ARTICLE IN PRESS

+ MODEL

Available online at www.sciencedirect.com

SCIENCE DIRECT®

ELSEVIER

Journal of Cleaner Production xx (2005) 1–8

Journal of Cleaner Production

www.elsevier.com/locate/jclepro

REACh as a paradigm shift in chemical policy – responsive regulation and behavioural models

Martin Führ [a,*], Kilian Bizer [b]

[a] Legal Theory and Comparative Law at the University of Applied Sciences Darmstadt, ~~Darmstadt,~~ Germany
[b] University of Göttingen, Germany

Accepted 10 October 2005

Abstract

The European Union is changing its general approach to chemical regulation by introducing the new programme REACh, i.e. Registration, Evaluation and Authorisation of Chemicals. In this paper we argue that REACh is nothing less than a paradigm shift in the regulatory approach of the EU. Generally speaking, REACh places all major responsibilities with firms rather than on administrative bodies. At the same time, this policy is far from undemanding: companies marketing substances falling under REACh must ensure that along the production chain dangers to health and environment will be mastered throughout all intermediate and final users of the substance or the product containing the substance. In other words, producers of REACh chemicals must start downstream information and communication processes along the entire production chain to meet the requirements of the directive, which is stipulating both gathering the risk-related information and implementing appropriate risk-reduction measures. This paper aims to identify the major changes in the policy approach induced by REACh, and the type of behavioural model necessary to give a well-founded prognosis.

In this paper we describe briefly *responsive regulation* as the new underlying paradigm of regulation as opposed to hierarchical regulation. From there we proceed to analyse the concept of self-responsibility in this context, and suggest adopting an agent-specific approach. In order to form expectations about the possible outcome of such regulation, behavioural models need to be well-defined for a systematic analysis of incentives imposed by REACh. We propose a behavioural model of *homo oeconomicus institutionalis* in order to allow cognitive limits and rule-following behaviour of individuals in complex situations. As can be seen, cognitive limits as well as rule-following behaviour are of paramount importance to highly complex regulations such as REACh. In conclusion, REACh demands not only a new paradigm of regulation, such as responsive regulation, but also a modified approach of behavioural analysis for prognosis, such as the concept of *homo oeconomicus institutionalis*.

Further, the incentives facing agents regulated by REACh need to be analysed. Apparently, REACh does not sufficiently take into account that regulative approaches based on self-responsibility must be supported by adequate incentives, in order to reach the objectives.

Keywords: Regulation of chemical substances; Self-responsibility; Responsive regulation; Behavioural model; Homo oeconomicus institutionalis

1. Responsive regulation and the role of self-responsibility – an introduction

The classic approach to regulation is one of the intervening states prescribing a policy which clearly indicates allowed and forbidden behaviour. The forbidden behaviour is sanctioned either by fines, prison terms or social contempt. In the case of fundamental norms such as the requirement not to kill each other, such an approach is fairly effective. Norm adherence is relatively stable, norm violations can be monitored quite effectively and in more or less efficient ways, and legitimacy is rarely questioned. As fiction of crime suggests, murderers might occasionally be able to set up a "perfect murder" but actual murder cases display very little need to a highly adaptative flexibility as most cases can be cleared without

* Corresponding author.
E-mail addresses: fuehr@sofia-darmstadt.de (M. Führ), bizer@sofia-darmstadt.de (K. Bizer).
URL: www.sofia-research.com

0959-6526/$ - see front matter © 2005 Published by Elsevier Ltd.
doi:10.1016/j.jclepro.2005.10.003

ever changing police procedures and new regulatory approaches. But is this true for more complex norms as well?

The regulation of chemicals is a regulatory field with high relevance to sustainability as well as including very complex regulatory issues. Of the approximately 30,000 ''old chemicals'' used on a significant scale there is little known about toxicity or other health and environmental impacts (''toxic ignorance'').[1] Information about single substances is scattered over a range of producers, formulators and applicators. And what is known is frequently insufficient to assess the risks to health and environment. The traditional approach would suggest forbidding the production or use of all toxic or otherwise harmful substances. But in this approach the regulatory agency faces three enormous problems: firstly, it does not know which substances have dangerous impacts, and the information is not only costly, but basically not obtainable without cooperation of the industry. Secondly, impacts may change depending on production processes. Thirdly, some substances may be of high importance in certain industries and impossible to substitute. In such cases conflicts arise between health and environment on one hand, and jobs as well as economic interests on the other hand.

