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Working Paper — Digitized Version

The international management of biodiversity

Kiel Working Paper, No. 529

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Suggested Citation: Stähler, Frank (1992) : The international management of biodiversity, Kiel Working Paper, No. 529, Kiel Institute of World Economics (IfW), Kiel

This Version is available at:

<https://hdl.handle.net/10419/46719>

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Kieler Arbeitspapiere Kiel Working Papers

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**THE INTERNATIONAL MANAGEMENT
OF BIODIVERSITY**

by Frank Stähler
October 1992

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The Kiel Institute of World Economics

ISSN 0342 - 0787

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D-W-2300 Kiel 1, FRG

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AG 3992 / 92
Wirtschaft
Kiel

Abstract: The Earth Summit in Rio was expected to pave the way for more and effective cooperation with respect to biodiversity. This paper discusses the approaches which were adopted at the summit and the benefits of biodiversity which are closely related to innovations of the biotechnology industries. The paper shows that the project-related support is principally able both to guarantee a certain degree of preservation and to avoid administration problems which originate from information asymmetries and rent-seeking. The project-related control of environment-friendliness can serve as an effective, although insufficient second-best instrument unless a general pricing rule for different international environmental services is available. However, the paper also shows that the agreed-upon preferential access of developing countries to patented biotechnology products will encounter a lot of problems.

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1. Introduction: Biodiversity and the Earth Summit

The Earth Summit in Rio was expected to pave the way for more and effective cooperation with respect to biodiversity. Natural scientists accuse land- and forest-users that they are making hundreds of plants and animals extinct year by year, not taking into account the potential productivity of these species for the biosphere and human living conditions. An intensive use of biospheres for timber production and agricultural purposes obviously conflicts with a long-run survival of potentially decisive elements of the natural environment. Natural scientists demand the abolishment of land uses which are incompatible with long-run sustainability.

Biodiversity losses can be attributed to several externalities of economic processes in the developing countries, especially of agriculture (see Swanson (1992)) and other land developments. As a logical consequence, the summit formulated a convention on biological diversity which is already signed by many participants of the Rio Conference. This convention mentioned explicitly the condition of sustainability for the resource uses which should serve as a restriction on the national sovereignties in exploiting national resources. The United States of America, however, refused to join the convention because the Bush administration feared economic drawbacks for their domestic biotechnology industry.

None of the conference participants expected that the developing countries will afford resource conservation on their own. They accepted biodiversity as a world-wide task and acknowledged the need of strong support by the industrialized countries. Like in the Montreal Protocol on Substances that Deplete the Ozone Layer, the industrialized countries declared to bear the *incremental costs* to meet the diversity targets. They considered the implementation of a special environmental fund which should be paid by the developed countries. The negotiation sessions which prepared the Earth Summit proposed that an agency should administer the environmental fund. The draft convention did not contain any rules of demands and responsibilities ("to be decided on the conference"), so that the concrete allocation procedure was a subject of controversial discussions.

The developing countries also demanded "equitable and preferential access ... to the results of research, the products developed and the benefits and profits arising from the exploitation of the relevant genetic material".¹ Biodiversity resources, especially agriculture and the tropical forests of developing countries, provide a wide range of genetic material. For example, the scientific use of genetic material induces a lot of innovations in the field of seeds and pharmaceuticals. Until now, seed producers and the pharmaceutical industry have exploited this genetic material of different plants and animals free of charge. These industries which devote a huge amount of resources to research and development are mostly sited in the developed countries. Hence, the developing countries wanted to participate in the benefits of biodiversity-related innovations. Thus, those developing countries which provide genetic material demanded to "... be exempted from royalties on patents relating to the products of this research". Patents, intellectual property rights and other restrictions should not be imposed for this group of countries unless they conflict with environmental objectives.

The biodiversity agreement of Rio reflects the general outcome of the Earth Summit (see also Heister, Klepper, Stähler (1992)). The developing countries did not succeed either in establishing different funds for different environmental issues or in democratically deciding about the distribution. Instead, countries have to apply for project-related support and the specialists check the "biodiversity-friendliness" of these projects. The assessment of specialists and the proposals which the assembly of the participants of the convention brings forward serve as the decision basis. But essentially the industrialized countries control the fund. They integrated the fund into the already existing Global Environmental Facilities (GEF), which support also other projects which enhance the global environmental quality. Additionally, most of the industrialized countries agreed to a preferential access to biotechnology products for participating developing countries. Because it was also consensual among the industrialized countries to protect intellectual property rights, transfers to the concerned firms will compensate them for their research efforts.

