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Competition and Cooperation in Environmental Policy: Individual and Interaction Effects[1]

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ABSTRACT

The theory of regulatory competition suggests a race to the bottom of environmental standards. This theory, however, has not found much empirical support. Several attempts to account for this theoretical failure have been made in the literature, which mainly refer to the underlying assumptions of the theory. In this article, we present an alternative explanation. We argue that in reality regulatory competition is overlapped by other mechanisms affecting the adjustment of national policies. Most important are the effects emerging from regulatory cooperation at the level of the European Union (EU). To arrive at more precise theoretical predictions, we therefore not only analyze the individual effects of competition and cooperation on national policies, but also the impact of their interaction.

Introduction

The theory of regulatory competition suggests that in the field of environmental policy the presence of regulatory competition leads to a 'race to the bottom' of environmental standards. This theory, however, has not found much empirical support (Drezner 2001). There is even evidence for 'races to the top'. For example, a number of countries quickly followed the 'environmental forerunner' California in adapting strict car emission standards (Vogel 1995, 1997).

Several explanations for this failure of the theory have been given in the literature. The theory rests on a whole number of implicit assumptions. For example, it is assumed that the costs of stricter environmental standards are high enough to cause severe competitive disadvantages to firms exposed to these standards and to lead firms to change their investment locations. However, environmental costs may in fact be relatively low compared to other cost categories and may thus not constitute important facts for the firms' decision-making (Vogel 1997; Jänicke 1998). Second, the theory is

based on the idea of competition among firms within a common market or a free trade regime. However, in reality it is often permitted to wall off a country against foreign products on the basis of health and environmental reasons. In this case, competitive disadvantages of an industry in a high standard country might be not very serious (Holzinger 2003). Third, the theory does not differentiate between product standards and process standards. However, in case of product standards races to the top are more likely than races to the bottom (Scharpf 1996, 1997). There are some more assumptions of the theory, which have been contested (Wilson 1996; Levinson 1996).

In this article another kind of explanation of the failure of the race to the bottom hypothesis will be presented: We argue that the absence of downward pressures might be a consequence of the interaction of regulatory competition with another factor, namely international regulatory cooperation. Empirically, regulatory competition is related to regulatory cooperation in two ways. First, regulatory competition among countries presupposes economic competition among them, that is, the existence of a common market or a free trade regime. This, in turn, presupposes the presence of international cooperation and institutions creating and preserving the market. Second, as in a common market different environmental standards may lead to distortion of competition, the harmonization of standards is often demanded by political actors. A typical example is the EU with its classical harmonization approach in environmental policy (Holzinger 2000). The presence of harmonization can, but need not necessarily dominate regulatory competition. Thus, the interaction of the two factors may lead to various effects on environmental regulation in the countries concerned.

In order to arrive at empirically more precise predictions the theory must take into account both criticisms. As the examples dealing with the presuppositions of the theory have shown, it is important to carefully analyze the conditions under which the mechanisms of regulatory competition and regulatory cooperation can be expected to be effective. An even more challenging analytical problem emerges from the fact that the different mechanisms might be effective at the same time. Hence, we need to find ways to analytically cope with potential interaction effects of regulatory competition and regulatory cooperation.

It is an implication of the theory of regulatory competition that the environmental policies of the involved countries will eventually converge as a consequence of 'regulatory races' to the bottom (or the top, in special cases). Competition drives the levels of regulation towards an equilibrium – which is usually thought to be the 'lowest common denominator' of the policy of the most 'laissez-faire' country (Drezner 2001: 59). Thus, in theory, full convergence can be expected at an imagined end point of the process. Although, empirically, these patterns must not necessarily lead to complete

similarity of policies, the degree of similarity is expected to increase significantly.

Similarly, the mechanism of regulatory cooperation implies that national policies converge because member states are legally required to adjust their regulations to the arrangements spelled out in international or supranational laws and agreements. Whenever policies are totally harmonized full convergence can be expected.

Therefore, the effects of regulatory competition, as well as of regulatory cooperation are convergence effects. In developing a theory on the effects of regulatory competition, regulatory cooperation and their interaction, we therefore have to ask two central questions: What determines the degree of convergence and what determines the level of regulation at which convergence occurs? In section two, we briefly introduce regulatory competition and regulatory cooperation. In section three, we analyze the convergence effects for both mechanisms individually. We develop theoretical expectations not only of the conditions under which the two mechanisms will be effective, but also of the degree and level of national policy convergence. The interaction effects of the two mechanisms are analyzed in section four. Some empirical illustrations are given where available and appropriate. Section five briefly indicates avenues for empirical testing.

Concepts

Regulatory competition

With the increasing integration of European and global markets and the abolition of national trade barriers, there is a certain potential that international mobility of goods, workers and capital puts pressure on the nation states to redesign domestic market regulations in order to avoid regulatory burdens restricting the competitiveness of domestic industries (Goodman and Pauly 1993; Keohane and Nye 2000). The presence of mobile capital can induce governments to attract capital from elsewhere by lowering environmental standards on the one hand, and on the other, domestic capital can threaten to exit and this way exert pressure on the governments to lower the level of regulation. This way, regulatory competition among governments may lead to a race to the bottom in environmental policy, implying policy convergence (Hoberg 2001: 127; Simmons and Elkins 2003; Drezner 2001: 57–59).

The concept of regulatory competition is based on economic theories of systems competition or regulatory competition (Tiebout 1956; Oates and Schwab 1988; van Long and Siebert 1991; Sinn 1993, 1996). While the economic literature focuses on normative questions, such as the effect of systems competition on efficiency or democracy (Vanberg 2000), the political

science literature has concentrated on the question, whether regulatory competition actually works and whether it induces races to the top or bottom.

The empirical literature generally finds 'lack of empirical support' (Drezner 2001: 75) for the hypothesis that regulatory competition necessarily leads to convergence 'at the bottom'. There is case study evidence for races to the top but no systematic confirmation of a race to the bottom (Tobey 1990; Vogel 1997; Jänicke 1998; Beers and van der Bergh 1999; Kern 2000). Theoretical work suggests that there are a number of conditions, which may drive policy in both directions (Vogel 1995; Scharpf 1996, 1997; Kern et al. 2000; Drezner 2001; Holzinger 2002, 2003). These factors include, for example, the presence of economic competition in a field, the type of policy concerned, the relative market shares of the countries involved in competition, or the presence of other interests than business in national politics, such as environmental groups or green parties.