In such a context the hierarchical regulation is doomed to fail: up to now, risk evaluation and developing risk minimisation strategies are part of the work of the European Commission and the Member States – based on the toxicology data of the industry in the framework of the Existing Substances Regulation 793/93/EC. The outcome is disillusioning. Out of the 30,000 old substances, 141 were placed on a priority lists; from these, some two dozens are subject of a Commission Recommendation.[2] In a relevant number of substances, factual risk-reduction measures are still lacking both on the Community level and in the field of enforcement by Member States authorities.

The passing of the REACh-Regulation [12] will shift responsibility towards producers and importers and requires them to assess risks and develop risk minimisation strategies. The intention of this change-over is at least not symbolic in the sense of an implicit intended implementation deficit: the ambitious objective of risk prevention on a high level is unambiguously maintained.[3] To meet this objective with a policy of self-responsibility is quite a challenge to legislators: if the state intends to intervene, it must adopt an approach which takes into account the incentive situation of the relevant actors and design a regulatory framework which makes it reasonable to them to comply. REACh is attempting such an approach by carefully framing responsibilities and demanding information as well as requiring the adoption of self-responsible risk-reduction policies of firms. Generally speaking, REACh places all major responsibilities with firms rather than on administrative bodies. At the same time, this policy is far from undemanding: companies marketing substances falling under REACh must ensure that dangers to health and environment will be reduced along the production chain throughout all intermediate and final users of the substance or the product containing the substance. In other words, producers of REACh chemicals must start information and communication processes along the entire value chain to meet the requirements of the directive.

In the regulation of chemicals, REACh is not falling short of a paradigm shift from hierarchical regulation to responsive regulation [1,23]. Mandatory regulation is based on the assumption that individuals will follow normative obligations set by the state. Such norm compliance will occur, if not voluntarily, then in the face of administrative control and impending sanctions. In contrast, the starting point of responsive regulation is the self-interest of the relevant actors. Responsive concepts aim to direct self-interested behaviour in a certain direction by modifying the institutional framework. Since it is difficult to induce cooperation of different actors by means of command-and-control policies, responsive regulation tends to offer an institutional setting designed to enable and facilitate[4] both individual and cooperative behaviour of the relevant actors and still contains sufficient incentives supporting this behaviour.

The term institutions refers to a system of formal and informal rules including mechanisms enforcing those rules or obligations [24]. This perspective reflects the observation that human behaviour is neither mastered by legal obligations or the self-interest alone but is rather influenced by the surrounding context imprinting the cognitive perception, the way of thinking as well as specific forms of habitual behaviour (cf. chapter 4.2.) Regulatory concepts should consider the whole range of motivational factors and the possibilities influencing them in order to choose the right institutional fit for the regulatory choice problem at stake.

The state is no longer trying to collect all relevant information, to process it according to risk assessments, and to design appropriate reactions, but it is shifting such responsibilities to firms which are much more likely to have access to such information, will be able to design appropriate communication and information processes possibly even at lower costs and have an incentive to reduce risks connected with their substances. The ''carrots and sticks'' approach, characteristic for responsive regulation, is applied by REACh to the regulation of chemicals.

[1] See Refs. [10,22,26].

[2] See http://ecb.jrc.it/existing-chemicals/ > > existing chemicals > risk assessment > OJ Recommendation; as of April 8, 2005.

[3] Legally speaking this obligation derives from Art. 2, 6 und 174 EC; cf. Refs. [8,21,17].

[4] ([23], p. 111; italics in the original): ''Responsive law aims at *enablement and facilitation*; restrictive accountability is a secondary function. A new kind of lawyerly expertise is envisioned – expertise in the articulation of *principles of institutional design and institutional diagnosis*. Such principles would analyse the characteristic institutional problems that are associated with carrying out different kinds of mandates and exercising different kinds of powers in different kinds of environments, and would point to the institutional mechanisms by which such problems may be corrected or moderated. The long term goal would be a capacity 'to determine the most harmonious fit between the purposes and characteristics of particular agencies and various control techniques' [25].''