¹ The quotations in this section originate from the draft of the convention.

A preliminary assessment of the several suggestions and the Rio agreements with respect to biodiversity must focus on two major issues. On the one hand, the protection of biodiversity does not represent a challenge which is self-explaining in economic terms. Additionally, not only participants of the Earth Summit disputed the organization of the fund. Academic proposals of a fund which is solely based on financial transfers and compensates environmental protection conflict with the outcome of Rio, too. Therefore, a preliminary assessment must analyse whether these proposals are superior with respect to efficiency and long-run stability. On the other hand, biodiversity serves as a crucial but still free input for several innovations in rapidly increasing industries. Patent laws and other safeguards which are introduced to protect against the free use of intellectual property rights incur several problems of their own. These problems should be taken into account when the parties agree to a preferential access for developing countries.

This paper is organized as follows: Section 2 concentrates on the indeterminate value of biodiversity and the corresponding evaluation problems. Section 3 discusses the role of an environmental fund. I will show that the project conditionality of financial support is able to prevent possible shortcomings of an insufficient system of purely financial transfers. Section 4 contains an analysis of the potential effects of a preferential access to biotechnology products. Section 5 deals with the possibilities of reconciling the demands of the biotechnology industries and those of the biodiversity resource owners. Section 6 summarizes and concludes the paper.

2. The Indeterminate Value of Biodiversity

Any approach to value the benefits of biodiversity faces a lot of determination problems. First of all, cost-benefit-assessments do not solely dominate the discussion about biodiversity. The ethical question whether human mankind has the right to decide on the survival of other living organisms stands at the heart of the environmentalists' contest. Denying to evaluate the survival of species in terms of mankind's benefits prohibits any utilization of natural resources at the expense of other living organisms. Costs and benefits which are subject of environmental economics do not play any role for such an extreme conservation policy and should be irrelevant until this policy definitely rules out any extinction.

Such green ideas strongly influence the discussion on biodiversity and render any standard approach useless (see also the general discussion in Kneese, Schulze (1985)). The incompatibility of these approaches prevents an integration in terms of supplementing conventional benefits unless, for example, the tourist industry addresses the problems of wildlife protection as an externality problem. The discussions on the conference mentioned explicitly these "intrinsic values" although any acknowledgement of such values will only be possible on a political but not on an academic basis. I refrain from adopting this radical conservationists' view but I have to acknowledge that a lot of political pressure originates from those extreme ideas. It is noteworthy that in most cases such ideas come to the minds of inhabitants of highly developed countries.²

The "conventional" benefits of biodiversity are at least twofold. On the one hand, biodiversity lowers the research and development costs of biotechnology industries significantly because it serves as a highly productive in-situ-stock of genetic materials. On the other hand, biodiversity represents an insurance for agriculture because it diminishes the risks of productivity variations. Agriculture can rely on many instead of only a few species which are themselves subject to natural risks. Again, seed producers which are a special branch of the biotechnology industry are able to use a resource stock which they cannot fully substitute by an expensive laboratory ex-situ-stock. But there may exist other services of biodiversity as well. Because we are still very ignorant with respect to the interdependences among several biospheres and their elements, biodiversity could also ensure a high degree of adaptability of all living organisms. Biodiversity could also serve as an insurance against both natural global change and man-made environmental risks if this hypothesis is true.

The dominant uncertainty with respect to the effects of human actions on biodiversity would cause no special problem if a loss of biodiversity were reversible. But extinction is irreversible.³ So, if we are in doubt about the

² Weitzman's (1991) interesting paper has just started the discussion about the evaluation of a "utility-of-diversity-for-its-own-sake".

