How Tourism Can Save Nature

Michael Hübler[†]

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Abstract

This paper sets up a two-sector, two-period trade model of a developing country which is abundant in a non-renewable natural resource but scarce in industrial goods. It shows that lower future travel costs, rising demand for tourism and higher preferences for the environment slow down today's optimal depletion of the natural resource that can be used for consumption or for exporting tourism services. The benefits that accrue from sustainable resource use can be distributed such that the myopic developing country and forward-looking industrialized countries, which demand tourism services, are better off. The paper explains the underlying economic mechanisms in mathematical and graphical form. It derives the socially optimal policy instrument and discusses and evaluates its implementation. Accordingly, a subsidy, which modifies relative prices by up to ten percent and is mainly financed by the industrialized countries, may suffice to correct for the not anticipated future development of tourism.

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[*]The responsibility for the contents of this discussion paper rests with the author. Since discussion papers are preliminary, it may be useful to contact the author about results or caveats.

[†]Corresponding author, email: huebler@iuw.uni-hannover.de, tel: +49-511-762-19569, fax: +49-511-762-2667, Leibniz Universität Hannover, Königsworther Platz 1, 30167 Hannover, Germany; Centre for European Economic Research (ZEW), Mannheim, Germany.

1 Introduction

The value of world-wide exports of travel services has been continuously growing during the last decades. Figure 5 in the Appendix illustrates the soaring trend of annual global service exports during the last decades. This development is not surprising, because the value of total global production has been growing as well, and tourism is one of the largest sectors world-wide. The sticking point is that this development will be reinforced in a globalizing future world, whereas the destinations of tourism, related to natural resources (and cultural resources, not further discussed here) are not growing, but mostly being irretrievably depleted. If natural resources are depleted today, this will not only have a negative impact from a “nature-loving” or biodiversity perspective, but also from a strictly economic perspective. Hence, this paper puts forward a profound economic argument for preserving nature. Policy action is urgent in order to prevent the irreversible destruction of valuable natural resources and to preserve them for the pleasure and fascination of future generations. As a theoretical benchmark for policy action, this paper answers the question: how does future tourism affect today’s depletion of natural resources in a globalizing world? The paper mathematically describes and graphically illustrates the underlying economic mechanisms with the spotlight on international trade, which has not been done by the literature so far. Based on this, it derives the globally optimal policy instrument.

Many tourists seek for unspoilt beaches, coral reefs, rain forests, savannas, natural lakes, and so forth, with rich biodiversity including amazing wildlife. Such natural resources are often found in developing countries in the sub-tropical and tropical zone. Eco-tourism[1] seeking for unspoilt nature without destroying nature is becoming ever more popular. Figure 6 in the Appendix depicts evidence from South Africa as an example. The figure illustrates the soaring trend in the number of arrivals of foreign travellers to South Africa over the last couple of decades. 88 percent of these foreign travellers came for holiday reasons (Statistics South Africa, 2012). A large number of visitors came from high-income, industrialized countries, whereby the UK, the USA and Germany were the

[1] Eco-tourism, a specific ecological, nature-seeking and nature-preserving form of tourism, is relevant for this analysis, because it tries to avoid negative external effects of tourism. Otherwise, the negative effects of tourism on the environment might dominate the positive effects. Nonetheless, this analysis is not restricted to eco-tourism in its current form, but takes any form of nature-related tourism into account.

most frequent sources of tourists (Statistics South Africa, 2012). South Africa has about twenty national parks[2] that attracted almost five million visitors (PMG, 2012) in the season 2011/12 with an upward time trend. Due to their rich biodiversity and their natural uniqueness, natural resources, such as the national parks in South Africa, cannot be replaced by human activity. They would need a very long time horizon to recover after destruction and are hence treated as non-renewable resources in the following analysis.

It seems, however, that the expected future demand for nature-related tourism services cannot be satisfied because of the exploitation and destruction of nature for today's consumption. Virunga National Park, located in the Democratic Republic of the Congo, for example, is Africa's oldest national park and now under serious pressure through deforestation and plans for oil depletion. Another example is the Great Barrier Reef at the eastern Australian coast with its immense maritime biodiversity. This unique natural resource is in danger because of the expansion of Australian harbors. Another example is the Brazil Amazon rain forest with its immense biodiversity on the land, in the water and in the air. This unique natural resource is under pressure because of forest clearance for agriculture, large-scale depletion of soil resources and large-scale hydro power projects that provide the energy for resource extraction.

Against this background, this paper scrutinizes the dilemma of natural resource conservation for future tourism versus consumption today from a theoretical point of view, probably as the first contribution. The research idea, the model setup and the results presented in this paper are new in the literature, i.e. there is presumably no economic analysis that deals with the relation of today's resource depletion and future tourism in a globalizing world with international trade. Based on an algebraic analysis, this paper presents an economic argument for the conservation of natural resources. It elucidates the economic mechanisms resulting in a situation that can be resolved with the help of international transfers from industrialized to developing countries.

From a policy perspective, the implications of this analysis relate to the concept of REDD (Reducing Emissions from Deforestation and Degradation)[3] and the corresponding literature (e.g. Ollivier, 2012; Kerr, 2013; Lubowski and Rose, 2013). In contrast to REDD, there is *no global environmental externality*, such as climate change, that motivates

[2] http://www.sanparks.org.
[3] http://www.un-redd.org.

international payments in the following analysis. Instead, international trade and tourism motivate international payments by industrialized countries. This has important policy implications: different to the climate change challenge, not all countries are necessarily engaged in future tourism, and hence not all countries are expected to contribute to financing the related policy. Hence, different to the climate policy controversy, a global treaty of all countries or at least major countries is not strictly necessary with respect to future tourism. Specific donor countries with interest in tourism may finance specific recipient countries with unique natural resources. Unlike REDD, the following analysis encompasses not only forests, but also coral reefs, beaches, savannas, and so forth, i.e. it has a much broader scope. Accordingly, the focus of REDD appears to be too narrow and could be integrated into a broader global framework. In this sense, the policy approach derived in this paper is similar to the idea of protected area certification (cf. Dudley, 2008, 2010), yet with a more specific focus on international nature-seeking tourism.

Three developments are expected to amplify future tourism in the *long-run* and hence the demand for travel services: (1) Transportation technologies have experienced incredible technical progress during the last a hundred years and are expected to make further progress in the future. This development will reduce transportation costs and enhance transportation volumes. (2) The population of emerging economies is expected to grow, and the per capita income of industrialized and emerging economies is expected to grow as well (following corresponding projections like OECD, 2008; Chateau et al., 2011). As a consequence, global consumption including demand for tourism services will further soar (c.f. the historical developments depicted by Figures 5 and 6). (3) Preferences and economic activities are expected to shift away from natural resource- and pollution-intensive production towards less natural resource- and pollution-intensive industrial production in the vein of economic development. As a consequence of these three developments, the demand for nature-related tourism services is expected to rise in the future.

This paper anticipates the rising future demand four tourism services and answers the question: how does future tourism influence today's resource use with respect to intertemporal optimality? Technically speaking, the three future developments sketched above raise today's shadow price for a non-renewable natural resource located in a developing country so that more of the resource is preserved. An optimal subsidy on resource preservation exactly mimics this shadow price. The subsidy bill can be financed by the developing country that owns the resource and the industrialized countries that consume tourism services such that all countries are better off from an inter-temporal perspective. This means, the resulting welfare gain can be distributed among the countries so that all gain from this policy, given their different time horizons of economic decisions (short-term for poorer developing, long-term for richer industrialized countries). According to a crude estimate, a subsidy, which modifies relative prices by up to ten percent and is mainly financed by the industrialized countries, may suffice to correct for the not anticipated future development of tourism.

The paper proceeds as follows: section 2 positions the paper within the literature. First, section 3 sets up a stylized model of a developing country and solves it under the assumptions of myopic and forward-looking autarky as well as myopic and forward-looking trade. Second, it studies the impact of the three developments discussed above, i.e. technical progress in transportation, a growing population size and a higher preference for the environment, on future tourism within this model framework. Third, it derives a policy rule to achieve the social optimum and shows how to distribute the policy costs among developing and industrialized countries so that all countries are better off. Section 4 concludes with a discussion of the practical implementation of this policy.