Regulatory cooperation

Environmental policy convergence might not only be the result of competitive pressures emerging from economic integration. It can also emerge from deliberate activities of national governments to reduce such pressures through regulatory cooperation at the supranational or international level. This pattern of 'obligated transfer' (Dolowitz and Marsh 2000: 15) or 'convergence through harmonization' (Bennett 1991: 225) refers to constellations, in which national governments are legally required to adopt policies and programs as part of their obligations as members of international institutions. In other words, national policies converge because of corresponding legal obligations defined in international or supranational law.

We use the term regulatory cooperation here in its strictest meaning, as being equivalent with international legal obligation. In a wider understanding, regulatory cooperation might also include non-binding agreements and all kinds of voluntary activities of international organizations. However, as the effects of non-binding policies are even more difficult to predict than the effects of legal obligation and of regulatory competition, the inclusion of non-binding international policies would strongly increase the complexity of the hypotheses. We thus prefer to stick to the narrow meaning of regulatory cooperation. The meaning of 'cooperation' is thus equivalent to its meaning in cooperative game theory.

Regulatory cooperation as a source of policy convergence is generally traced to the existence of interdependencies or externalities which push governments to resolve common problems through cooperation within international institutions, hence sacrificing some independence for the good

of the community (Drezner 2001: 60; Hoberg 2001: 127). Once established, institutional arrangements will constrain and shape the domestic policy choices, even as they are constantly challenged and reformed by their member states. This way, international institutions are not only the object of state choice, but at the same time consequential for subsequent governmental activities (Martin and Simmons 1998: 743). However, as member states voluntarily engage in international cooperation and actively influence corresponding decisions and arrangements, the impact of international legal obligations on national policies constitutes no hierarchical process; it can rather be interpreted as 'negotiated transfer' (Dolowitz and Marsh 2000: 15).

The impact of legal obligation on cross-national policy convergence has been analyzed in particular for the EU. There are several studies which emphasized the strong institutionalized forces for harmonization at the Community level superseding national tendencies for divergence (Hurwitz 1983; Brickman et al. 1985). More recent studies focusing on the Europeanization of domestic policies, processes and institutions arrive at a more differentiated picture, indicating both the influence of national institutions and interest constellations as well as peculiarities of the European legislation in question (Caporaso et al. 2001; Héritier et al. 1996; Knill 2001). In the field of environmental policy a broad range of supranational, and in particular EU law and international regimes exist.

Convergence effects of regulatory competition and cooperation

An analysis of the impact of regulatory competition and regulatory cooperation on environmental policy convergence needs to distinguish two levels of their effects: (1) the effects each of the two mechanisms has individually (2) the interaction effects of the two mechanisms. With respect to the first level, we ask the following questions: First, under which conditions can we expect the respective mechanism to be effective at all? Not every mechanism works in all countries and all environmental policy areas. For example, regulatory competition is only effective among market economies. Similarly, regulatory cooperation does not take place in all fields of environmental policy. Thus, the conditions under which the two mechanisms have an effect on policy convergence differ for each of them. Second, given the effectiveness of a mechanism, which factors will then increase or decrease policy convergence?

It is difficult, however, to isolate the effects of each mechanism empirically. Often both factors are present at the same time. This leads us to the second level of analysis: What are the interaction effects of the two mechanisms? Their individual 'scopes of effectiveness' are not fully congruent but have intersections with respect to both policies and countries. For areas where the two mechanisms overlap, what are the consequences of the interaction? Are

the convergence effects strengthened by the interaction of several factors? Are they diminished? Or does one factor dominate the other and if so, under which conditions?

We first develop some conjectures on the individual effects of regulatory competition and regulatory cooperation and then go on to their interaction effects. In each section, the discussion is related to three questions: Under which conditions can convergence of policy outputs be expected as a result of each causal factor?; Which degree of convergence will be achieved by each factor?; At which level of regulation will policies converge for each causal factor? Can we expect a regulatory race to the top or a race to the bottom?

We talk of policy convergence, if the policies of at least two countries became more similar over time. We focus on policy output; i.e., the policies adopted by a government. We do not consider the convergence of policy outcomes, because outcomes are affected by many intervening variables during the process of implementation (Inkeles 1981).

With respect to the level of convergence, it is impossible to formulate theoretical expectations in many cases. Usually, lax environmental standards are identified with the 'bottom', strict standards with the 'top' (Drezner 2001; Holzinger 2003). However, it is not always easy to identify what is the top and what is the bottom in a policy. When general principles or policy instruments are compared, it does not make much sense to speak of levels of convergence. Therefore, the level of convergence can only be measured when the policies under consideration come in degrees, which can be associated with a normative judgment on the quality of an intervention.

The idea of convergence of policies implies decrease in variation of policies among the countries under consideration over time. Thus, convergence is the decrease of standard deviation from time t_1 to t_2. A change in the regulatory level implies an upward or downward shift of the mean from time t_1 to t_2 (Botcheva and Martin 2001: 4). Convergence at the top or bottom presupposes therefore both decrease of standard deviation and an upward or downward shift of the mean. We will use this terminology throughout the paper.

To assess the extent of convergence, as well as shifts in the level of regulation a point of reference is needed. We assume as the reference point a situation where no mechanism is at work and where the policies of the countries under consideration are characterized by diversity.

Regulatory competition

The theories of regulatory competition imply some restrictions on the scope of effectiveness of this mechanism (Scharpf 1996, 1997; Vogel 1995; Holzinger 2003). First, convergence effects are likely only for policies which

affect competition among national industries. No convergence is predicted for policies subject to low competitive pressures from international markets. This holds true for all environmental policies that are not directly related to products or to production processes, such as ambient quality standards, or nature protection. It also holds true if trade-related policies are concerned, but the effects of the regulation on production costs are low (Vogel 1995; Jänicke 1998). In this case they do not affect competition between industries in different countries (Table 1).

Second, we expect convergence only among countries which are subject to competitive pressure from international markets. We would not predict convergence of national policies among countries which are not exposed to competitive pressures. This scenario can be expected, if, as a result of trade barriers, there is a low degree of economic interaction between countries. Moreover, even in constellations of high economic interaction and exchange, no converging pressures might emerge as a result of lacking competition in and between non-market economies. This scenario applies in particular to the Eastern European countries before 1990.