³ I was told that scientists are experimenting to reproduce extincted animals. They plan to use gnats which had sucked the blood from these animals before amber

benefits, the protection of biodiversity has an option value. According to Arrow and Fisher (1974), the potential learning effects in subsequent periods which were useless when an irreversible development alternative is chosen determine the option value. Weisbrod (1964) demonstrated that option values are political and public issues when - besides uncertainty and irreversibility - the resource owners are not able to trade the option value with uncertain future users because the options are a public good. Prohibitive high transaction costs render any exclusive access to genetic resources non-achievable, but nowadays, the developing countries have other options to use those areas. Free access was efficient in the past when biodiversity was a free good. Now, there will be no longer any free lunch for innovators when only sacrifices in terms of other utilizing opportunities can safeguard biodiversity in developing countries. Additionally, the use of genetic products itself can worsen the degree of biodiversity. The exploitation of genetic materials is negligible because extractions for R&D do not change the stock of the biosphere significantly, but some R&D-based products, especially for the agriculture, can deteriorate the survival chances of natural species. Hence, it turns out that the tropical forests as well as other areas which provide genetic material represent a prototype of public option values. The strong impact of biodiversity on innovations leads to the conjecture that its option value could be very high. However, a numerical calculation might be restricted to regional options (e.g. Krutilla et al. (1972)) but non-applicable to the world-wide biodiversity.

In principle, natural scientists could calculate the number of existing plant and animal varieties as a measure of biodiversity although - as we experienced in the past - there remains a significant portion to be disclosed at least in the oceans and the tropical forests. Biodiversity is not separable according to individual varieties which sum up to a total effect. The survival conditions of plants and animals are highly interdependent and render any isolated in-situ-treatment of a specific plant or animal illusory. The lack of knowledge concerning the feed-backs and the degree of biodiversity are

locked them in. If these scientists succeed in breaking the irreversibility constraint, the biodiversity resources represent an exhaustible resource which is relatively, but no longer absolutely scarce. Then, the costs of preservation must be compared with the costs of restoring. The scientific efforts to overcome the irreversibility originate from the expected absolute scarcity in the same way as the development of backstop technologies originated from the prospected absolute scarcities of fossil fuels (see for the basic concept of backstop technologies Nordhaus (1973)).

responsible for a great extent of uncertainty surrounding any biodiversity management. Even worse, the conflict does not only arise by the extreme uncertainty with respect to the change in numbers. For instance, a number x representing biodiversity as the survival of x species is hardly exchangeable against another state of biodiversity also containing x species which are at least partially not identical to the first one. In economic terms, we are not only lacking a kind of "biodiversity production function" but also a vector of weights which should be given to the specific components; i.e. the varieties, of biodiversity and a corresponding aggregation rule.

However, the negotiation sessions which prepared the Earth Summit demanded to establish an expert group which should deal with the determination of the ecological, economic, aesthetic and cultural value of biological diversity. Such an economic assessment of the benefits and of the corresponding costs could in principle lead to the determination of an "optimum" rate of depletion (which could be zero). Observing the dispute among cost-benefit-specialists, it would have been very interesting for environmental economists to learn how the expert group accomplished the assessment. Baumol and Oates (1971) assumed Herculean proportions already for problems which can be considered as ridiculous in terms of complexity compared to the assessments of biodiversity's benefits.

If appropriately defined in economic terms, sustainability with respect to biodiversity embraces a lot of the option value ideas. A sustainable development is intended to save the regeneration ability of nature because extinction does not only bear the risk of unknown side-effects but also the risk of the loss of unknown future benefits. It is noteworthy that a sustainable development does not necessarily indicate that all resource extractions should be fixed on a certain degree that does not change the resource stock. A concept of sustainable development should take resource-conserving investments into account, too, because accompanying measures can ameliorate the regeneration ability and allow a higher rate of sustainable resource use (Pearce, Barbier, Markandya (1990)).

3. The Economics of an Environmental Fund

An environmental fund aims at an effective enforcement of global environmental objectives. Even if one assumes that an expert group were able to solve the above mentioned assessment problems, an outcome in form of a complex value function is not workable. Instead, it would be hard enough to agree upon concrete fixed objectives which appropriate measures and regulations should meet. From the point of view of theoretical elegance, fixed standards assume a value function which assigns a constant positive utility to just fulfilment and overfulfilment and an infinite negative utility to every non-fulfilment. But the convention did not fix well-specified environmental standards because such an overall strictness is hardly defensible on scientific grounds and - even more important - hardly feasible in the political arena. The industrial countries succeeded in integrating the support into the GEF and rendered an expert group superfluous. Because the industrialized countries pay the fund, they also dominantly control the agency which administers the fund and enforces compliance with the environmental objectives. Contrary to the ideas which the developing countries have brought in, the fund will only support biodiversity-enhancing or -preserving projects. The fund does not support mere preservation although financial transfers seemingly enjoy superiority because they do not incur any welfare losses of misspecification which originate from inferior information of the agency.