Self-responsibility plays a vital role in responsive regulation, but it should not be misunderstood as merely shifting the decision to agents and a withdrawing of the state [13]. In complex environments, it is impossible for the state to exactly determine obligations of agents. In such circumstances, it is reasonable to impose self-responsibility on agents, making them liable for damages occurring, if they did not fully take into account consequences of their decisions. In order to monitor the results, the regulatory agency must interact not only with the group of agents directly addressed, but also with other groups which might be affected in cases of negligence on behalf of the norm addressees. In the end, self-responsibility as an element of policy design requires not only a proactive state, but an interactive state with all relevant groups.

2. The concept of self-responsibility in policy design

If self-responsibility is applied as an element of policy design, all relevant agents should be aware of their responsibilities and obligations. Any company engaged in environmentally sensitive activities must meet with certain obligations. These obligations consist of three types, separated in categories of responsibility (see Fig. 1: categories of responsibility):

1. Companies face strict obligations with direct sanctions if they are not met, for example ''do not operate an industrial installation without permission'' (Art. 4 et esq. IPPC-Directive 96/61/EC) or ''do not cause an environmental damage'' (Environmental Liability Directive 20004/35/EC) – *strict accountability*.
2. In addition, companies face basic obligations (e.g. Art. 3 IPPC-Directive 96/61/EC) which are not clearly determined for each agent individually ex ante. These obligations require agents to show ex post how they attempt to fulfil the obligation. In a way, such obligations are quite demanding because agents must anticipate what they will have to justify. These obligations can be termed *self-responsibility*.
3. Finally there is a broad area in which the law does not formulate any expectations. In this area informal rules can govern behaviour, but there are no legal consequences if agents disregard such rules even though other agents might react unfavourably. This area can be called *personal responsibility and the obligations are of an ethical nature*[5]

These categories help to distinguish between self-responsibility as a category of legal obligations even if not determined ex ante, and other categories of responsibility. They also make it clear that self-responsibility might have certain advantages and disadvantages from a regulatory perspective. If legal norms are supposed to change human behaviour, the crucial question is how reliable is self-responsibility in achieving social objectives. In order to assess the possible contribution of self-responsibility we will look at the four major groups concerned by self-responsibility: the responsible parties, the administration, third parties and the general public.

2.1. Responsible parties

Responsible parties of duties deriving from environmental legislation are mostly companies. They are obliged by law to align their behaviour in a certain direction. At the same time they often have considerable freedom in choosing how to fulfil these obligations. This poses a challenge to companies: they cannot simply meet specific limit values and consider all obligations met, but instead must develop an understanding of general normative requirements and their consequences for their action. Companies no longer satisfy the law by complying with minimum standards, but by outlining proactive behaviour[6] in reaction to basic normative requirements. Self-responsibility requires a radical change in the self-perception of companies.

The challenge for companies is to develop adequate company policies to meet their substance stewards' obligations and to implement them. Furthermore they should ask with whom they should cooperate to fully meet these obligations.

REACh is demanding a risk assessment of each substance. Additionally adequate reduction measures are to be undertaken (Art. 13 (6) REACh),[7] but it is up to the manufacturer or importer to define the ''appropriate measures'' and answer the question what is the contribution of every actor in the chain of value added (cf. chapter 4.1).

2.2. Administrative implementation

Regulations based on self-responsibility provide a general perspective for responsible parties how to act or to decide within certain policy fields. The legal framework usually combines both elements of responsibility:

- strict provisions defining a concrete behaviour (rules as ''do not market a substance without registration'' or ''undertake the xy-test'') as well as
- basic obligations (e.g., risk reduction according to Art. 13 (6) REACh) combined with procedural requirements, the latter serving to safeguard the former.

Implementation through administrative processes is a cumbersome exercise for all parties involved; all the more if the legal provisions require individual assessments normally to

[5] See – also for the similarities and differences to the definitions by Kant – Ref. [13], 53.

[6] See Enquete Commission [9] of the German Bundestag on the ''Protection of Humanity and the Environment'' (ed.): Responsibility for the Future – Options for Sustainable Management of Substance Chains and Material Flows, Bonn, 1994 (Economica) and the study on behalf of the Enquete Commission by Führ et al. [16] summarized in Ref. [14].