2 Literature

This section positions the paper within the literature. The paper is first related to the literature on international trade and the environment, second, to the literature on economic growth and the environment, and third, to the literature on tourism and the environment. The integration of tourism into a trade theory framework (and in reduced form a growth theory framework) is our novel step.

The first related literature stream has surveyed, under which conditions free trade is good for the environment and under which conditions it can result in the (full) exhaustion of a non-renewable resource (for an overview see Copeland and Taylor, 2003; for influential contributions see Grossman and Krueger, 1993; Antweiler et al., 2001). In the following analysis, we assume that a developing country is dependent upon a non-renewable natural resource in autarky. Opening up to trade enables it to preserve part of the resource so that it can sell tourism services derived from the natural resource on the international market. The developing country can in turn import industrial goods. The literature on trade and the environment assumes implicitly or explicitly international trade in goods or in some cases international factor mobility, wherein natural resources can sometimes be used to produce goods. The crucial element of the following analysis is the introduction of international nature-seeking tourism services into a trade framework. The novel result is that the natural resource is not depleted as usual, but preserved in order to provide this service. This view is in particular in contrast to the pollution haven debate that discusses whether globalization shifts pollution- and resource-intensive production to developing countries with low environmental regulation (e.g. Janicke et al., 1997; Levinson and Taylor, 2008). This view also goes beyond the literature that examines the effects of opening up a developing economy for trade without taking into account future tourism (c.f. Barbier, 2007).

The second related literature stream has scrutinized, under which conditions economic growth driven by technical progress and population growth can be sustained without instantaneously increasing emissions or without fully exhausting a natural resource (for overviews see Xepapadeas, 2005; and more compactly Smulders, 1999; furthermore within the classical work by Dasgupta and Heal, 1979; and regarding climate change and directed technical change Acemoglu et al., 2012). Such a development is sometimes called 'green growth'. Following the environmental Kuznets curve hypothesis (based on Kuznets, 1955; e.g. Stern, 2004), our analysis assumes that the preference for environmental quality, in this case for the natural resource, increases in (per-capita) income. This effect is called income effect or (income-induced) technique effect (c.f. Antweiler et al., 2001). It implies that more of the resource will be preserved for future societies when income rises today. In a broader sense, the following analysis assumes that exogenous technical progress, population growth and per-capita income growth amplify the supply of and the demand for tourism and in this way induce 'green growth'. This means tourism *saves nature* in form of the natural resource. This mechanism adds a new channel of 'green growth' to this literature.

The third literature stream has studied the impact of tourism on economic performance and growth at the sector and macro level (for overviews see Tisdell, 2001; Dwyer and Forsyth, 2006; Stabler et al., 2010). It has contrasted the benefits of tourism with its negative external effects on the public good environment (nature) and sought the optimal level and way of tourism or more specifically of eco-tourism. Eco-tourism can be viewed as a kind of tourism that appreciates unspoilt, undisturbed nature, flora and fauna, without doing harm to nature. This literature has also developed econometric and modeling methods for disentangling the drivers of tourism demand and supply and forecasted future tourism. Transportation costs, often approximated by aviation travel costs, population size and income are identified as drivers of tourism demand (c.f. Dwyer and Forsyth, 2006, chapter 1). These drivers will be taken up by the following analysis. Yet the inclusion of the insights from the tourism literature into the trade and growth literature with their elaborated methodological portfolios is missing so far. The following analysis fills this gap by setting up a straightforward model in the trade theory tradition (c.f. Krugman et al., 2014; Markusen et al., 1995; Markusen, 1975) with a simplified inter-temporal view related to growth theory. It introduces a function, which converts a non-renewable natural resource into tourism services, and an inter-temporal two-period view as new elements. To our knowledge, there is no directly comparable model setup existing in the literature.

3 Model

This section sets up and studies a one-country, two-sector, two-period model under autarky and trade as well as with a myopic and a forward-looking perspective. The model is kept as simple as possible in order to describe the economic mechanisms in mathematical and graphical form.

We project the future to two periods $t = \{1; 2\}$. We imagine a small endowment economy that we label 'South' within our framework. 'South' indicates that we are dealing with a developing country which is abundant in a non-renewable natural resource, in other words in an environmental good E with the initial endowment $\bar{E}^1$. An upper bar indicates an exogenous parameter throughout the paper. The upper index '1' symbolizes the first model period. Regarding E, one can imagine rain forests, savannas, natural lakes, unspoilt beaches, coral reefs, and so forth. Due to their rich biodiversity and their natural uniqueness, these natural resources cannot be replaced by human activity and are hence treated as non-renewable in the analysis. The comparative advantage of the South is created by the existence of the natural resource and the provision of tourism services based on this resource. The Southern economy has a comparative disadvantage in producing the industrial good I. The industrialized countries, that form the rest of the world in the model, do not own a comparable natural resource. Their comparative advantage is, on the contrary, the production of the industrialized good. For the South, it is not possible to replace its natural resource by artificially produced tourism facilities, and if it were possible, it would not create a comparative advantage, because industrialized countries have a much better capability in creating artificial tourism facilities. For example, a modern, luxurious hotel in central Africa itself has no advantage compared to modern, luxurious hotels in North America; but a national park in the amazing African countryside with its unique wildlife clearly creates an advantage.

Both, the environmental and the industrial good, are consumed by a representative Southern consumer and generate utility $U^t(I^t, E^t), U_I^t > 0, U_I^t < 0, U_E^t > 0, U_E^t < 0$ in each period t. A lower index indicates a partial derivative with respect to the index variable throughout the paper. Consumption E^t reduces the remaining resource stock. One can for example imagine that a rain forest is sacrificed for wood and farm land. We can now solve this basic model under different assumptions.

3.1 Autarky

In autarky, the South can produce the amount $\bar{I}^1$ of the industrial good in each period t. The two-period objective of the autarkic economy reads:

$$\max_{I^1,E^1,I^2,E^2} [U^1(I^1, E^1) + U^2(I^2, E^2)] \quad (1)$$

3.1.1 Myopic

In the myopic case, $\max_{I^1,E^1}[U^1(I^1, E^1)]$ is calculated in the first step while ignoring the second step, i.e. the second period, and $\max_{I^2,E^2}[U^2(I^2, E^2)]$ is calculated in the second step. It is trivial that under the above-mentioned conditions, the myopic consumption pattern reads:

$$I^{1*} = I^{2*} = \bar{I}^1 \quad (2)$$
$$E^{1*} = \bar{E}^1; \; E^{2*} = 0$$

This means, the resource is fully exhausted in period one ignoring second period consumption. Consumption is limited to the industrialized good in the second period.

3.1.2 Forward-looking

In the absence of time discounting, changes in preferences, demographic change, extraction costs or technical progress, the economy will choose the following straightforward optimal forward-looking consumption pattern in the forward-looking case:

$$
\begin{aligned}
I^{1*} &= I^{2*} = \bar{I}^1 \\
E^{1*} &= E^{2*} = \frac{1}{2}\bar{E}^1
\end{aligned}
\tag{3}
$$

This means, natural resource consumption is distributed 50:50 over the two periods. This describes the optimal solution, because we introduced a consumption function which is concave in each argument. Hence, the utility gain of consuming more in one period is smaller than the utility loss in the other period, if natural resource consumption is distributed unequally across the two periods.

3.2 Trade

Let us now imagine that the Southern economy opens up its market for international trade, more specifically to the international tourism market. We assume a small open economy that takes prices of traded goods as given by the world market. Since the economy is scarce in the industrial good I, it will presumably import the industrial good in each period, which we express as I^{M^t}.

Now we introduce a *new element* which is in the spotlight of this paper: the environmental good remaining at time t after exploiting and consuming E^t is available for international tourism services denoted by T^t. This means, each unit of E can either be directly consumed or indirectly exported as a tourism service good. In the latter case, tourists travel to the developing Southern country and pay for enjoying the natural resource. This revenue is used for important the industrial good. Accordingly, the economy opens up to trade in a broader sense, including international tourism.