However, the additional problems which arise if financial transfers try to regulate the use of biodiversity resources must also enter the academic discussion. First of all, academic discussions often neglect the existence of a severe information problem. Until now, scientists could record the history of biodiversity easily because no incentives existed to manipulate domestic data when biodiversity was no problem of scarcity and environmental concern. When biodiversity will be financed by the developed countries, the well-known lemon problem can arise (Akerlof (1970)). The agency faces two problems in the case of financial transfers. On the one hand, several standards and contingencies can only incompletely specify the contracted biodiversity services. On the other hand, the control costs to ensure full compliance can be prohibitively high for some environmental protection issues. This may not be the case for tropical forests because satellite data can easily monitor and verify

protection. But whenever protection must take place in areas which are also subject of agricultural or industrial use, monitoring problems arise because the control parameter "no human activity" which is suitable for wildlife protection cannot serve as an indicator.

The sovereignty of countries which are contract partners also restricts the control options. It is rational for every country to exploit an eventually given discretionary margin and deviate from the agreed-upon protection of biodiversity. Therefore, countries provide only lemons, i.e. low-quality protection, in the case of severe control problems because the agency cannot distinguish and reward high-quality protection measures. These discretionary margins are a function of the degree of information asymmetries and the credibility of contract breach sanctions by the agency in the case of detection. The sovereignty of the developing countries leaves only the threat of changing the contract partner to the agency. If the environmental criteria are very detailed with respect to regions, even these contract breach sanctions are incredible because - ex definitione - the respective biodiversity cannot be provided by another region. If there is no regional specification, the agency can shrink but not completely eliminate the discretionary margin.

Whether the financial transfers just cover the incremental costs is more a question of the bargaining powers of the agency and the country than a question of the convention's text. The bargaining power of the developing countries depends crucially on the regional specification of objectives. For example, if a certain area of tropical forest is to be protected and the site of the forests does not play any role, developing countries compete for the fund resources. At first glance, the necessary transfers are likely to cover solely the incremental costs unless collusion among forest-owners is workable. On the contrary, a very detailed regional specification of standards renders every developing country a monopolist who will be able to skim the bargaining gains. Hence, from the point of view of the industrialized countries, a more general project-supporting fund is at least cheaper.

But even in the case of no regional specification, rent-seeking can result in a bilateral monopoly unless the fund's allocation rule can prevent such an outcome by simulating a negatively sloped demand curve for biodiversity or environmental preservation. Consider a country i which owns $T_i^{\#}$ units of a

global environmental resource, say $T_i^{\#}$ km² tropical forests. If biodiversity concerns do not matter for i , this country could use this area more beneficially by siting agriculture, industrial facilities, etc. These alternative uses are the opportunity costs for i in the case of environmental protection and define the preservation cost function $C_i(T_i)$ which exhibits increasing marginal costs because land is by and large a fixed factor.

Any auctioning mechanism which is based on sealed bids obviously conflicts with political feasibility. Therefore, suppose on the agency's side a very simple (and basically very naive) allocation procedure: in every period, a constant specific amount of money, F , which should at least be able to protect an area of size \underline{T} endows the agency. The agency asks the forest-owning countries to convey offers of at least, say, also \underline{T} which specify the area of preservation and the corresponding demanded compensation.⁴ Offers will be common knowledge contrary to the underlying cost functions and the agency prefers the "cheapest" offers which exploit the fund, i.e. the set of offers which seemingly maximizes the preservation area. Because I am only interested in a first sketch of allocation problems, I focus on i 's possible strategies and present no explicit equilibrium analysis.⁵

Preservation of area \underline{T} at the expense of F reflects the monopolistic outcome. Because the marginal revenues with respect to preservation are zero, an exclusive supplier of an environmental resource will just meet the reservation level \underline{T} and exploit the whole fund if the costs are lower than F . If there are several countries, country i could still try to reap the whole fund by offering more and more preservation in the competition until it reaches its resource limit $T_i^{\#}$. Then, i 's implicit price which is the ratio of the fund resources F to the increasing preservation level T_i follows a declining path.

A strategy that seeks to absorb the whole fund faces also strictly decreasing profits. But a successful absorption of the fund by just one country i is equivalent to a future monopolistic bargaining position. If the discount rate r_i

4 This minimum offer should guarantee a minimum coherent area of tropical forests which is able to safeguard biodiversity services.