The general theoretical expectation concerning the degree of convergence holds that the effects of regulatory competition increase with the economic openness of the countries under consideration. The more a country is integrated into the world market or into a regional common market, such as the EU internal market or the North American Free Trade Agreement, the more it is subject to competitive pressures, and the more its capital is mobile. The mechanism of regulatory competition has thus stronger effects in countries whose economies are highly economically integrated and weaker effects in less integrated countries. The more exposed a country is to competitive pressures following from high economic integration into

TABLE 1: *Effectiveness and effects of regulatory competition*

Conditions of effectiveness
Regulatory competition leads to policy convergence only among countries whose markets are not segmented by barriers to trade
Regulatory competition leads to policy convergence only among market economies
Regulatory competition leads to policy convergence only if the policies actually affect the competitive position of the industries concerned
Degree of convergence
Policy convergence through regulatory competition increases with the extent to which countries are exposed to competitive pressures following from high economic integration
Level of convergence
Whenever there is a strict free trade regime, excluding exceptional trade barriers, there will be a decrease of both standard deviation and mean, irrespective of the type of regulation (race to the bottom)
In case of product regulation, there will be a decrease of standard deviation but an increase of mean (race to the top)

international markets, the more likely it is that its policies will converge to other states with international exposure.

There is an ongoing debate in the literature on the level of convergence caused by regulatory competition. In this context, a distinction is often made between product and production process standards (Scharpf 1996, 1997; Holzinger 2003). While for product standards, several factors might inhibit a race to the bottom and even trigger a race to the top, we find a widely shared expectation that policy convergence will occur at the lowest common denominator in the case of process standards (Drezner 2001; Holzinger 2002, 2003). Typical examples of process standards are sulphur dioxide (SO_2) or nitrogen oxide (NO_x) emission standards for large combustion plants. Strict standards demand filters, which raise production costs. Then the domestic steel industry, for example, suffers from a competitive disadvantage against the steel producers abroad, if these need not apply the same strict standards. In order to avoid such a disadvantage governments may want to decrease their standards to the level of other countries.

In contrast to the process standards, industries in both low-regulating and high-regulating countries have a common interest in harmonizing product standards to avoid market segmentation. Whether harmonization occurs at the level of high-regulating or low-regulating countries depends on a number of additional factors. Most important is the extent to which high-regulating countries are able to factually enforce stricter standards. If it is possible to erect exceptional trade barriers, as for example for health or environmental reasons under EU and WTO rules, convergence at a high level of regulation is likely (Scharpf 1997: 523; Vogel 1995; Epiney 2000; Sandhoevel 1998). If such exceptional trade barriers cannot be justified, by contrast, competitive pressure is expected to induce governments to lower their environmental standards (Holzinger 2003: 196). Moreover, an upward move of regulatory levels can only be expected, if the harmonization advantage is valued higher by business and governments than the cost difference between high and low levels of regulation (Holzinger 2003: 192). The classical example of a race to the top of product standards is car emission standards. When California raised its emission standards, most US states followed quickly (Vogel 1995). California was permitted to apply its standards to foreign car producers. The harmonization advantage is large for technology avoiding exhaust emissions. The most important reason for this is that licensing procedures for cars are very expensive and firms want to avoid multiple licensing procedures.

By contrast, none of these conditions avoiding downward pressures on national regulation is given for production standards. In these cases, there are neither harmonization incentives to avoid market segmentations, nor do national governments have the opportunity to erect exceptional trade barriers. Hence, if the regulation of production processes increases the costs

of products, regulatory competition will generally exert downward, rather than upward, pressures on economic regulations (Scharpf 1997: 524).

In the following we assume in case of product standards that the erection of exceptional trade barriers for the sake of the environment is possible, and that the advantage through harmonization of the standards outweighs the cost difference between lax and strict environmental standards. Whenever both conditions are met, a regulatory race to the top can be predicted.

Regulatory cooperation

As with regulatory competition, regulatory cooperation actually leads to the convergence of policies across countries only if some conditions are met. First of all, it is quite obvious that convergence effects can only be expected amongst the member countries of the institution or regime with obligatory potential. Second, an impact of international institutions is likely only for policy areas in which international institutions have obligatory potential; i.e., the power to enact legally binding rules. To fulfil this condition it is thus not sufficient that a certain policy area falls under the jurisdiction of an institution with obligatory potential, but that the institution actually has obligatory powers in this policy area. The EU constitutes a typical example. Although the EU as a supranational institution has broad powers to enact legally binding rules, its obligatory potential varies not only across but also within many policy areas under its jurisdiction. While the obligatory potential is quite high with respect to market-creating policies, such as the harmonization of environmental product standards, the picture looks rather different for other areas, such as nature protection or environmental taxes.

For the mechanism of regulatory cooperation, the general expectation is that convergence increases with the degree of integration of countries into international institutions. The more countries are members in international institutions, the wider is the spatial scope of convergence. The more memberships in international organizations or regimes an individual country has, the more international regulations it has to implement (Table 2).

The degree of convergence as a result of regulatory cooperation depends also on the obligatory potential an international institution has. This is usually associated with the type of regulatory output, and in particular, the type of harmonization used. Convergence effects will be very strong if policies rely on total or minimum harmonization of national regulations, hence significantly restricting the potential for domestic interpretations and deviations. The picture looks quite different, however, if policies are defined in a less rigid way. In this respect, varying levels of discretion for members are conceivable, for example, differentiated regulatory requirements or mutual recognition. In these constellations, persisting diversity or divergence rather than convergence of national policies constitutes a plausible outcome.

With respect to the degree of convergence, the various harmonization techniques form a scale with mutual recognition on the one end, and total harmonization on the other. In the following, we concentrate on total and minimum harmonization, whereas differentiated harmonization and mutual recognition are not treated. Differentiated harmonization can be expected to have similar effects as total harmonization. The only difference is that it cannot be expected to lead to convergence. Mutual recognition as a technique of regulatory cooperation has the same effects as regulatory competition alone.