[7] ''Any manufacturer or importer shall identify and apply the appropriate measures to adequately control the risks identified in the chemical safety assessment, and where suitable, recommend them in the safety data sheets which he supplies in accordance with Art. 29.''

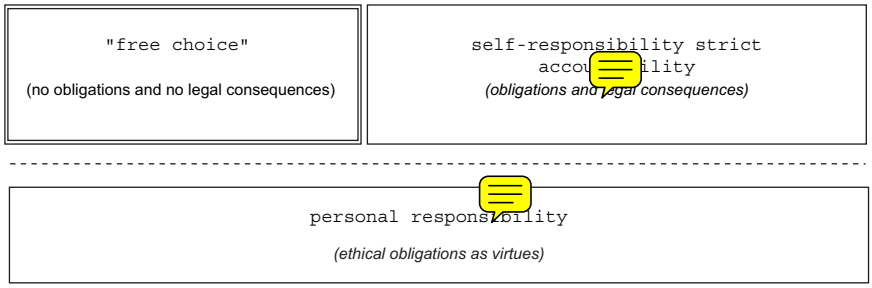

Fig. 1. Categories of responsibility.

a large extent based on information provided by the responsible parties.

As regulation based on self-responsibility is governed by basic obligations, such policies do not only require more resources for administrative processes, but they make it also more difficult, by requiring the administration to specify what follows from general obligations for individual companies.

With REACh, administrative implementation forms only a small part of the institutional framework; in fact the obligations rest directly with industrial actors. Albeit from an administrative perspective, two questions remain crucial: firstly the conditions must be defined of an EC-wide monitoring system covering the risk-reduction results; secondly the interfaces should be established with other sectors of environmental legislation (e.g., the IPPC-Directive, the Water Framework-Directive and the EC Waste law)[8] since REACh-substances and their related risks occur in one way or another under these regulations.

2.3. Third party perspective

Environmental law is supposed to protect the general public but also individuals against undesired consequences of economic activities. As self-responsibility is relatively unspecific in terms of direct legal obligations, the question arises whether it can provide sufficient protection. In any individual case, it is crucial to show how the specification of basic normative requirements will lead to a certain level of protection and whether this is considered to be sufficient.

In addition, it is relevant for the incentive situation of companies as well as the administration to meet their obligations whether agents have the right to sue if protection is insufficient. Softer, but equally important, is that third parties can command resources to participate in decision-making processes as well as to protect their rights.

2.4. General public perspective

The general public aims to secure transparency of procedures as well as results. Such transparency should be provided so that individual citizens can inform themselves. To provide such information it is helpful to report the implementation of laws on a regular basis. In addition an easily accessible discourse should take place to discuss policy results as well as alternatives.[9]

2.5. First results

Self-responsibility reacts to the increasing problem of the incapacity of the state to adequately address regulatory problems within a strict hierarchy between a commanding state and obeying responsible parties. This mandatory approach is argued to have led to over-bureaucratic, under-informed attempts to regulate behaviour. Effective regulation must be based on active cooperation to address informational deficits. In addition, efficient regulation over time should make agents aware of their creativity and innovation potential. This asks for a regulatory approach which demands proactive behaviour but simultaneously allows for creative solutions, as well as cooperative strategies among agents, combines command-and-control with informational and cooperative policies as well as economic incentives. As such a policy mix takes into account the specific incentives situation of the responsible parties can be defined as *responsive regulation*[10] – in contrast to mandatory regulation. While the former allows as much freedom of choice as possible without forgoing the objectives, the latter is unresponsive to the specific circumstances of groups of agents. While the former requires agents to act self-responsible taking into account also the circumstances of others, the latter merely defines strict obligations towards the state.

Self-responsibility reflects the core problem of modern environmental law between strict regulation and a dynamic but flexible regard of special circumstances. In many cases the legislative organ can indeed decide between mandatory and responsive regulation. But in an increasing number of cases, mandatory regulation is doomed to fail, as informational as well as other preconditions cannot be met. In such cases, the legislature is well advised to adopt a policy based on self-responsibility. An example is substance-related risk minimisation strategy for which legislative and administration lack the necessary information.

The question, then, remains as to what type of self-responsible policies will be adopted. While it is possible to simply recur to symbolic policy which postulates objectives without adjusting adequate incentives to make agents follow the

[8] See Ref. [17].