5 I will present a comprehensive approach of a fund-based preservation game in another paper.

of i is sufficiently low, it could pay to bear even large losses today to gain monopoly power tomorrow. Biodiversity destruction means irreversibility so that every country which the fund does not compensate will use the areas of tropical forests for other purposes which will rule out biodiversity forever. In such a case, i is able to realize the combination (\underline{T}, F) in all subsequent periods because it remains the exclusive supplier of the specific biodiversity resource. This irreversibility does not apply to preservation policies with respect to carbon dioxide. Reforestation is able to build up a new stock of carbon-dioxide-binding resources but cannot restore the destroyed biodiversity.⁶

Let (T_i', F) be the combination when the fund just covers the costs of preservation. Then there exists a range until (T_i', F) is reached in which the rent-seeking strategy will still be able to provide positive present profits. Two subsets divide the range of (T_i, F) with $T_i' < T_i$: a set which guarantees positive or zero discounted profits and a set of negative discounted profits, each including expected future monopoly gains. If $T_i^\#$ is a binding constraint, the last set is empty. A rent-seeking country i will offer levels of preservation which exploit the whole fund until it either reaches its resource capacity or faces zero discounted profits. If it reaches this "maximally fully fund-exploiting offer" and a competitor conveys a cheaper bid, i 's next price-reducing bids will leave the set of maximally fund-exploiting offers because i knows that he has lost the monopoly race.⁷ Different last maximally fund-exploiting bids accrue to different discount rates, to different national resource endowments and to different opportunity cost functions. The marginal costs at the minimum offer level \underline{T} determine country i 's final offer after it has left the competition for the monopoly prize.

Suppose that country j has made its last fund-exploiting offer in a two-country-case while i is still able to calculate positive discounted profits. Then, the winning offer of i which reaps the whole fund must be a little bit lower in the implicit price than the marginal costs of j at \underline{T} . No cheaper bid of j will

⁶ But note also the reservation of footnote 3.

⁷ This analysis mirrors only a specific variant of the possible games with respect to the information partitions of the players. I implicitly assume that the cost functions are common knowledge among the resource countries (which implies that the first offer is directly the winning one) or that the participants learn them quickly.

follow this bid. Assume that the agency pays compensations at the beginning of every time period when the participants have made their offers and that all bidding stages for every time period have no temporal meaning in terms of delay costs and the like (Fudenberg, Tirole (1991): 70 ff.). In the case of an infinite time horizon, if there exists a non-empty set of T_i s which fulfil

$$F - C_i(T_i) + \frac{F - C_i(\underline{T})}{r_i} > 0 \quad \text{and}$$

$$\frac{F}{T_i} < \frac{dC_j}{dT_j} (T_j = \underline{T})$$

i will choose the lowest T_i of this set because future gains overcompensate temporary losses and i is a monopolist in the present and all subsequent periods.⁸ It is noteworthy that not necessarily the lowest-cost-country will win this race - if it comes to such an end - because a sufficiently low rate of discount can outweigh cost inferiority. So besides low-cost-countries also "patient" countries can hope to be awarded the monopoly prize.

Lower minimum offers avoid such an outcome because they render the success of a rent-seeking strategy much more unlikely. However, there may exist specific minimum thresholds for biodiversity preservation so that this option can fail to cure the rent-seeking results. Alternatively, the agency could commit to contract with a minimum number of countries or to fix a minimum price to avoid a high future dependency on one country. Both strategies have to keep the irreversible loss of areas in countries which are not compensated in mind so that the structure of the game will differ in the second period from that one in the first. In the model, irreversibility diminishes the set of potential participants in the second period even if the agency can avoid dominant rent-seeking. Hence, this exit game is much more complex than the comparably simple task to avoid the exploitation of the fund by one country in the first period. Uncertainty will increase this complexity because different private

⁸ If all but one country have dropped down their rent-seeking strategy but the remaining one cannot meet the marginal costs of the last \underline{T} -supplier, \underline{T} -offers until marginal costs are reached are not optimal because they would leave wind-fall profits to the last maximally fund-exploiting bidder.

information partitions induce different strategies of offers and - eventually even unpaid - preservation policies. Because the countries are likely to anticipate or at least to speculate about the future constellations of participants, no general financial allocation mechanism of a given fund can be recommended on purely theoretical grounds. Also long-term contracts are not suitable to prevent an exploitation of the fund donors because there exists no international legislation which can enforce future compliance.