Total harmonization can only be found in the EU. In the environmental field it has so far only been used for products. The regulation of car exhaust emissions follows this technique since the introduction of the catalyst car in 1989 (Holzinger 1994: 329). Other examples are noise emission standards for lawn-mowers or standards for detergents. Minimum harmonization has been used for air and water quality standards, such as the SO_2 directive or the quality standards for drinking and bathing water, but also for process standards, such as those provided in the waste directives (Rehbinder and Stewart 1985: 210).

Moreover, the converging impact of legal requirements depends on the international institution's capacity to enforce legally binding rules. For the following analysis of the levels of convergence and of the interaction effects, however, we assume that there are no enforcement problems and all countries fully comply with international law. Otherwise it would be impossible to derive any predictions.

Having elaborated on the conditions under which regulatory cooperation results in the convergence of national policies, we still have no information

TABLE 2: Effectiveness and effects of regulatory cooperation

Conditions of effectiveness
Regulatory cooperation leads to policy convergence only amongst states which are members of the same international institution with obligatory potential
Regulatory cooperation leads to policy convergence only in policy areas where international institutions have obligatory potential
Degree of convergence
Policy convergence through regulatory cooperation increases with the extent of integration of nation states into international institutions
Policy convergence increases with the extent to which regulatory cooperation requires the harmonization of national policies
Policy convergence increases with the extent to which international institutions are able to enforce their regulatory output
Level of convergence
If regulatory cooperation requires the total harmonization of national standards, the level of convergence implies no significant changes of the mean
If regulatory cooperation requires the minimum harmonization of national standards, the level of convergence implies an upward shift of the mean

on the convergence level. With respect to legal obligation, the answer to this question basically depends on factors such as decision rules, interest constellations and the distribution of power between the involved actors (typically national governments), which shape the negotiations at the level of international institutions.

In light of this constellation, which might vary from case to case, it is difficult to develop general hypotheses on the conditions under which the negotiated agreement reflects a shift of mean towards either the top or the bottom. In principle, every result within the span of existing national regulations is possible, depending on the dynamics of the international decision-making process. Notwithstanding this openness, the literature generally predicts an outcome, which reflects a compromise in the middle between countries favouring extreme positions of either rather strict or weak regulations (Drezner 2001: 61; Holzinger 1994: 465–468). In the following analysis we therefore assume that the level of harmonization will take place at the mean of the national regulation levels.

However, even if we assume that the final agreement reflects a compromise between high-regulating and low-regulating countries, we still need to know whether and in which direction the mean of national regulatory levels will change as a result of this compromise. Predicted mean changes are different for total and minimum harmonization. In the case of total harmonization, the expected result is that convergence coincides with no mean changes of regulatory levels. The required upward and downward moves of national standards will neutralize each other, hence implying no significant departure from the status quo. For total harmonization we can assume that all countries move to the level of standard agreed upon, as we have ruled out enforcement problems. In fact, after the change to total harmonization in the case of EU car emission regulation in 1989, all new cars sold in the EU were fitted with catalysts after 1993, the year of introduction of this standard (Holzinger 1995).

The constellation looks different, however, in cases of minimum harmonization. Here it is still possible for countries with a preference for higher regulatory levels to enact standards beyond the minimum level specified in international agreements. While deviations to the top are therefore still possible, countries with lower standards are obliged to raise their standards levels at least to the international minimum level. We thus predict that minimum harmonization is likely to result in shifting the regulatory mean upward. This expectation rests on the assumption that not all high-regulating countries will lower their standards towards the minimum level. This is justified because countries that chose a higher level of protection before can be assumed to have had good reasons for that. They will thus not change their policy as a result of international regulatory cooperation, if they are not obliged to. A case in point is the German Large

Combustion Plant Regulation. This regulation contains some standards that are stricter than the requirements spelled out in the corresponding EU Directive (Knill and Lenschow 1998). Another example is the 1978 directive on lead content of gasoline. Here, too, Germany kept its stricter standards (Rehbinder and Stewart 1985: 209).

Interaction of regulatory competition and cooperation

In this section, we develop some conjectures on the interaction effects of two mechanisms. Again, we first delineate the scope of effectiveness for the interaction of several factors and then formulate hypotheses on the degree and level of convergence. The interaction analysis pursues the aim of comparing situations where no mechanism is effective to situations where both mechanisms interact.

Both mechanisms can be in effect at the same time. They are not in general mutually exclusive. Depending on the type of harmonization used and on the type of standard the effects of the interaction will differ. In cases of total harmonization, there is no room for competition left. All countries must apply the same regulation. Here, cooperation fully supersedes competition. With other forms of harmonization, such as minimum harmonization, regulatory competition could still have effects, as there is still room for diverse regulations in the countries.

Both mechanisms can also follow each other as the stages of a process. For example, in the media regulation case described in the article by Harcourt in this issue, the process started with a diversity of regulations at the national level. In a second phase, with the EU directive, a common market was created and enforced. The mechanism of regulatory competition became effective. In the third phase, attempts for regulatory cooperation were made. This sequence of diversity, regulatory competition and regulatory cooperation may seem natural in a European context. However, a sequence where cooperation appears before competition is also conceivable. For example, competition could develop after a minimum standard has been adopted by an international organization.

It will be shown that in some cases the consequence of the interaction depends on the sequence in which the mechanisms become effective. Therefore, we analyze the interactions in a sequential mode. We start from the situation where no mechanism is at work and where the policies of the countries under consideration are characterized by diversity. Then we sequentially introduce the mechanisms, starting with the situation where regulatory competition is in effect before regulatory cooperation. Next, we change the sequence, introducing first regulatory cooperation, and second regulatory competition.

The theory of regulatory competition implies that countries move their levels of regulation towards an equilibrium. In theory, full convergence can be expected at the end of the process. During the process, there is ever increasing convergence. We cannot know in general at which stage regulatory competition is when regulatory cooperation becomes effective. Thus, in the cases where regulatory cooperation becomes effective after regulatory competition, we assume increased but not yet full convergence. For regulatory cooperation, however, it is reasonable to assume that the member states adjust their national regulations comparatively quickly to the international one. Thus, in cases where regulatory cooperation becomes effective before regulatory competition, we assume that the full effect of the international regulation has already been reached.