Although we look at environmentally friendly eco-tourism, we take into account that tourism can harm or exhaust to some extent the natural resource. Tourists, for example, unwillingly disturb animals or tread down plants. As a result, tourism T^t reduces the stock $\bar{E}^t$ of the natural resource E. We assume that this effect is realized within the same period. This means, intensive tourism creates a stepping-on-toes effect that immediately reduces the effective volume of the resource that generates utility through tourism services. A specific functional form may take into account that this negative environmental externality will exacerbate with more intensive tourism by assuming a convex damage function. In our analysis with general functional forms, we keep this aspect implicitly in mind when interpreting the results. Let us assume that the function $T^t = \Gamma^t(E^t|\bar{E}^t), \Gamma_{E^t} < 0, \Gamma_{E^tE^t} > 0$, is a production possibility frontier in the tradition of the trade literature (c.f. Markusen, 1975; Markusen et a., 1995). It describes how many units of the tourism service good T^t can be generated from a specific number of units of the natural resource E^t. The maximum amount of E^t is given by $\bar{E}^t$, and the maximum amount of T^t is thus given by $\Gamma^t(\bar{E}^t)$. This means, a larger remaining resource stock $\bar{E}^t$ shifts the function outward from the origin as illustrated by Figure 1; and thus $\Gamma_{\bar{E}^t} > 0$. If tourism becomes more and more intensive, a point can be reached, in which the positive utility gain is exactly counterbalanced by the negative environmental effect of tourism. At this point, the production possibility frontier will collapse to $T^t = \Gamma^t = 0$ and no tourism will occur anymore. Notably, this specification takes the *negative external effects of tourism* in the maximization of social welfare into account. An analysis at the level of individual profit-maximizing firms, on the contrary, would not internalize these external effects. In order to allow for choosing no trade from a welfare-maximizing perspective, we must include $T^t = \Gamma^t = 0$ into the solution space.

`Figure 1`

In the model, T^t is not measured as an area (say in hectare), but as a tourism service in value form. This value is perceived by the foreign consumer in his residential country. This means, it includes travel costs and monetized travel time and travel risks. Better technologies reduce travel costs and risks and therefore increase the amount of T^t that is generated from one unit of E^t. Let us for simplicity assume that the Southern economy does not itself consume the resource in form of tourism services T^t. One can imagine that the inhabitants of the South are used to their environment and draw no utility from visiting it. They can, however, use the revenue from tourism for buying the industrial good on the international market. Assuming that the trade budget is balanced in each period, denoting prices on international markets by p and recalling that $T^t = \Gamma(E^t)$, the following condition holds:

$$\bar{p}^I \cdot I^{M^t} = p^{T^t} \cdot \Gamma^t(E^t|\bar{E}^t) \tag{4}$$

While the international price for I is assumed to stay constant, the price for tourism services p^{Tt} can exogenously change between periods. We choose $\bar{p}^I = 1$ as the numeraire price. Total consumption of the industrial good is then $I^t = \bar{I} + I^{M^t}$. We derive the exogenous *price ratio* $\bar{p}^{T^t} = \frac{p^{Tt}}{\bar{p}^I}$ (dimensionless) which we will use throughout the paper.

In the first period, the full resource stock $\bar{E}^1$ is available so that $\Gamma^1(E^1|\bar{E}^1)$ describes the production possibility frontier. In the second period, the remaining resource stock is given by $\bar{E}^2 = \bar{E}^1 - E^1$. A higher E^1 shifts $\Gamma^2(E^2|\bar{E}^2)$ inward towards the origin; this means, higher resource use in the first period reduces the potential for resource use and for providing tourism services in the second period and hence $\Gamma^2_{E^1} < 0$. We can now solve this trade model under different assumptions.

3.2.1 Myopic

Equation (4) is used to express imports of the industrial good in the following maximization problem. In the myopic trade case

$$\max_{I^t, E^t} U^t[I^t, E^t] = \max_{E^t} U^t[\bar{I} + \bar{p}^{T^t} \cdot \Gamma^t(E^t|\bar{E}^t), E^t] \tag{5}$$

is maximized for the first period, this means for E^1, ignoring the second period and thereafter for the second period, this means for E^2. Hence, the full available resource stock is distributed among E^1 and T^1 in the first period ignoring the second period. Formally, we derive and solve $\frac{dU^t}{dE^t} = 0$ as outlined in the Appendix and obtain:

$$\Gamma^t_{E^t}(E^t|\bar{E}^t) = -\frac{1}{\bar{p}^{T^t}} \cdot \frac{U^t_{E^t}(E^t)}{U^t_{I^t}(E^t|\bar{E}^t)}, \quad \forall t = \{1; 2\} \tag{6}$$

$$\Rightarrow E^{t*};\ I^{t*}$$

This solution is first calculated for period one. This leaves the economy with a residual $\bar{E}^2 = \bar{E}^1 - E^1$ as the resource endowment for the maximization problem in the second period. If (first period) tourism creates a more severe negative externality, $\bar{E}^2$ will be smaller. This negative externality will be taken into account in the optimization. As a result, a smaller volume of tourism services will be provided so that more of the resource will be available in the future and the externality will be mitigated. The above equation implicitly provides the optimal solution E^{t*}. The optimal solution I^{t*} is obtained by inserting E^{t*} in Equation (4). Graphically, the solution for the first period is given by the tangency point of the line with the slope $s^1 := -\frac{1}{\bar{p}^{T^1}} \cdot \frac{U^1_{E^1}}{U^1_{I^1}}$ with the production possibility frontier Γ^1 with $\Gamma^1_{E^1} < 0$ as shown in Figure 2a on the left hand side. The horizontal axis describes the use of the natural resource E for production of I in the positive direction. The difference between the production point E^1 and the full endowment $\bar{E}^1$ is left for the future period and denoted by $\bar{E}^2$. s^1 describes the negative inverse price for tourism services, $-\frac{1}{\bar{p}^{T^1}} = -\frac{\bar{p}^I}{p^{T^1}}$ with $\bar{p}^I = 1$, weighted by the ratio of marginal utilities, as described by Equation (6). The negative sign corresponds to the negative slope in Figure 2.

Figure 2

When the exogenous price for tourism rises, the slope of the line will be lower, i.e. less negative, and as a result, a smaller amount of the resource stock will be used for consumption, and a larger amount will be used for tourism. As an unintended side effect, this is also beneficial for second period consumption because tourism does not diminish the resource stock. The situation based on the resource stock left after period one is shown on the right hand side in Figure 2b. The line has the same slope $s^2 = s^1 < 0$ as in the first period because prices are assumed to stay constant. The production possibility frontier function is assumed to stay constant as well so that $\Gamma^2 = \Gamma^1$.

Clearly, the introduction of international tourism leaves more of the resource for the second period compared with myopic autarky, where the resource stock is completely exploited in the first period. It is not clear, however, whether more or less is left after the first period compared with forward-looking autarky where half of the resource stock is exploited in the first period. More of the resource will be left after the second period, denoted by $\bar{E}^3$, because part of the resource is used for second period tourism.

3.2.2 Forward-looking

In the forward-looking case, the maximization problem reads:

$$\max_{I^1,E^1,I^2,E^2}[U^1(I^1,E^1)+U^2(I^2,E^2)] \quad w.r.t. \tag{7}$$
$$I^1 = \bar{I} + \bar{p}^{T^1} \cdot \Gamma^1(E^1|\bar{E}^1)$$
$$I^2 = \bar{I} + \bar{p}^{T^2} \cdot \Gamma^2(E^2|\bar{E}^2)$$
$$\bar{E}^2 = \bar{E}^1 - E^1$$

This maximization problem can be further simplified to:

$$\max_{E^1,E^2}\{U^1[\bar{I}+\bar{p}^{T1}\cdot\Gamma^1(E^1|\bar{E}^1),E^1]+U^2[\bar{I}+\bar{p}^{T2}\cdot\Gamma^2(E^2|\bar{E}^1-E^1),E^2]\} \tag{8}$$