These impediments do not indicate that any effort of an international fund and a corresponding agency is useless. But the outcome is not likely to meet the results of theoretical elegance when information problems and irreversibilities are absent. The more detailed the biodiversity claims are the worse is the bargaining power of the industrialized countries already in the first period, but the less dominant are the lemons. However, the majority of the industrialized countries preferred and pushed through an integration into the GEF. The GEF supports already several projects of biodiversity preservation which have proven to enhance the environmental quality. This control serves as an effective second-best substitute for a first-best allocation rule which meets the requirements of a consistent pricing rule for international environmental services. The GEF does not reward the mere retainment of environmental resources and is therefore no subject of strategies which try to build-up a monopolistic bargaining position. The industrialized countries can expect a higher degree of efficacy because the GEF devotes resources only to projects which improve the conditions of biodiversity so that sovereignty issues cannot conflict with long-run sustainability.

However, whether the GEF will succeed to preserve an essential part of biodiversity resources is in doubt. The project conditionality shrinks the possibility set of measures which achieve a stabilized stock of biodiversity resources because projects are no necessary condition for preservation. The irreversibility urges the international environmental policy to find a general pricing rule for biodiversity services which overcomes the limited possibilities of mere project-related support. The stability and the irreversibility aspects recommend a bilateral bargaining between an agency and every developing country. Every contract should package several environmental services to avoid a rent-seeking outcome and future instability. Irreversibility and the risks

of rent-seeking call for a minimum number of participating countries at the expense of the cheapest-bid-rule.

Environmentalists suspect the project-related support to build up long-run strategic advantages for the industrialized countries which will shrink the bargaining power of developing countries. They accuse this strategy as a kind of "neo-colonialism". In Rio, the small number of industrialized countries and the tight links among them in other fields of mutual concern allowed them to form a workable interest group although the Bush administration refused to cooperate. Opposed to this cohesion, the developing countries differ strongly in their preferences with respect to the financial support for the preservation of different global environmental resources. Hence, it was a natural outcome that an international institution which is commonly controlled by the industrialized countries and performs like a monopolist is likely to reap all the bargaining gains because the competition among the developing countries allows the GEF to cover merely incremental costs.

Additionally, if the agency also succeeded to finance a substantial part of essential projects, the industrialized countries were able to improve their future bargaining position. If in, say, ten years the developed countries will agree upon a specific degree of environmental preservation, a credible threat to stop the financial aid for projects which are also essential for the economic development could enforce compliance with these objectives. Compliance could be enforceable when this threat is credible because fund resources could be easily redevoted to other environment-enhancing projects. The developing countries' representatives could prefer this financial support today at the expense of a worse bargaining position tomorrow if they discount the future very strongly. Modern bargaining theory has demonstrated that comparably high discount rates lower the bargaining power coefficient of the generalized Nash bargaining outcome (Binmore, Rubinstein, Wolinsky (1986)). The real biodiversity game would be played in the future while the industrialized countries invest in their bargaining power during the preplays. However, this subtle conjecture can only turn out as true if the essential local environmental problems of developing countries are closely linked to the global problems which are the main concern of the industrialized countries. One cannot observe such links today and thus cannot call the GEF-like support of projects a "neo-

colonialism"-strategy. However, the potential impact of discounting on the Rio outcome should not be overlooked.

4. The Economic Implications of A Preferential Technology Access

The preferential technology access to biotechnological inventions represents the other keystone of the compensations laid down in the convention. Preferential access means that the developing countries will be able to circumvent at least partially the licence fees for biotechnology products or processes without risking direct retaliation through trade policies. Many inventions in the biotechnology industry originate from a long-term and very cost-intensive research on genetic materials which is provided by global environmental resources. The regulation by patents and intellectual property rights responds directly to imitative activities which can destroy incentives to create of new products and production processes. Actually, very little is known about the very nature and the determinants of innovations. Today, economists accept that a workable innovation process is only possible at the expense of the competitive performance on the product markets. An innovation must be able to gain a specific lead rent which at least covers the sunk costs of research and development. Hence, a too high degree of competition on the market for biotechnological products conflicts with an eventually more valuable barrier which shelters monopoly rents and encourages beneficial innovation efforts. The observation of positive externalities supports the hypothesis of positive social benefits of specific barriers to entry: in highly innovative industries, innovations themselves obviously encourage further innovations which were impossible without the basic invention.

