleemann, 2001). Both theoretical analysis of the principles behind the economic theory of federalism related to spillovers from protected areas and the respective empirical investigations of the Brazilian federal system have shown that there still is a great need for adequately rewarding ecological services provided by the local level.

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References

Arantes, A., 2006. ICMS Ecológico, uma oportunidade histórica de Goiás. Article by the secretary of state of the State Environmental Ministry of Goiás SEMARH (Secretário do Meio Ambiente e dos Recursos Hídricos), 1 February 2006. Accessed at 〈www.semarh.goias.gov.br〉 on 26 May 2006.

Azzoni, C.R., Isai, J.Y., 1994. Estimating the costs of environmental protection in Brazil. Ecological Economics 11 (2), 127–133.

Baldock, D., Dwyer, J., Sumpsi Vinas, J.M., 2002. Environmental integration and the CAP. A Report to the European Commission, DG Agriculture, Institute for European Environmental Policy, London, September 2002.

Bauer, S., Abresch, J.-P., Steuernagel, M., 1996. Gesamtinstrumentarium zur Erreichung einer umweltverträglichen Raumnutzung. Metzler-Poeschel, Stuttgart.

Bergmann, E., 1999. Lenkung der Flächenausweisung über Zuweisungen? Informationen zur Raumentwicklung 9, 555–564.

Bernardes, A.T., 1999. Some mechanisms for biodiversity protection in Brazil, with emphasis on their application in the State of Minas Gerais. World Bank, Washington, DC.

Buchanan, J.M., 1950. Federalism and fiscal equity. American Economic Review 40, 583–599.

Court of Auditors, 2000. Special Report No. 14/2000 on 'Greening the CAP' together with the Commission's replies, Official Journal of the European Communities, 2000/C 353/01, 8.12.2000.

CPRH (State Agency of the Environment of Pernambuco), 2003. Decret Nr. 25.574 of June 2003. 〈http://www.cprh.pe.gov.br/ctudo-secoes--sub.asp?idsecao=178〉, accessed 27 May 2004.

Döring, T., 1997. Subsidiarität und Umweltpolitik in der Europäischen Union. Metropolis, Marburg.

Echavarría, M., 2000. Valuation of water-related services to downstream users in rural watersheds: determining values for the use and protection of water resources. FAO Background Paper No. 4, presented at the Electronic Workshop "Land–Water Linkages in Rural Watersheds," 18 September–27 October 2000, Rome.

Ewers, H.-J., Rehbinder, E., Wiggering, H., 1997. Umweltbezogene Erweiterung des Finanzausgleichs. Zeitschrift für Gesetzgebung 2, 135–147.

Freitas, A., 1999. ICMS Ecológico–Um Instrumento Econômico para Conservação da Biodiversidade. WWF Brasil, Brasilia.

Gowdy, J., 1997. The value of biodiversity: markets, society, and ecosystems. Land Economics 73 (1), 25–41.

Grieg-Gran, M., 2000. Fiscal incentives for biodiversity conservation: the ICMS Ecológico in Brazil. Discussion Paper 00-01, International Institute for Environment and Development, London.

Hansjürgens, B., 1996. Föderalismustheorie und europäische Umweltpolitik. Ökonomische Kriterien für die Verteilung umweltpolitischer Kompetenzen in der EU. In: Postlep, R.-D. (Ed.), Aktuelle Fragen zum Föderalismus: Ausgewählte Probleme aus Theorie und politischer Praxis des Föderalismus. Metropolis, Marburg, pp. 73–98.

Hansjürgens, B., Messner, F., 2002. Die Erhebung kostendeckender Wasserpreise in der Wasserrahmenrichtlinie. In: von Keitz, S., Schmalholz, M. (Eds.), Handbuch der Wasserrahmenrichtlinie—Inhalte, Neuerungen und Anregungen für die nationale Umsetzung. Erich-Schmidt-Verlag, Berlin, pp. 293–319.

Horton, B., Colarullo, G., Bateman, I.J., Peres, C.A., 2003. Evaluating non-user willingness to pay for a large-scale conservation programme in Amazonia: a UK/Italian contingent valuation study. Environmental Conservation 30 (2), 139–146.

Köllner, T., Schelske, O., Seidl, I., 2002. Integrating biodiversity into intergovernmental fiscal transfers based on cantonal benchmarking: a Swiss case study. Basic and Applied Ecology 3, 381–391.

Leite, F.H.F., 2001. O ICMS Ecológico no Rio de Janeiro. Monografia de Bacharelado, Instituto de Economia, Universidade Federal do Rio de Janeiro, Rio de Janeiro.

List, J.A., Bulte, E.H., Shogren, J.F., 2002. "Beggar thy Neighbor": testing for free riding in state-level endangered species expenditures. Public Choice 111 (3), 303–315.

Loureiro, W., 1998. Incentivos Econômicos para Conservação da Biodiversidade no Brasil: ICMS Ecológico. IAP, Curitiba.

Loureiro, W., 2002. Contribuição do ICMS Ecológico à Conservação da Biodiversidade no Estado do Paraná. Tese Doutorado. Universidade Federal do Paraná, Curitiba.

May, P.H., Veiga Neto, F., Denardin, V., Loureiro, W., 2002. Using fiscal instruments to encourage conservation: municipal responses to the 'ecological' value-added tax in Paraná and Minas Gerais, Brazil. In: Pagiola, S., Bishop, J., Landell-Mills, N. (Eds.), Selling Forest Environmental Services: Market-based Mechanisms for Conservation and Development. Earthscan, London, pp. 173–199.

de Melo, J.J., Prates, J., 2007. EcoTerra Model—economic instruments for sustainable land-use management in Portugal. Paper presented at the 7th International Conference of the European Society for Ecological Economics, Leipzig, 5–8 June 2007.