We start by solving for E^2. The solution is given by Equation (6) for $t = 2$. E^{2*} and I^{2*} are dependent on the resource stock $\bar{E}^2$ remaining after period 1. When deriving total utility $\frac{dU}{dE^1} = 0$ with $U = U^1+U^2$ from Equation (8), we take into account that first period resource consumption reduces the resource stock remaining for consumption and tourism in period two $\bar{E}^2 = \bar{E}^1 - E^1$. This allows us to formulate the maximization problem as a function of E^1 and to derive:

$$\Gamma^1_{E^1}(E^1|\bar{E}^1) = \underbrace{-\frac{1}{\bar{p}^{T^1}}\cdot\frac{U^1_{E^1}(E^1)}{U^1_{I^1}(E^1|\bar{E}^1)}}_{s^1<0}\underbrace{-\frac{\bar{p}^{T^2}}{\bar{p}^{T^1}}\cdot\Gamma^2_{E^1}(E^{2*}|\bar{E}^1-E^1)\cdot\frac{U^2_{I^2}(E^{2*}|\bar{E}^1-E^1)}{U^1_{I^1}(E^1|\bar{E}^1)}}_{\sigma>0} \tag{9}$$
$$\Rightarrow E^{1**};\ I^{1**}$$

The solution strategy (cf. Jakob et al., 2013) follows that of the myopic case and is outlined in the Appendix. The above equation implicitly yields the solution E^{1**}, and Equation (4) then yields the solution I^{1**}. Note that $\Gamma^2_{E^1} < 0$ so that first period consumption of the resource reduces the second period resource stock and hence contracts the production possibility frontier. Hence, the slope of the line characterized by the right hand side is smaller, i.e. less negative, than in the myopic case described by Equation (6). We denote the new slope by $s^1 + \sigma < 0$ (with $s^1 < 0$, $\sigma > 0$ and $\mid s^1 \mid > \sigma$). σ represents a shadow price that takes the impact of today's resource consumption on future resource use for tourism or consumption into account. In the graphical solution in Figure 3, this moves the tangency point to the left so that more of the resource is left for the future. The slope of the second period line is again $s^2 = s^1 < 0$ because there is no shadow price in the absence of a third model period.

Figure 3

However, it must hold that Equation (9) is less than or equal to zero, since $\Gamma^1_{E^1} < 0$ represents the *negative* slope of the tangent in the first period, to obtain an *interior* solution.[4]

The optimal quantities of E and T and hence (via Equation 4) I for the second period are derived given the resource stock remaining in the second period as depicted by Figure 3b. Let us denote the forward-looking second optimal solution for the second period by E^{2**} and I^{2**}.

4 Scenarios

Three aspects are expected to significantly change *future tourism* and as a repercussion today's resource use. To assess these aspects, we formulated three scenario assumptions and analyze their impact on Equation (9).

(1) Transportation technologies have experienced incredible technical progress and can be expected to make further progress in the future. This can happen in form of breakthrough technologies as well as substantial gradual technical improvements. Let us recall the progress from the first primitive, highly risky prototype planes to the current multi-passenger, high-efficiency long-distance aeroplanes. Several decades ago, overseas travels were hardly affordable for a large part of the population. Today, discount airlines

[4] Otherwise, there would be no interior solution with a positive amount of E, but a corner solution. This would imply that the utility drawn from using the full resource stock (for tourism or consumption) in the second period exceeded the utility drawn from consuming anything of the resource stock today. Thus, in this case, the full reserve stock were preserved for the future. To obtain an interior solution for Equation (9), it must hold that $-\frac{1}{\bar{p}^{T^1}} \cdot \frac{U^1_{E^1}}{U^1_{I^1}} - \Gamma^2_{E^1} \cdot \frac{\bar{p}^{T^2}}{\bar{p}^{T^1}} \cdot \frac{U^2_{I^2}}{U^1_{I^1}} > 0 \Rightarrow \mid -U^1_{E^1} \mid > \mid -\Gamma^2_{E^1} \cdot \bar{p}^{T^2} \cdot U^2_{I^2} \mid$ with $\Gamma^2_{E^1} < 0$ and all other variables being larger than zero. This condition holds more likely if on the left hand side the consumption of E is lower today (period 1) so that its marginal utility is higher today and it creates a smaller utility loss to relinquish some consumption of E today for the sake of future (period 2) tourism. It also holds more likely if on the right hand side one unit of the natural resource conserved today generates less future tourism services, if the increase of the price for tourism services over time is smaller, and if the shift of the Southern preferences from consuming the natural resource E to consuming the industrial good I is less pronounced so that I's future marginal utility becomes smaller.

start providing long-distance connections, and consumers travel worldwide. Breakthrough technologies and substantial technical progress are expected to reduce travel costs as well as risks of accidents in the long-run, say within the next century. This includes travel costs in form of direct monetary costs and indirect monetized travel time and risks. As a result, the production possibility frontier will shift outward towards the provision of more tourism services T, i.e. each unit of the natural resource will generate more units of the tourist service net of direct and indirect travel costs. In Equation (9), σ becomes larger. As a result, the slope of the tangent characterized by Equation (9) will become smaller, in other words less negative. Thus, the tangency point with the production possibility frontier of period one will move to the left, and a smaller amount of the resource will be consumed today, while a larger amount will be preserved for future tourism. At the same time, production and income will rise in the second period because of the technical progress. This is visualized in Figure 4, where the production possibility frontier is stretched upwards so that more T can be generated from each unit of E.

Figure 4

(2) The population of emerging economies will grow, and the per capita income of industrialized as well as emerging economies will increase (following corresponding projections like OECD, 2008; Chateau et al., 2011). With rising income, tourists will likely search for new nature-related experiences that create long-lasting pleasant memories. Hence, eco-tourism is expected to increase. This expectation follows the environmental Kuznets curve literature (based on the seminal concept by Kuznets, 1955; for a more recent and critical discussion see Stern, 2004). It can also be derived from the stylized fact that the preference of consumers for enjoying the environment rises with higher per capita income. This is known as the income effect or the income-induced technique effect in the literature (following Antweiler et al., 2001; based on Grossman and Krueger, 1993). These demographic and economic developments will ceteris paribus jointly result in higher demand for tourism services by the rest of the world and thus in a higher world market price for tourism services $\bar{p}^{T^2}$ provided by developing countries in the future. In Equation (9), a higher $\bar{p}^{T^2}$ will increase σ and hence also reduce the slope of the tangency. Again, a smaller amount of the resource will be consumed today, while a larger amount will be

preserved for future tourism. Due to the rising demand and higher world market price for tourism in the second period, the slope s^2 is flatter than s^1 in Figure 4, and it is flatter than s^2 in Figure 3b as well.

(3) The preferences of the Southern economy under scrutiny are expected to shift away from natural resource consumption towards natural resource conservation and industrial goods consumption in the vein of economic development. This assumption can be motivated by the environmental Kuznets curve and the income-induced technique effect as before. At the micro level, this assumption is also related to the observation that people living in rural low-income economies mainly depend on the exploitation of natural resources for subsistence farming, "livestock rasing, fishing, basic materials and fuels" (Barbier, 2007, Introduction). This dependence on the exploitation of natural resources, however, vanishes with economic development and the transition from an agriculture to an industry economy (accompanied by environmental policy). The (marginal) utility drawn from the consumption of the natural resource declines relative to the (marginal) utility drawn from the consumption of industrial goods. This third mechanism acts in the same direction as the first two mechanisms. Now the marginal utility of future industrial goods consumption $U^2_{I^2}$ rises in Equation (9) relative to that of today's industrial goods consumption $U^1_{I^1}$ so that σ increases. Again, more of the resource will be preserved for future tourism. This mechanism is visualized in Figure 4 too.

Notably, the three aspects positively interact with each other, i.e., they enhance each other in a complementary way, as indicated by the multiplicative connection in Equation (9).

5 Policy

This section first shows how a policy instrument can be designed that generates the optimal situation. It then shows, how the policy costs can be shared between industrialized and developing countries so that the policy can be successfully implemented and both are better off. Finally, it provides crude numerical estimates of the policy effects under scrutiny.