The interaction of regulatory competition and regulatory cooperation limits their scope of effectiveness to countries which are members of international organizations with binding rules and which belong to a common market. This is, for example, true for all EU member states. Moreover, interaction will be effective only for those policies for which the international organization has the power to enact binding international law and which affect the competitive position of national industries. This is true for the binding standards for products and production processes. About half of the environmental policies at the EU level belong to this group.

The effect of the interaction of regulatory cooperation with regulatory competition depends on the type of legal harmonization used, total or minimum harmonization. With total harmonization, regulatory cooperation dominates regulatory competition. Whenever total harmonization is agreed upon, regulatory competition cannot develop or it will stop. Therefore, the interaction of both mechanisms should lead to full convergence at the level of harmonization. As there is no full convergence with minimum harmonization alone, the interaction effect with regulatory competition is not so obvious.

Moreover, the level of harmonization depends on the type of policy – product or the process regulation – and on the sequence of interaction. We will analyze the interaction effects first for total, and second for minimum harmonization. For each type of harmonization each sequence of interaction is treated. Therefore, altogether eight cases are to be considered (Table 3).

We first assume that after an initial phase of diversity of the countries' policies, the mechanism of regulatory competition starts working, and after some time regulatory cooperation takes place. The mean in the initial phase is given by the median country because, for simplicity, the regulatory distance between the countries is assumed to be equal.

Case (1). What happens to the standard deviation and the mean in case of product regulation? While both remain constant in the initial phase, after

the onset of regulatory competition the standard deviation decreases, whereas the mean increases. There is a race to the top, as was shown above. Next, an international agreement is concluded which totally harmonizes the product standard. Following the assumption made above, harmonization takes place at the mean of regulatory levels. The mean is thus higher than in the beginning. After harmonization, standard deviation decreases to zero (full convergence at the standard), implying that the level of the mean from now on is the same as the level of the standard. Therefore, the interaction leads to full convergence and an upward shift of the mean compared to its position in the initial phase.

An example can again be taken from car emissions regulation. Obligatory regulation of car emissions at the EU level started in 1970. Thus, the phase before can be seen as a phase of regulatory competition. However, in fact there was no competition but harmonization at the level of the UN Economic Commission for Europe (ECE). The regulations developed there aimed at promoting free trade by means of technical harmonization. This was voluntary regulation; the countries were free to apply the provisions. Beginning in 1970, the EU had simply adopted all UN ECE emission standards as directives. The EU directives were amended several times, always in line with the ECE regulations. The ECE standards became stricter over time and were usually adopted by all European states (Holzinger 1995). This was not regulatory competition in a strict sense; rather it was voluntary cooperation. However, there was a kind of regulatory 'race to the top' of car emissions standards that was driven by the desire for harmonization. EU legal obligation used this harmonized standard. The EU standards removed from the ECE regulations for the first time in 1989. At that time, the regulation took place at the strictest standard conceivable, that is, above the mean of the member states' positions. This was an exceptional case, however (Holzinger 1994: 273ff.).

Case (2). For process standards, the results are similar. The only difference is that regulatory competition in this case drives the mean downward before total harmonization becomes effective. Thus, we again

TABLE 3 *Cases distinguished in the analysis of interaction effects*

Case	Type of harmonization	Sequence of interaction	Type of regulation
1	Total harmonization	Competition before Cooperation	Product
2			Process
3		Cooperation before Competition	Product
4			Process
5	Minimum harmonization	Competition before Cooperation	Product
6			Process
7		Cooperation before Competition	Product
8			Process

end up with full convergence, however, there is a downward shift of the mean compared to the initial situation. There is no European empirical example of total harmonization in the case of environmental process standards.

Cases (3) and (4). What happens if total harmonization by regulatory cooperation were to become effective before regulatory competition? This scenario does not make much sense, as total harmonization supersedes regulatory competition. This sequence implies however, that the level of convergence is different compared to the two cases discussed above. Total harmonization takes place at the mean of countries' positions in the initial phase. All countries converge to this level and stay there, as they are not permitted to deviate. There is no shift of the mean upward or downward in this scenario; and there is no difference between product or process standards, as this would presuppose the effectiveness of competition.

There are some European examples of environmental product standards using total harmonization, especially with respect to detergents and environmental chemicals. New products are immediately subject to EU regulation. However, as total harmonization supersedes competition, these examples cannot empirically confirm the effects derived above: No movements of regulation can be observed after total harmonization has been introduced. If standards are totally harmonized from the beginning, we cannot empirically compare the level of the standards to the situation in which there was competition before cooperation.

In contrast with total harmonization, the isolated effect of minimum harmonization does not lead to full convergence of policies. Cooperation does not fully replace competition in this case. The two factors truly interact. Again, however, the type of standard and the interaction sequence lead to different levels of convergence. The remaining four cases differ with respect to process and results.

Case (5). We start with the assumption that after an initial phase of diversity, regulatory competition precedes regulatory cooperation. Later on, international cooperation leads to the setting of a minimum standard. In the case of product standards, regulatory competition will lead to a decrease of standard deviation and an increase of the mean level of regulation as outlined above. Minimum harmonization is introduced at the current mean. Regulatory cooperation causes countries with policies below the mean to raise their standards to the minimum standard level as a result of legal obligation. Countries with regulations above the minimum standard are not obliged to decrease their standard levels. However, they will nevertheless decrease them. What is the background for this? When there is regulatory competition alone, the combination of the harmonization advantage combined with the possibility of erecting trade barriers drives the race to the top. The presence of regulatory cooperation in the form of minimum

harmonization, however, implies that market segmentation (the application of trade barriers against products complying to the minimum standard) is no longer possible. No state will follow another country applying stricter standards, as its products cannot be excluded from this country's market. Therefore, a country applying stricter standards suffers a competitive disadvantage – provided that stricter standards coincide with higher production costs. Thus, full convergence at the level of the minimum standard occurs – as with total harmonization. Regulatory competition shifts the mean upward in the beginning, cooperation fixes this mean as the minimum standard, and finally, cooperation and competition drive all countries towards the minimum standard, so that mean and minimum standard become identical.