Mesquita, C.A.B., 2004. RPPN da Mata Atlântica. Conservação Internacional, Belo Horizonte.

Millennium Ecosystem Assessment, 2005a. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

Millennium Ecosystem Assessment, 2005b. Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC.

Minas Gerais, 2005. Deliberação Normativa COPAM no. 86, de 17 de junho de 2005. Estabelece os parâmetros e procedimentos para aplicação do Fator de Qualidade, referente às unidades de conservação da natureza e outras áreas especialmente protegidas, previsto no Anexo IV, III, d), da Lei no. 13.803, de 27 de dezembro de 2000, que dispõe sobre a distribuição da parcela da receita do produto da arrecadação do ICMS pertencente aos municípios. Diário Oficial do Estado de Minas Gerais, Belo Horizonte.

MMA (Ministry of the Environment), Biodiversity and Forest Secretariat-SFB, 2002. National program for the conservation of biodiversity—DCBIO. Second National Report of Brazil to the Convention on Biological Diversity, preliminary version, Brasilia.

Musgrave, R.A., 1959. The Theory of Public Finance. McGraw-Hill, New York.

Oates, W.E., 1972. Fiscal Federalism. Harcourt Brace Jovanovich, New York.

Oates, W.E., 1998. Environmental policy in the European Community: harmonization or national standards? Empirica 25, 1–13.

Oates, W.E., 1999. An essay on fiscal federalism. Journal of Economic Literature 37, 1120–1149.

Oates, W.E., 2001. A reconsideration of environmental federalism. Discussion Paper 01-54, Resources for the Future, Washington, DC.

Olson Jr., M., 1969. The principle of "fiscal equivalence": the division of responsibilities among different levels of government. American Economic Review 59, 479–487.

Perner, A., Thöne, M., 2005. Naturschutz im Finanzausgleich. Erweiterung des naturschutzpolitischen Instrumentariums um finanzielle Anreize für Gebietskörperschaften. FiFo-Berichte, No. 3, Mai 2005, Finanzwissenschaftliches Forschungsinstitut an der Universität zu Köln, Köln.

Perrings, C., Gadgil, M., 2003. Conserving biodiversity: reconciling local and global public benefits. In: Kaul, I., Conceição, P., Le Goulven, K., Mendoza, R.U. (Eds.), Providing Global Public Goods: Managing Globalization. Oxford University Press, Oxford, pp. 532–555.

Postlep, R.-D., Döring, T., 1996. Entwicklungen in der ökonomischen Föderalismusdiskussion und im föderativen System der Bundesrepublik Deutschland. In: Postlep, R.-D. (Ed.), Aktuelle Fragen zum Föderalismus: Ausgewählte Probleme aus Theorie und politischer Praxis des Föderalismus. Metropolis, Marburg, pp. 7–44.

Ring, I., 2001. Ökologische Aufgaben und ihre Berücksichtigung im kommunalen Finanzausgleich. Zeitschrift für Angewandte Umweltforschung Sonderheft 13, 236–249.

Ring, I., 2002. Ecological public functions and fiscal equalisation at the local level in Germany. Ecological Economics 42, 415–427.

Ring, I., 2004. Naturschutz in der föderalen Aufgabenteilung: zur Notwendigkeit einer Bundeskompetenz aus ökonomischer Perspektive. Natur und Landschaft 79 (11), 494–500.

Rose, M.T., 1999. Überlegungen zur Berücksichtigung der ökologischen Ausgleichsfunktion ländlicher Räume im kommunalen Finanzausgleich–dargestellt am Beispiel des Landes Nordrhein-Westfalen. Zeitschrift für Angewandte Umweltforschung 12 (2), 267–279.

SEPLAN (Secretário do Planejamento e Meio Ambiente), 2003. ICMS Ecológico Tocantins. SEPLAN, Palmas, Tocantins.

Sigman, H., 2005. Transboundary spillovers and decentralization of environmental policies. Journal of Environmental Economics and Management 50, 82–101.

Similä, J., Thum, R., Varjopuro, R., Ring, I., 2006. Protected species in conflict with fisheries: the interplay between European and national regulation. Journal of European Environmental Planning and Law 5, 432–445.

SRU (Der Rat von Sachverständigen für Umweltfragen), 1996. Konzepte einer dauerhaft-umweltgerechten Nutzung ländlicher Räume. Sondergutachten. Metzler-Poeschel, Stuttgart.

Stoll-Kleemann, S., 2001. Barriers to nature conservation in Germany: a model explaining opposition to protected areas. Journal of Environmental Psychology 21 (4), 369–385.

Tiebout, C.M., 1956. A pure theory of local expenditures. Journal of Political Economy 64, 416–424.

Unnerstall, H., 2004. Rechtliche Grundlagen gegenwärtiger und zukünftiger ökonomischer Instrumente im Naturschutz und in der Flächenhaushaltspolitik. In: Döring, R., Rühs, M. (Eds.), Ökonomische Rationalität und Praktische Vernunft. Gerechtigkeit, Ökologische Ökonomie und Naturschutz. Königshausen & Neumann, Würzburg, pp. 249–274.

Unnerstall, H., 2006. Die verursachergerechte Kostendeckung für Wasserdienstleistungen als neues Instrument der Europäischen Umweltpolitik–Einordnung, Gehalt und Umsetzung. Zeitschrift für Umweltpolitik und Umweltrecht 449–480.

Young, C.E.F., 2005. Financial mechanisms for conservation in Brazil. Conservation Biology 19 (3), 756–761.