5.1 The optimal instrument

In reality, we observe the myopic trade case, since the future developments of tourism described in this paper are not taken into account and natural resources of developing countries are exhausted. As a result, the resource stock left for period two, the long-term, is considerably lower than what is socially optimal. The optimal policy instrument that leads from the myopic case to the socially optimal forward-looking case can be derived by comparing Equation (9) with Equation (6). Accordingly, for achieving the forward-looking social optimum, policy needs to support the provision of tourism services via an additive subsidy at the following rate:

$$\sigma = -\Gamma^2_{E^1} \cdot \frac{\bar{p}^{T^2}}{\bar{p}^{T^1}} \cdot \frac{U^2_{I^2}}{U^1_{I^1}} \tag{10}$$

It is $\sigma > 0$ because $-\Gamma^2_{E^1} > 0$. It must hold that $\sigma <\mid -\frac{1}{\bar{p}^{T^1}} \cdot \frac{U^1_{E^1}}{U^1_{I^1}} \mid$ according to Equation (9) so that the South does not completely dispense with consuming the resource today.

The dimensionless subsidy rate adds to the price ratio characterized by Equation (6); it modifies the inverse relative price for tourism services T in such a way that the optimal amount of the resource E is left for the future. The subsidy rate consists of three terms that characterize future tourism-related technical progress, $-\Gamma^2_{E^1}$ (a dimensionless marginal term representing aspect 1 of future tourism in the previous section), the future price of tourism relative today's price associated with rising demand, $\frac{\bar{p}^{T^2}}{\bar{p}^{T^1}}$ (a dimensionless ratio of price ratios representing aspect 2), and the resource-rich developing economy's future preference for the industrial good relative to its preference today, $\frac{U^2_{I^2}}{U^1_{I^1}}$ (a dimensionless ratio representing aspect 3).

As described in the previous section, it is likely that the demand for tourism services and hence their price will increase to a certain extent, that there will be at least some technical progress in transportation technologies and that the inhabitants of developing will have less interest in consuming their natural resources and more interest in consuming industrial goods when their income rises. If these future developments are not taken into account by developing countries, e.g. because of missing information, it will be economically reasonable to subsidize the conservation of natural resources for future tourism by taking the *change* in the variables in Equation (10) due to the development of future tourism into account. If no value is attributed to conserving the natural resource or future tourism at all, e.g. due to poverty, then optimal policy intervention needs to add the *absolute* values of the variables in (10).

5.2 Welfare effects

Under perfect foresight and rational behavior, the Southern government would implement this subsidy in its own interest. Unfortunately, today's situation appears to be the myopic trade case (or even the myopic autarky case). Political and economic agents in developing countries seek their own short-term profits, and people are under pressure must survive today, which both hinders a long-term perspective that takes nature into account. Therefore, neglecting their future value, natural resources in developing countries are heavily overexploited. Yet our analysis shows: if developing countries' governments stay reluctant or unable to preserve their natural resources, it will be economically reasonable that industrialized countries' governments finance the subsidy in order to benefit from future tourism. In our model, the developing country under scrutiny has no impact on international prices because it is assumed to be small. But a number of developing countries together will have an impact on international prices, and the loss of most of the natural resources in developing countries will destroy any possibility for future generations to enjoy nature-related tourism services. This will in particular create a welfare loss for tourists from industrialized countries. As on the supply side of tourism services, one single industrialized country government may not have sufficient market power to solve the problem alone. This means in terms of our model that the world market price for tourism services is also given for a single industrialized country demanding tourism services. Notwithstanding, concerted action of several (major) industrialized countries can solve the resource depletion problem examined in this paper.

Several questions arise regarding the *implementation of the optimal forward-looking policy* suggested by our analysis. The first question is, whether the trade case is superior to the autarky case. Our model allows for the choice between international trade and autarky. If opening up for international trade and tourism were detrimental for social welfare, the South would choose autarky and prohibit tourism. If there were no effect of trade and tourism on the economy, the South would be indifferent between opening up and not opening up. We know, however, from standard trade theory, that gains from trade accrue to countries that open up for international trade (e.g. Krugman et al., 2014).

Hence, we can conclude that the trade scenario is *at least* as good as the autarky scenario in terms of welfare.

The second question is, whether the policy derived above, which is welfare optimal across both periods in the trade case, is also superior today within the first period. In technical terms, we need to check whether the forward-looking trade solution given by Equation (9) is superior to the myopic trade solution given by Equation (6) within the first period. This is not fulfilled, because otherwise, the Southern government would also choose the forward-looking solution in the myopic case. Let us for the following considerations define the compensating variation $CV^1 > 0$ as the monetary payment to the South (the Southern consumer) in the forward-looking trade case that restores the South's first period welfare level of the mypopic trade case. It makes the South indifferent between the two cases expressed by indirect utilities V^t, income Y^t and a compensating transfer CV^t (paid in form of the industrial good):

$$V^t(\bar{p}^{T^t}_{forward}, Y^{t*} + CV^t) = V^t(\bar{p}^{T^t}_{myopic}, Y^{t*}), \quad \forall t = \{1; 2\} \tag{11}$$

Y^{t*} signifies income generated by the myopic optimal solution characterized by Equation (6). Note that the price for the industrial good has been chosen as the numeraire, whereas the relative price for tourism services $\bar{p}^{T^t}$ changes between the policy scenarios. In the first period, the price difference between $\bar{p}^{T^1}_{forward}$ and $\bar{p}^{T^1}_{myopic}$ is characterized by the optimal subsidy σ as expressed by Equation (10).

The consecutive third question is, whether industrialized countries, denoted by 'North', are willing to finance CV^1, still assuming that they have no market power on the world market for tourism services. Presumably, not when considering only the scope of the first period, recalling that demand for tourism will not soar until the second period. But in contrast to the myopic 'South', governments in the industrialized, high-income 'North' likely have a more forward-looking perspective. Hence, they would sacrifice some of today's consumption and thus welfare for the sake of higher future consumption. Given that the forward-looking trade solution given by Equation (9) is inter-temporally welfare optimal and abstaining from discounting, it holds that $CV = CV^1 + CV^2 < 0$ with $CV^1 > 0$ and $CV^2 < 0$ defined for the second period analog to the first period as outlined in the above Equation (11). In the second period, i.e. in the long-term, the South is better off in the forward-looking trade case than under the myopic trade case. The second period welfare gain[5] $CV^2 < 0$ through implementing the forward-looking policy is even higher than the first period welfare loss[6] $CV^1 > 0$. Informally speaking, the forward-looking solution provides an additional piece of cake compared to the myopic solution that can be distributed across North and South.

The solution for this policy problem is straightforward in theory: the total welfare gain CV is distributed among North and South and across the short-term and the long-term in such a way that the South is better off within both periods and the North is better off in the second period and in the sum over both periods. More precisely, in the first period the North transfers CV^1 to the South. In the second period the South more than offsets this transfer CV^1 by proving extended tourism services to the North. Yet the efficiency gain of the forward-looking policy creates an additional payoff given by $CV = CV^1 + CV^2$ which can be shared between South and North following any sharing rule. A straight-forward linear sharing rule written in general form would distribute the fraction φCV to the South and the remaining fraction $(1 - \varphi)CV$ to the North. φ will increase if, for example, handicaps like poverty, inequality, insufficient infrastructure and technological capability in developing countries are taken into account. φ will decrease if, for example, the North has a time preference larger than zero and hence charges an interest rate for borrowing the amount CV^1.

In this policy solution, the North invests into a better environment today, more specifically, a larger natural resource stock, in the future. This requires a binding contract between North and South. Consequently, the fourth question is whether a time-consistency problem occurs and whether the contract can be enforced. There is in theory no time-consistency problem for the following reason: the myopic South abstains from exhausting the natural resource today for receiving a transfer from the North. In the future, the South will directly face the increased demand for its natural resource due to soaring tourism. Albeit still being myopic, the South will then choose the optimal solution based on the large remaining resource stock. There is in theory no enforcement problem either: the South needs to preserve the natural resource today. If the South preserves the natural

[5] Under forward-looking trade the South would fall to the original welfare level under myopic trade when paying CV^2.

[6] Under forward-looking trade the South would receive CV^1 to reach the original welfare level under myopic trade.

resource today, the North will immediately grant a payment. This is captured by the contract. As a consequence, in the future, a larger resource stock will be available for tourism.

5.3 Estimation

This section evaluates the policies discussed in the last subsection based on the stylized model that we have analyzed. It provides crude illustrations of the scrutinized effects that give us an idea of their economic magnitude and policy relevance.