Before 1989, car emission standards in the EU were not totally harmonized. They followed the legal technique of optional harmonization, which is different from minimum harmonization. However, optional harmonization allows for both lower and stricter national standards, that is, with respect to the latter it is similar to minimum harmonization. Other member states exporting into a country which deviates from the EU standard can choose between this country's and the EU standard. Thus, trade barriers and market segmentation are impossible (Rehbinder and Stewart 1985: 8, 207ff.). In the case of car emissions, over twenty years usually all member states applied the Community standard. Sometimes countries used laxer standards. However, there was only one single short period in the eighties when Germany used stricter standards than provided for in the EU directive. The German car industry had voluntarily agreed to this because of its technological advantage (Holzinger 1994: 330, 48f.; Rehbinder and Stewart 1985: 209). This shows that standards above a cooperatively set minimum standard are usually not a viable option – given there is still competition.

Case (6). In the case of process standards the development is similar. Again, the difference is solely that regulatory competition in the first phase leads to a shift of the mean downward, and thus the minimum standard will be set at a lower level. After the minimum harmonization, all countries converge to the standard level, some because they are obliged to raise their standards, others because regulatory competition exerts a downward pressure with process standards. Thus, we have full convergence, however at a lower mean level of regulation than in the initial situation.

Although there are a few examples that EU member states have made use of the option to apply stricter process standards in case of minimum harmonization, such as in the case of the German regulation of large combustion plants, the general trend is that they do not, because it causes competitive disadvantages to their industries (Rehbinder and Stewart 1985: 210; Scheuing 1989: 169).

Case (7). What happens if the sequence is changed and minimum harmonization precedes regulatory competition? We start with product regulation again. After a phase of diverse policies, regulatory cooperation introduces a minimum standard. As usual, the standard level is at the mean. The countries with lower standards have to adjust their regulation level upwards. There is no full convergence yet, as national standards above the minimum standard are permitted. Assuming that some countries keep their higher standards, the mean shifts upward. Next, regulatory competition becomes effective and drives the countries, which apply higher standards, towards the minimum standard, because they suffer from a competitive disadvantage. As a consequence, the mean now falls back to the minimum standard level – which is equivalent to the initial mean. Thus, there is an intermediary but not an overall upward shift of the mean. Compared to both the isolated effects of minimum harmonization and the opposite sequence of interaction the mean is lower. We end up with full convergence, however.

A case in point is again the example of car emissions under optional harmonization given above. However, the sequence effect – that the mean is at a different level – cannot be illustrated with single cases, as we do not know at which level the regulation had taken place, if the sequence had been the other way round. This applies as well to empirical illustrations for the next case.

Case (8). Finally, what happens in the case of regulation of production processes if minimum harmonization is effective before regulatory competition? As with product regulation, the minimum standard leads to some but not full convergence and it raises the mean level of standards above the initial one, as some countries are obliged to adjust upwards. Regulatory competition drives the countries with stricter regulation towards the minimum standard, as a consequence of the downward competitive pressure. Therefore, the picture is exactly as with product standards, although for different reasons. While in the case of product standards the motive is the harmonization advantage, in the case of process standards the motive is avoiding competitive disadvantage. After an intermediary raise of the mean above the minimum standard, it falls back to the initial mean. Compared to the isolated effects of minimum harmonization the mean level is lower, but compared to the opposite sequence of interaction the mean level is higher. Again, we have full convergence.

The interaction of competition and minimum harmonization constrains the positive effects of minimum standards and of regulatory competition in the case of product standards, as it implies an upper limit at the level of the minimum standard. In the case of process standards, the interaction of both effects provides a lower limit to regulatory competition at the level of the minimum standard. Thus, given the interaction of cooperation and competition, the effects of total and minimum harmonization do not differ. In

contrast to the expectation formulated above, minimum harmonization is factually equivalent to total harmonization in the interaction with regulatory competition. The conclusions are summarized in Table 4.

Directions for empirical research

The analysis of regulatory competition and regulatory cooperation as mechanisms driving convergence in the field of environmental policy has yielded results about the conditions of their effectiveness, as well as conjectures about the degree of convergence and the regulatory level of convergence to be expected. How can these conjectures be tested empirically?

The basic hypotheses are concerned with increasing policy convergence as a result of increasing economic integration and increasing institutional integration. Thus, the independent variables are economic integration for the regulatory competition hypotheses, and institutional integration for the regulatory cooperation hypotheses. The former can be measured by an index of economic openness, the latter by an indicator based on the membership of countries in international institutions, as well as on the potential these institutions have in order to adopt obligatory regulation for the member states.

The dependent variable is the development of similarity of environmental policy output of various countries over time. Thus, a research design must first look at a greater number of countries, for example, countries from a certain region for which convergence shall be examined, or at a sample of countries from all over the world. In case of environmental policy, Europe or North-America would be particularly interesting, because these regions

TABLE 4: *Interaction effects of regulatory competition and cooperation*

Conditions of effectiveness
The interaction of regulatory competition and regulatory cooperation will only be effective for countries which are member of an international institution and which at the same time belong to a common market
The interaction of regulatory competition and regulatory cooperation will only be effective for policies for which the international institution has obligatory power and which affect the competitive position of industries
Degree of convergence
The interaction of regulatory cooperation and regulatory competition leads to the full convergence of national policies, irrespective of the type of harmonization, the type of policy, and the sequence of interaction
Level of convergence
Whenever regulatory cooperation precedes regulatory competition, the mean remains at the initial level, irrespective of the type of harmonization
Whenever regulatory competition precedes regulatory cooperation and product standards are concerned, the mean regulatory level raises compared to the initial level
Whenever regulatory competition precedes regulatory cooperation and process standards are concerned, the mean regulatory level declines compared to the initial level

have a relatively long history of environmental policy. Second, a research design must have a sufficient time horizon, as convergence implies growing similarity over time. For environmental policy the most obvious time span would be from 1970 onward, because 1970 was the starting point of modern environmental policy both at the national and the international level.

Different fields of environmental policy can be used to test the various conjectures made in this article. For example, to generally check for the similarity of policies those policies can be compared which do not imply any 'level of regulation', for example, the presence of environmental programs, the presence of certain principles for environmental policy (such as the polluter pays principle), or the presence of certain instruments (command and control, economic or voluntary instruments). In order to test the hypotheses on the level of regulation, the limit values for certain pollutants can be compared. Both product and process standards can be taken into account in order to check the theories of regulatory competition, for example, car emission standards and standards for large combustion plants.