Patents try to cure the disincentive which originates from uncompensated imitations on basically free markets by excluding the threat of a free-of-charge imitation for a certain period. However, patents can only serve as an incomplete instrument (see for the following e.g. Scherer, Ross (1990)). First of all, any legislation is not able to differentiate appropriate expiry dates for different innovations. But then the discounted research and development costs will meet the discounted monopolistic net gains of an innovation only by chance exactly. Additionally, an information-inferior agency must decide on the acceptance of an innovation to be patented. It cannot be ruled out that

applications for patents do not originate from the development of a new product or technology but rest on the assumption that this patent will erect a barrier to entry for competitors. On the contrary, "inventing-around" can easily circumvent the patent law. Additionally, the efficiency of patents depends not only on the date of expiry but also on the specific licensing rules which are laid down in the patent law. -

The industrial organization's literature cannot provide any general and unambiguous result whether a specific patent protection and corresponding royalties lead to an over- or underoptimal protection of innovations. Thus, it is by no means clear whether an obligation to transfer patent-protected biotechnologies on a preferential basis to developing countries will imply a further harmful disincentive for the introduction of highly beneficial innovations or will efficiently reap overoptimal rents if compensations are not sufficient. Because the biotechnology industry - attributed to high future growth rates - is still in its infancies with respect to their innovation abilities, I refrain from an ad-hoc assertion.

The contractors of the biodiversity convention will face the same problems when they have to determine the degree of compensations. Firms which receive compensations for the provision of biotechnological innovations have superior though no certain knowledge with respect to research and development as well as the market potentials of their products. Hence, they are likely to exaggerate the demanded compensations in order to earn extra rents. An authority deciding on the compensations runs the danger to induce a future cut of innovation efforts in the case of a coercive transfer when compensations fall short of the industry's demand. Alternatively, the authority has to devote a huge amount of compensations in the case of voluntary transfers to guarantee an - eventually even free-of-charge - preferential access which developing countries can finance. Because no market prices for intellectual property rights exist, a subsidization of technology transfers will unavoidably incur severe information problems unless this part of the agreement degenerates to a simple declaration of intent by granting too low subsidies. Additionally, a preferential access which constitutes an artificial comparative advantage does not exploit the potentials of a scarcity-based division of labour.

Even if the developing countries had the human capital capabilities to run biotechnology facilities, the industrialized countries could retaliate against an aggressive expansion strategy by the imposition of trade barriers on those biotechnology products which developing countries plan to export. Subtle product standards can easily close the still expanding market for pharmaceuticals for developing countries.

5. Preferential Technology Access and Biodiversity

A preferential technology access constitutes an in-kind-transfer contrary to a fund which pledges to pay financial transfers for mere preservation. In-kind-payments can play the same stabilizing role in international environmental agreements like the project-linked financial support of the GEF if they directly induce environmental protection. These stability aspects can justify cooperation in the field of biodiversity-friendly and biodiversity-enhancing technologies. However, donors which benefit from stability instead of receivers normally initiate in-kind-transfers. Rational receivers can be better off by financial transfers because they can satisfy their desires without considerable welfare losses which originate from the transaction costs of a reallocation.

Contrary to this conclusion, the developing countries suggested the preferential access. Strong political pressure of potential biotechnology users could have motivated this preference. But an issue-linking-strategy which originates from the parallel GATT negotiations explains this suggestion better. The GATT negotiations which some of the developed countries initiated deal generally with the acquisition of patents and intellectual property rights. The developed countries believe that the non-acknowledgement of patents and other intellectual property rights in other countries results in the worse performance of some of their industries on international markets. Hence, the industrialized countries are targeting a world-wide protection of their innovations but deny any compensation for the origin country which provides genetic material (see Acharya (1991) for details).

The purpose of the convention is not a doubtful efficiency-enhancement of the innovative performance of the biotechnology industries by coercive or strongly subsidized voluntary technology transfers. Contrary to the

establishment of the fund, a preferential access gains basically nothing in terms of the protection of biodiversity. The fact that also developing countries directly experience a further reduction of the world-wide genetic basis does not induce a retainment of biospheres. Every developing country has the option to destroy its domestic genetic basis and to rely on a free-rider-ticket which assumes a sufficient provision by other countries, too. Even worse, if the royalties for developing countries fall extremely short of the R&D costs and biodiversity-friendliness cannot be always guaranteed, an overintensive use of biodiversity-destroying biotechnologies could significantly endanger the effectiveness of a fund.