Equation (10) characterizes the optimal additive subsidy rate σ that consists of three components. The first component, $-\Gamma^2_{E^1} > 0$, describes how many units (in value terms) of future tourism services are obtained when conserving one unit (in value terms) of the natural resource today. Let us first make the optimistic assumption of $-\Gamma^2_{E^1} = 1$, i.e. the value of the generated future tourism services exactly matches the opportunity costs of not using the resource for consumption today. Let us for the moment further assume that prices remain unchanged so that $\frac{\bar{p}^{T^2}}{\bar{p}^{T^1}} = 1$ and that marginal utilities remain unchanged so that $\frac{U^2_{I^2}}{U^1_{I^1}} = 1$. Then $\sigma = 1$ follows. Let us now, for example, assume that the initial weighted inverse price of tourism services is $s^1 = -\frac{1}{\bar{p}^{T^1}} \cdot \frac{U^1_{E^1}}{U^1_{I^1}} = -2$ (see Equations 6 and 9). Under these exemplary assumptions, the additive subsidy will halve the original price ratio to $s^1 + \sigma = -1$. This implies a strong policy effect and hence a high subsidy rate and large financial resources.

Yet the assumption that the value of future tourism is not at all acknowledged by the South is a pessimistic extreme. Let us instead imagine that the South acknowledges that $\sigma = 1$ but does not anticipate the development of future tourism. This might be due to poverty reasons or lack of information about the future. For the time being, we keep the assumption $-\Gamma^2_{E^1} = 1$. Regarding the development of prices we refer to Figure 6 in the Appendix. The underlying data yield an average annual increase in the number of tourists heading for South Africa between 1992 and 2012 of about 8.3 percent. We choose South Africa as an example, because tourism seeking for nature and wildlife plays a major role in this country. Under the assumption that the price elasticity of demand for tourism services equals unity, this translates into an annual price increase for tourism services of the same amount. This leads to $\frac{\bar{p}^{T^2}}{\bar{p}^{T^1}} = 1.083$. We may use the following crude approximation for the change in marginal utilities driven by a shift of preferences for the consumption of the natural resource to industrial goods. According to WDI (2012), the share of the agricultural value added in the GDP (gross domestic product) of South Africa decreased by about 2.6 percent annually between 1992 and 2012. This leads to $\frac{U^2_{I^2}}{U^1_{I^1}} = 1.026$. With theses numbers, we obtain $\sigma \approx 1.11$. Compared to the example with $\sigma = 1$ above, an eleven percent subsidy will suffice to correct for the not anticipated future development if we assume that s^1 is only slightly larger than one. In relation to larger values of s^1, the subsidy rate will be lower. This indicates a reasonable magnitude of policy intervention and financial resources. This magnitude, however, hinges upon the term $-\Gamma^2_{E^1}$. If the value of the generated future tourism services becomes smaller, the subsidy rate will be scaled down. In this sense, the eleven percent rate marks an upper bound. The exact value of $-\Gamma^2_{E^1}$ is hard to determine, though, and might strongly vary across specific resources.

With respect to burden sharing of the policy costs, the following numbers may shed light on the feasibility of the proposed policy. According to WDI (2012), expenditures by international inbound visitors to low-income countries in 2012 amounted to 17.2 bill. US-$. This constitutes approximately 0.03 percent of the total GDP of high-income countries and almost three percent of the total GDP of low-income countries (based on WDI, 2012, data). Although the numbers are smaller for nature-related tourism and although the subsidy bill may constitute less than ten percent of these numbers, these shares nevertheless suggest a low fraction φ borne by developing countries, for instance, $\varphi = \frac{1}{10}$.

6 Discussion

The analysis is based on a stylized model in general theoretical form, albeit sufficiently detailed to derive the above-mentioned policy aspects. The general theoretical form abstains from using specific functional forms so that the results have general quality and are not subject to specific assumptions on functional forms or parameter values. The model draws upon economic intuition and a graphical and mathematical description of the economic mechanisms. The analysis abstains from explicitly discounting the future for mathematical and graphical simplicity and to make the results independent of ongoing controversies about the right way of discounting (e.g. Gollier and Weitzman, 2010).

Instead, the paper distinguishes between myopic behavior and perfect foresight. When explicitly discounting the future, higher discount rates will reduce the resource stock that is left for the future today, albeit it would not change the results qualitatively.

The crude numerical examples illustrate the magnitude of the economic mechanisms and their policy relevance, but cannot replace a detailed CGE (Computable General Equilibrium) model analysis, which is left for future research. The practical implementation of the proposed policies involves aspects that are beyond the scope of this *trade theory-based analysis.*

7 Conclusion

This paper has studied the impact of future tourism – seeking for unique, non-renewable natural resources – on today's conservation of the natural resources. Such resources are often found in developing countries, for example located in the tropical zone (comparative advantage). Developing countries are on the contrary weak in industrial production that involves capital accumulation and the creation and application of advanced technologies (comparative disadvantage). The opposite applies to industrialized countries that are abundant in capital and advanced technologies (comparative advantage) but lack such natural resources (comparative disadvantage).

The paper has explicitly derived the shadow price for the natural resource that future tourism creates today so that more of the resource is preserved. It has argued that the welfare optimal policy is a subsidy on resource preservation equal to this shadow price. It has exposed that the resulting welfare gain can be shared between developing countries (that provide tourism services) and industrialized countries (that demand tourism services) so that the developing countries are better off today and in the future and the industrialized countries are better off in terms of the sum of welfare today and in the future. This means, forward-looking governments in industrialized countries anticipate rising preferences of their populations for tourism and preserve natural resources in developing countries, whose populations might have myopic short-term attitudes and lack information about future developments. This creates a win-win situation, in which tourism saves nature.

This result has been obtained by integrating tourism and an inter-generational perspective into a model that follows the trade theory literature (c.f. Krugman et al., 2014; Markusen et al., 1995; Markusen, 1975). This insight in particular contrasts with the pollution haven hypothesis which posits globalization enhances pollution- and resource-intensive production in developing countries with low environmental regulation (see e.g. Janicke et al., 1997; or Levinson and Taylor, 2008). It adds a new mechanism to the 'green growth' hypothesis that posits, economic growth is possible while simultaneously preserving the environment (see e.g. Xepapadeas, 2005; or Smulders, 1999).

The policy implementation goes beyond REDD (Reducing Emissions from Deforestation and Degradation). It is not restricted to carbon emissions, nor to forests. It includes any valuable natural resource such as unspoilt beaches, coral reefs, natural lakes or savannas, especially those containing rich and unique biodiversity so that any destruction is irreversible. A global fund is required, which is financed by governments of industrialized countries and supports the preservation of nature in developing countries in its various forms. Different to climate policy, it is not necessary that all (industrialized) countries contribute to the fund. If only specific countries are strongly engaged in nature-seeking international tourism, then mainly these countries will have the obligation to contribute to the fund. This simplifies the establishment of a global treaty compared to the climate policy case. The policy implementation is, however, also subject to challenges, for example, how the costs of subsidizing natural resource preservation are distributed among donor countries. As usual in the domain of international trade, there are winners and losers within countries. In this case, the tourism sector in developing countries benefits from the policy under discussion, whereas the sector that exploits natural resources is worse off. This may justify social transfers within developing countries.

Numerical illustrations indicate that a subsidy, which modifies relative prices by up to ten percent, may suffice to correct for the not anticipated future development of tourism. If a developing country does not attribute any value to future tourism and the future value of its natural resource, considerably stronger policy intervention will be necessary in order to correct for this myopia. Such policy intervention will be more difficult to finance. Putting the value of tourists' expenditures in perspective to GDP, it becomes obvious that in any case the industrialized countries need to bear the major part of the subsidy bill.

This stylized conceptual analysis has hopefully opened a new avenue for future research. Future research could first collect more historical data on tourism travel volumes and costs and experts' judgements on their future developments, especially focusing on specific countries. It could then set up a more complex, sectoral general equilibrium model and calibrate it to the available data.