Moreover, different policy fields can be used to control for the conditions of effectiveness. The research should include policies, which affect the competitive position of a country's industry, that is, in particular, trade-related policies, such as standards for product and production processes. It should also include policies which will not affect the competitive position, for example, nature conservation or bird protection. In this case, no convergence is predicted as a result of regulatory competition. Similarly, the research should include both policies, for which there are obligatory measures at the international level, and policies, for which there exist no international measures and thus convergence cannot be the result of international cooperation.

The selection of countries can also help to control for the conditions of effectiveness. A study should include both members and non-members of international institutions which release regulatory output in the field of environmental policy. Likewise it should include both participants in a common market or in the world market and non-participants, or market economies and non-market economies, such as the Eastern European states before 1990.

If a study finds convergence in areas where neither regulatory competition nor regulatory cooperation can be expected to be effective, other factors might be at work. An example would be a policy field which does not affect the competitive position of a country and where at the same time no international regulation exists. Convergence in such a field indicates the presence of other factors. There are at least three candidates for other driving forces for convergence: parallel problem pressure in the countries (Simmons and Elkins 2003: 275; Rose 1991: 9; Bennett 1988: 417), political

pressure from international institutions (Dolowitz and Marsh 1996: 347; Guler et al. 2002: 212; Tews 2002: 118), or transnational communication and learning (DiMaggio and Powell 1991; Rose 1991; Levi-Faur 2002; Haas 1992; Bennett 1991; Radaelli 2000).

Finally, the conjectures developed in this article depend on the theoretical assumptions that both regulatory competition and regulatory cooperation lead to the convergence of policies. However, in case regulatory cooperation consists of the adoption of differentiated environmental standards, adapted to the ecological and economic needs, as well as to the political preferences in different countries, no convergence of policies will take place.

Similarly, regulatory competition alone can lead to diversity. In competitive markets, prices and products are often highly differentiated, reflecting different consumer preferences. Why should this not happen in regulatory markets, as well? If the preferences of voters and consumers for environmental policies vary over the countries, and if these preferences are reflected in the governments' decisions on environmental standards, this may lead to different national policies. For example, the downward pressures exerted through international competition can be successfully counteracted, if environmentally friendly consumers buy the products complying with stricter environmental standards even if they are more expensive. In this case, no competitive disadvantages for the national industry will be created and the government can sustain the stricter standards. Strong and varying preferences of consumers across countries can thus prevent convergence and races to the bottom. Even in case the citizens have a strong preference for strict environmental policies only as voters but are not willing to pay for the higher costs as consumers, it is possible that no races to the bottom take place. The government takes voters preferences into account and keeps environmental standards at a high level. It can compensate the concerned industries for their competitive disadvantage by subsidies. This is a very likely pattern, given that subsidies belong to the most frequently used instruments of environmental policy.

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REFERENCES

Beers, C. and van der Bergh, J.C.J.M. (1999) An Empirical Multi-Country Analysis of the Impact of Environmental Regulations on Foreign Trade Flows, *Kyklos*, 50, 29–46.

Bennett, C. (1988) Different Processes, One Result. The Convergence of Data Protection Policy in Europe and the United States, *Governance*, 1, 162–183.

Bennett, C. (1991) What Is Policy Convergence and What Causes It?, *British Journal of Political Science*, 21, 215–233.

Botcheva, L. and Martin, L.L. (2001) Institutional Effects on State Behavior. Convergence and Divergence, *International Studies Quarterly*, 45, 1–26.

Brickman, R., Jasanoff, S. and Ilgen, T. (1985) *Controlling Chemicals. The Politics of Regulation in Europe and the United States*, Ithaca, New York, Cornell University Press.

Carporaso, J., Cowles, M. and Risse, T. (2001) *Transforming Europe. Europeanization and Domestic Change*, Ithaca, London, Cornell University Press.

DiMaggio, P.J. and Powell, W.W. (1991) The Iron Cage Revisited. Institutionalised Isomorphism and Collective Rationality in Organizational Fields, in W.W. Powell and P.J. DiMaggio (eds.) *The New Institutionalism in Organizational Analysis*, Chicago, Chicago University Press, pp. 63–82.

Dolowitz, D.P. and Marsh, D. (1996) Who Learns What From Whom. A Review of the Policy Transfer Literature, *Political Studies*, 44, 343–357.

Dolowitz, D.P. and Marsh, D. (2000) Learning from Abroad: The Role of Policy Transfer in Contemporary Policy Making, *Governance*, 13, 5–24.

Drezner, D.W. (2001) Globalization and Policy Convergence, *The International Studies Review*, 3, 53–78.

Epiney, A. (2000) Flexible Integration and Environmental Policy in the EU – Legal Aspects', in K. Holzinger and P. Knoepfel (eds.) *Environmental Policy in a Europe of Variable Geometry?*, Basel, Helbing & Lichtenhahn, pp. 39–64.

Goodman, J. and Pauly, L. (1993) The Obsolescence of Capital Control, *World Politics*, 46, 50–82.

Guler, I., Guillén, M. and Macpherson, J. (2002) Global Competition, Institutions and the Diffusion of Organizational Practices. The International Spread of ISO 9000 Quality Certificates, *Administrative Science Quarterly*, 47, 207–233.

Haas, P. (1992) Introduction: Epistemic Communities and International Policy Coordination, *International Organization*, 46, 1–35.

Héritier, A., Knill, C. and Mingers, S. (1996) *Ringing the Changes in Europe. Regulatory Competition and the Transformation of the State*, Berlin, de Gruyter.

Hoberg, G. (2001) Globalization and Policy Convergence: Symposium Overview, *Journal of Comparative Policy Analysis*, 3, 127–132.

Holzinger, K. (1994) *Politik des kleinsten gemeinsamen Nenners. Umweltpolitische Entscheidungsprozesse in der EG am Beispiel des Katalysatorautos*, Berlin, Edition Sigma.

Holzinger, K. (1995) A Surprising Success in EC Environmental Policy: The Small Car Exhaust Emission Directive of 1989, in M. Jänicke, and H. Weidner (eds.) *Successful Environmental Policy*, Berlin, Edition Sigma, pp. 187–202.

Holzinger, K. (2000) Optimal Regulatory Units: A Concept of Regional Differentiation of Environmental Standards in the European Union, in K. Holzinger and P. Knoepfel (eds.) *Environmental Policy in a Union of Variable Geometry?*, Basle, Helbing&Lichtenhahn, pp. 65–108.