In a recent paper, Swanson (1992) proposes to establish international informational property rights. These informational property rights resemble intellectual property rights and should compensate resource owners for the "identified usefulness of unmodified natural resources". However, a system of informational property rights would face insurmountable obstacles. On the one hand, the very nature of innovations leaves the information which genetic basis was used exclusively to the innovators. On the other hand, several environmental resources offer the same genetic potential because genetic potentials can inhabit different species. Hence, an agency could not create unambiguous informational property rights because the agency cannot determine the original biodiversity resource which implied the invention.

The issue-linking strategy of developing countries as a respond to the GATT negotiations should make the industrialized countries reconsider their trade policies if they are really interested in sustainability and biodiversity. The developing countries are facing a lot of severe trade barriers, especially for agriculture and manufactured goods. The issue linking strategy seems to originate from the talks about intellectual property rights and the reluctance of several developed countries to abolish trade barriers. The demand of a preferential access seems to stem from the GATT round which is likely to improve the conditions for the industrialized countries by a tighter protection of knowledge but also probably misses to open markets which are decisive for the developing countries. Environmental agreements will suffer the burdens of unsolved conflicts of international trade policies as long as these countries are

merely treated as resource suppliers which are prohibited to compete in the markets for agricultural and manufactured goods.

It is of course illusory to hope for a new order of international trade before internationally coordinated efforts to protect biodiversity should be started. At best, a preferential access will eventually not alter the effectiveness of the fund. A specific fund-raising mechanism could increase this effectiveness. Governments could impose a special tax on biodiversity industries which pays the fund at least partially because biotechnology industries benefit from a retainment of biodiversity. The biotechnology industries and the governments could comprise the control authorities of the agency. Because these industries have superior knowledges of any contract breach with respect to their biodiversity needs and a strong incentive to reveal these informations, the agency can cope with non-compliance more effectively. However, the agency will still face information problems to detect a deterioration of biodiversity which is not directly harmful for innovations but for the biosphere and the human living conditions in general. As we experience that fairness aspects often dominate environmental decision making (Stähler (1991)), the reluctance to bias detection possibilities in favour of an industry is likely to prevent such a mechanism.

6. Summary and Conclusions

Compared to a global climate policy, biodiversity seems to represent a more urgent challenge for the world community. Although a delay of effective international cooperation with respect to global change may be very costly, the costs of restoring biodiversity seem to be infinite. Hence, international environmental policies should focus more on problems of biodiversity and ecosystems but the results of Rio are not in that way promising. This paper has indicated that the potential benefits of a retainment of the present in-situ-stock may be very large even if preservation policy concentrates solely on the impacts for biotechnological industries and agriculture. The paper has also demonstrated that the project-related support is principally able both to guarantee a certain degree of preservation and to avoid administration problems which originate from information asymmetries and rent-seeking. The project-related control of environment-friendliness can serve as an effective second-best instrument unless a general pricing rule for different international

environmental services is available. But the creation of an effective pricing rule is a very urgent challenge with respect to biodiversity.

Additionally, the planned biotechnology transfer which developing countries brought into the discussion limits the efficacy of the Rio agreement. The organization of such a technology transfer will face a lot of severe problems because these transfers make no sense in terms of preservation and are likely to endanger beneficial innovative efforts in the developed countries. This potential drawback gave reason for the U.S. government not to join the agreement. This transfer originates from the GATT negotiations which are likely to introduce an international shelter for intellectual property rights. But the chances that trade barriers for the developing countries will be abolished are low. So the biodiversity agreement has to bear the problems of unsolved trade conflicts and those of a too low degree of participation. It remains an open question whether the industrialized countries will accept a change in their trade policies or whether they will sacrifice future innovations to protect their domestic agriculture and some of their old and cost-inferior industries.

Acknowledgements:

This article originated from a project about the stability of international environmental agreements. I gratefully acknowledge financial support by the Volkswagen Foundation. I am also indebted to Johannes Heister, Gernot Klepper, Peter Michaelis and Ernst Mohr for useful comments on a former version. Of course, all remaining errors are in my full responsibility.

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