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9 Appendix

This passage demonstrates how in the myopic trade case Equation (6) is obtained from Equation (5). The maximization problem in (5) is solved by total-differentiating the equation (cf. Jakob et al., 2013):

$$\begin{aligned} & \max_{I^t, E^t} U^t[I^t, E^t] \\ \Rightarrow \quad & dU^t = U^t_{I^t} \cdot dI^t + U^t_{E^t} \cdot dE^t \end{aligned}$$

Making use of the balanced trade budget defined by Equation (4), we can eliminate the industrial good and write the equation solely in form of the natural resource, restructure the equation and equate it to zero to obtain the optimum expressed by Equation (6):

$$\begin{aligned} & \max_{E^t} U^t[\bar{I} + \bar{p}^{T^t} \cdot \Gamma^t(E^t|\bar{E}^t), E^t] \\ \Rightarrow \quad & dU^t = U^t_{I^t}(E^t|\bar{E}^t) \cdot \bar{p}^{T^t} \cdot \Gamma^t_{E^t}(E^t|\bar{E}^t) \cdot dE^t + U^t_{E^t}(E^t) \cdot dE^t \\ \Rightarrow \quad & \frac{dU^t}{dE^t} = U^t_{I^t}(E^t|\bar{E}^t) \cdot \bar{p}^{T^t} \cdot \Gamma^t_{E^t}(E^t|\bar{E}^t) + U^t_{E^t}(E^t) = 0 \\ \Rightarrow \quad & \Gamma^t_{E^t}(E^t|\bar{E}^t) = -\frac{1}{\bar{p}^{T^t}} \cdot \frac{U^t_{E^t}(E^t)}{U^t_{I^t}(E^t|\bar{E}^t)} \end{aligned}$$

In the forward-looking trade case, Equation (9) is obtained from (8) in the analog way:

$$\max_{E^1, E^2} \{U^1[\bar{I} + \bar{p}^{T1} \cdot \Gamma^1(E^1|\bar{E}^1), E^1] + U^2[\bar{I} + \bar{p}^{T2} \cdot \Gamma^2(E^2|\bar{E}^1 - E^1), E^2]\}$$

We aim at formulating the maximization problem solely as a function of E^1. We solve recursively. As a starting point, we insert the optimal myopic solution for the second period E^{2*} for E^2. This solution is given by Equation (6) for $t = 2$. For deriving total utility $\frac{dU}{dE^1} = 0$ with $U = U^1 + U^2$ from Equation (8), we take into account that first period resource consumption reduces the resource stock $\bar{E}^2 = \bar{E}^1 - E^1$ remaining for consumption and tourism in period two. The marginal change in the sum of utility over both periods reads:

$$\begin{aligned} \Rightarrow dU &= \left[U^1_{I^1}(E^1|\bar{E}^1) \cdot \bar{p}^{T^1} \cdot \Gamma^1_{E^1}(E^1|\bar{E}^1) + U^1_{E^1}(E^1)\right] dE^1 \\ &+ \left[U^2_{I^2}(E^{2*}|\bar{E}^1 - E^1) \cdot \bar{p}^{T^2} \cdot \Gamma^2_{E^1}(E^{2*}|\bar{E}^1 - E^1)\right] dE^1 \end{aligned}$$

Note that $\Gamma^1_{E^1} < 0$ as depicted by Figure 1 and $\Gamma^2_{E^1} < 0$ so that first period consumption of the resource reduces the second period resource stock and hence contracts the production possibility frontier. Equating to zero and rearranging terms yields the optimum expressed by Equation (9):

$$\begin{aligned} \Rightarrow \frac{dU}{dE^1} &= \left[U^1_{I^1}(E^1|\bar{E}^1) \cdot \bar{p}^{T^1} \cdot \Gamma^1_{E^1}(E^1|\bar{E}^1) + U^1_{E^1}(E^1)\right] \\ &+ \left[U^2_{I^2}(E^{2*}|\bar{E}^1 - E^1) \cdot \bar{p}^{T^2} \cdot \Gamma^2_{E^1}(E^{2*}|\bar{E}^1 - E^1)\right] = 0 \\ \Rightarrow \Gamma^1_{E^1}(E^1|\bar{E}^1) &= -\frac{1}{\bar{p}^{T^1}} \cdot \left[\frac{U^1_{E^1}(E^1)}{U^1_{I^1}(E^1|\bar{E}^1)} + \bar{p}^{T^2} \cdot \Gamma^2_{E^1}(E^{2*}|\bar{E}^1 - E^1) \cdot \frac{U^2_{I^2}(E^{2*}|\bar{E}^1 - E^1)}{U^1_{I^1}(E^1|\bar{E}^1)}\right] \end{aligned}$$

10 Figures

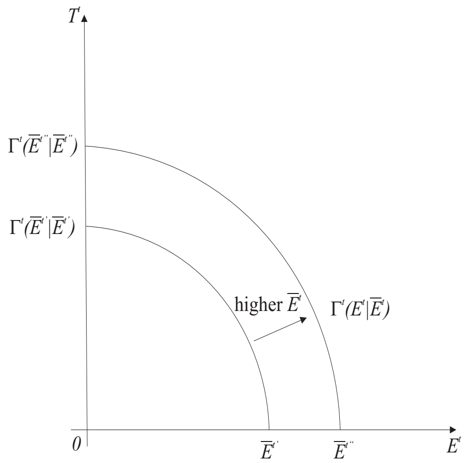

Figure 1: A higher natural resource stock $\bar{E}^t$ expands the production possibility frontier described by $T^t = \Gamma^t(E^t|\bar{E}^t)$. The production possibility frontier Γ^t specifies how many units of the tourism service good T^t can be generated from a specific number of units of the natural resource E^t. Negative external effects of tourism are included.

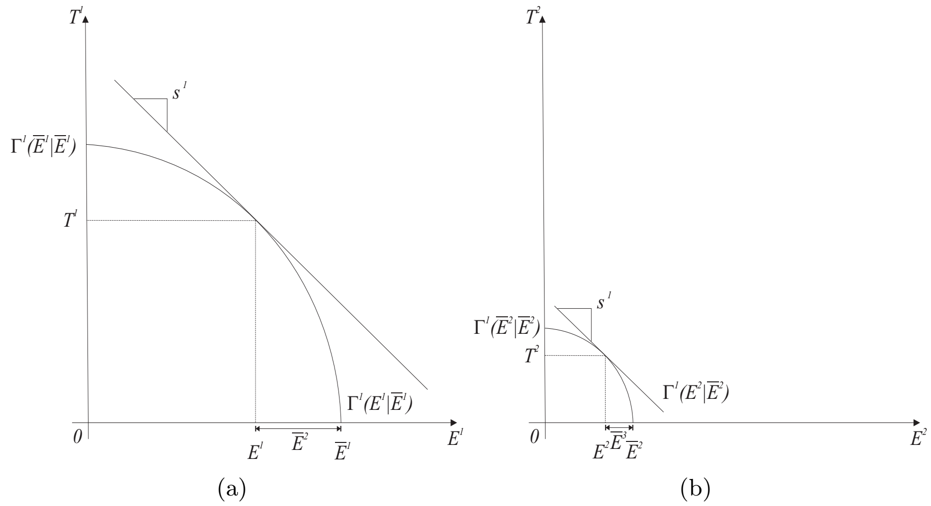

Figure 2: In the myopic trade case, the impact of resource depletion in the first period (a) on the second period (b) is ignored. The tangency line with the slope s^1, which describes the price for the natural resource, E, relative to the price for tourism services T in the first period, does not anticipate and include future prices. Therefore, a large part of the resource stock is consumed in the first period, indicated by E^1 in (a), so that a small part $\bar{E}^2$ is left as the resource stock for the second period in (a) and (b).