Holzinger, K. (2002) The Provision of Transnational Common Goods: Regulatory Competition for Environmental Standards, in A. Héritier (ed.) *Common Goods: Reinventing European and International Governance*, Lanham, Rowman and Littlefield, pp. 59–82.

Holzinger, K. (2003) Common Goods, Matrix Games, and Institutional Solutions, *European Journal of International Relations*, 9, 173–212.

Hurwitz, L. (1983) *The Harmonization of European Public Policy. Regional Responses to Transnational Challenges*, Westport, Greenwood Press.

Inkeles, A. (1981) Convergence and Divergence in Industrial Societies, in: Mustafa, O. A., Holzner, B. and Suda, Z. (eds.), *Directions of Change. Modernization Theory, Research and Reality*, Boulder, Westview Press.

Jänicke, M. (1998) Umweltpoltik – global am Ende oder am Ende global? Thesen zu ökologischen Determinanten des Weltmarkts, in B. Ulrich (ed.) *Perspektiven der Weltgesellschaft*, Frankfurt a.M., Suhrkamp, pp. 332–344.

Keohane, R. and Nye, J. (2000) Globalization: What's New? And What's Not? (And So What?), *Foreign Policy*, 118, 104–112.

Kern, K. (2000) *Die Diffusion von Politikinnovationen. Umweltpolitische Innovationen im Mehrebenensystem der USA*, Opladen, Leske+Budrich.

Kern, K., Jörgens, H. and Jänicke, M. (2000) Die Diffusion umweltpolitischer Innovationen. Ein Beitrag zur Globalisierung von Umweltpolitik, *Zeitschrift für Umweltpolitik*, 23, 507–546.

Knill, C. (2001) *The Europeanisation of National Administrations*, Cambridge University Press, Cambridge.

Knill, C. and Lenschow, A. (1998) Coping With Europe. The Implementation of EU Environmental Policy and Administrative Traditions in Britain and Germany, Journal of European Public Policy 5, 595–614.

Levi-Faur, D. (2002) *Herding towards a New Convention. On Herds, Shepherds and Lost Sheep in the Liberalization of the Telecommunications and Electricity Industries*. Paper presented at the workshop 'Theories of Regulation' Nuffield College, University of Oxford.

Levinson, A. (1996) Environmental Regulations and Industry Location: International and Domestic Evidence, in: Bhagwati, J. and Hudec, R. E. (eds.), *Fair Trade and Harmonization, Volume 1: Economic Analysis*, Cambridge-London: MIT Press, pp. 393–427.

Long, N. van and Siebert, H. (1991) Institutional Competition Versus ex-ante Harmonisation. The Case of Environmental Policy, *Journal of Institutional and Theoretical Economics*, 147, 296–311.

Martin, L. and Simmons, B. (1998) Theories and Empirical Studies of International Institutions, *International Organization*, 52, 729–757.

Oates, W.E. and Schwab, R.M. (1988) Economic Competition Among Jurisdictions. Efficiency Enhancing or Distortion Inducing?, *Journal of Public Economics*, 35, 333–354.

Radaelli, C. (2000) Policy Transfer in the European Union: Institutional Isomorphism as a Source of Legitimacy, *Governance*, 13, 25–43.

Rehbinder E. and Stewart, R. (1985) *Environmental Protection Policy*, Berlin-New York, Walter de Gruyter.

Rose, R. (1991) What is Lesson-Drawing? *Journal of Public Policy*, 11, 3–30.

Sandhoevel, A. (1998) Strategien für ein Miteinander von Umweltordnung und Welthandelsordnung, *Zeitschrift für angewandte Umweltforschung*, 3–4, 496–508.

Scheuing, D.H. (1989) Umweltschutz auf der Grundlage der Einheitlichen Europäischen Akte, *Europarecht*, 1989, 152–192.

Scharpf, F.W. (1996) Politische Optionen im vollendeten Binnenmarkt, in M. Jachtenfuchs and B. Kohler-Koch (eds.) *Europäische Integration*, Opladen, Leske+Budrich, pp. 109–140.

Scharpf, F.W. (1997) Introduction: The Problem-solving Capacity of Multi-level Governance, *Journal of European Public Policy*, 4, 520– 538.

Simmons, B.A. and Elkins, Z. (2003) Globalization and Policy-Diffusion: Explaining Three Decades of Liberalization, in M. Kahler and D.A. Lake (eds.) *Globalizing Authority: Economic Integration and the Changing Structure of Governance*, Princeton University Press, pp. 275–302.

Sinn, H-W. (1993) *How much Europe? Subsidiarity, Centralization and Fiscal Competition*, CES Working Paper No. 39, Center for Economic Studies: University of Munich.

Sinn, H.-W. (1996) *The Subsidiarity Principle and Market Failure in Systems Competition*, CES Working Paper No. 103, Center for Economic Studies: University of Munich.

Tews, K. (2002) Politiktransfer: Phänomen zwischen Policy-Lernen und Oktroi. Überlegungen zu unfreiwilligen Umweltpolitikimporten am Beispiel der EU-Osterweiterung. *Zeitschrift für Umweltpolitik und Umweltrecht*, 25, 173–201.

Tiebout, C.M. (1956) A Pure Theory of Local Expenditures, *Journal of Political Economy*, 64, 416–424.

Tobey, James (1990) The Impact of Domestic Environmental Policies on Patterns of World Trade. An Empirical Test, *Kyklos*, 43, 191–209.

Vanberg, V. (2000) Globalization, Democracy, and Citizens' Sovereignty: Can Competition among Governments Enhance Democracy?, *Constitutional Political Economy*, 11, 87–112.

Vogel, D. (1995) *Trading Up: Consumer and Environmental Regulation in the Global Economy*, Cambridge, Harvard University Press.

Vogel, D. (1997) Trading Up and Governing Across: Transnational Governance and Environmental Protection. *Journal of European Public Policy*, 4, 556–571.

Wilson, J.D. (1996) Environmental regulations and Industry location: International and Domestic Evidence, in J. Bhagwati and R.E. Hudec (eds.) *Fair Trade and Harmonization, Volume 1: Economic Analysis*, Cambridge-London, MIT Press, pp. 429–457.

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