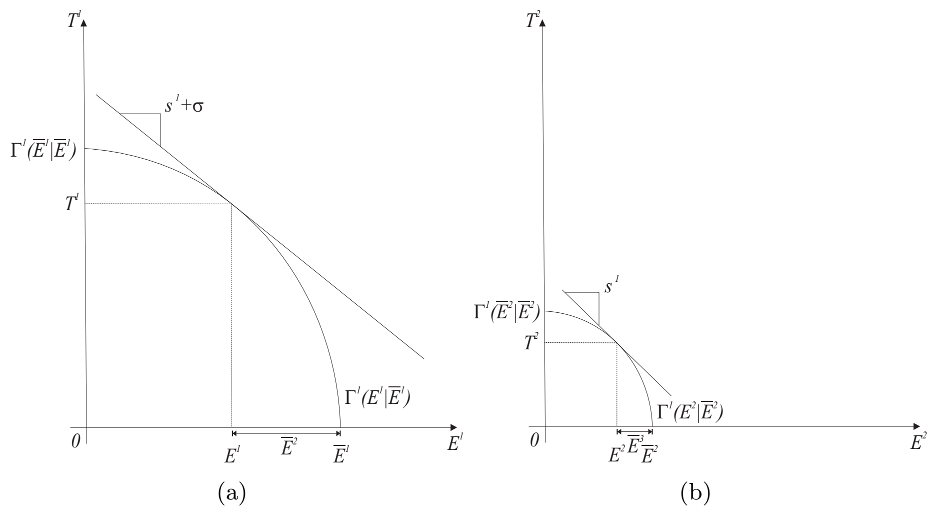

Figure 3: In the forward-looking trade case, the impact of resource depletion in the first period (a) on the second period (b) is taken into account via the tangency line that describes the relative price of tourism services. The slope of the tangency line now consists of the relative first period price s^1 and a shadow price σ. Since the second period price for tourism services is now higher than in the myopic case, the slope of the tangency line is already lower in the first period, i.e. less negative, in (a) than in the myopic case. As a result, a smaller part of the resource stock is consumed in the first period, indicated by E^1 in (a), and a larger part is available for tourism and for the second period, indicated by $\bar{E}^2$ in (a) and (b).

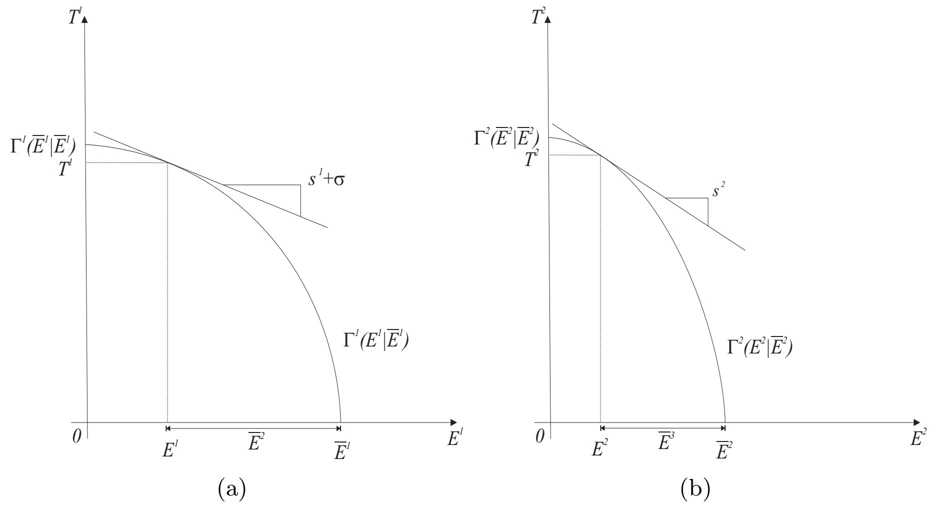

Figure 4: In the forward-looking trade case with booming future tourism, the second period price for tourism services is even higher than in the forward-looking case. Hence, the slope of the tangency line, consisting of the first period price s^1 and the shadow price σ is even lower in the first period, i.e. less negative, in (a) than in the forward-looking case. As a result, a minor part of the resource stock is consumed in the first period, indicated by E^1 in (a), and the major part is available for tourism and for the second period, indicated by $\bar{E}^2$ in (a) and (b).

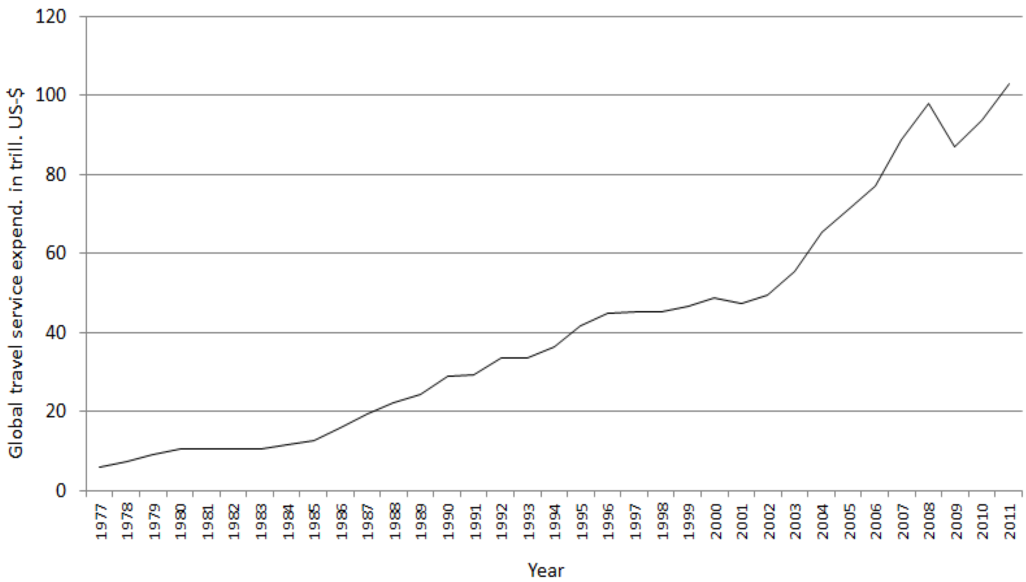

Figure 5: Annual volume of global travel service exports over time (in trill. current US-$, data taken from WDI, 2012).

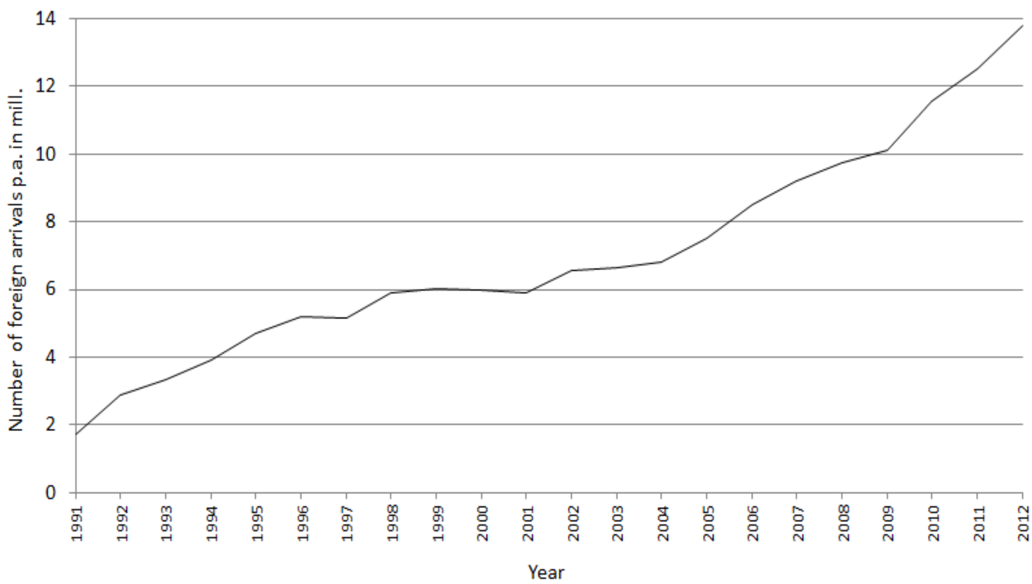

Figure 6: Annual number of foreign travellers arriving in South Africa over time (in mill., data taken from Statistics South Africa, 2010/12). In 2012 88 percent of foreign travellers came for holiday reasons (South Africa Statistics, 2012, p. 21). Most overseas travellers in 2012 came from the UK, the USA and Germany. South Africa has 19 national parks (http://www.sanparks.org). In 2011/12 South African National Parks visitors totaled 4.7 mill. p.a., while Krueger National Park alone attracted 1.4 mill. (PMG, 2012).