[9] See Ref. [3]: Electronic Public Participation (ePP).

[10] See the contributions in Refs. [4,5]: responsive Regulierung.

objective [18], serious policies of self-responsibility will balance between strict obligations and a realm of self-responsibility within which the whole range of different incentives is adjusted to make agents search for innovative solutions.

3. Self-responsibility in REACh: a prognosis based on behavioural models

If the legislature decides to introduce self-responsibility in a policy field, the central question is how the agents will react to unspecified obligations. The more is known about the reaction of agents, the easier it is to solve the regulatory choice problem, i.e., which policy mix will provide to meet the objective and a maximum of freedom of choice at the same time? In order to predict behaviour, the legislators, as well as their consultants need to apply a behavioural model. The decision as to which behavioural model to adopt directly influences the decision which instruments should be applied. To introduce self-responsibility as a regulatory approach requires a relatively complex model of institutionally embedded actors. We call this model the *homo oeconomicus institutionalis*.

As indicated above, REACh does not fall short of a paradigm shift in chemical control policy as it provides companies with an enormous self-responsibility. Risk assessment and risk evaluation as well as the development and implementation of risk minimisation strategies are primarily placed into the hands of producers and importers of such chemicals. Thus, a successful risk management policy needs to identify

- Which contributions from individual agents are necessary and which can be expected?
- Does the incentive situation within REACh reflect shortcomings of individual agents?
- How should the institutional arrangement react to missing incentives or other barriers to compliance?

The legislative institutions should provide a set of instruments which allows public and private agents to cooperate and to organize their interaction along the product line of toxic substances.

3.1. Contributions of agents

It is quite clear that agents along the production chain of toxic substances have different capabilities to reduce risks. The relevant groups of agents along the value chain are producers and importers as primarily subjects to the substance-related obligation (primary substance responsibility), as well as downstream-users, such as formulators and the various applicators in the course of the production steps. Each group must meet different obligations within REACh, and each group is faced with different possibilities to react to these obligations. The constellation of these groups as well as the expected contributions along the chain of value added is given in Fig. 2.

A central factor is the provision of information, as well as the cooperative processing of information.[11] The primary responsibility rests with the producer or importer which is usually well-informed about the processes taking place within his realm and even the realm of formulators. But his knowledge about downstream-processes, as well as applications with their specific emissions and exposures, decreases along the production chain.

Therefore, a complete assessment of risks and the design of appropriate policies require interaction of more than two agents. The directive suggests a framework within which agents could organize their communication processes to assess risks, to design risk management and to detect which contribution for risk minimisation should be expected from whom. The determination of contributions stands at the end of a learning process of all agents involved. In a sense, REACh is timing the process by formulating expectations on distributing information, as well as installing communicational channels now, while actual risk minimisation is postponed until after the relevant agents know more about the production chain.

3.2. Prognosis with homo oeconomicus

The most important prognosis concerns the producers and importers of substances, but also of formulators.[12] Also interesting are, of course, the industrial downstream-users. The last two groups of actors, private consumers and disposers, are not covered explicitly by the REACh-mechanisms.[13] In a first step, a prognosis can be built on homo oeconomicus. This behavioural basis suggests that all behaviour can be explained by situational utility-maximising behaviour (Fig. 3).

3.2.1. Producers and importers as primary responsible actors

In a simplified, but realistic perspective, producers and importers oppose all measures endangering the market potential of their substance. Any attempt to reduce ‘‘toxic ignorance’’ is diagnosed as an attack on the market position of the firm. Their economic rationale favours non-cooperation with regulatory agencies, as well as with downstream-users. Even though ‘‘toxic ignorance’’ can bring about risks of liabilities, as well as marketing risks, most producers and importers trust that the burden of proof resting with damaged person rather than the damaging firm weighs heavily enough in order to take these risks lightly. The incentive for producers and importers to participate is rather slight.

REACh is changing this by mandatory registration – in the case of especially harmful substances also an authorisation is required – and an obligation to reduce risks in the future. The registration is a necessary condition to marketing the

[11] For this topic cf. [20].

[12] Formulators are firms which use the REACh-substances as original inputs for further transformation.

[13] The same holds true for an important group of actors, the whole range of different retailers (see Ref. [19]).

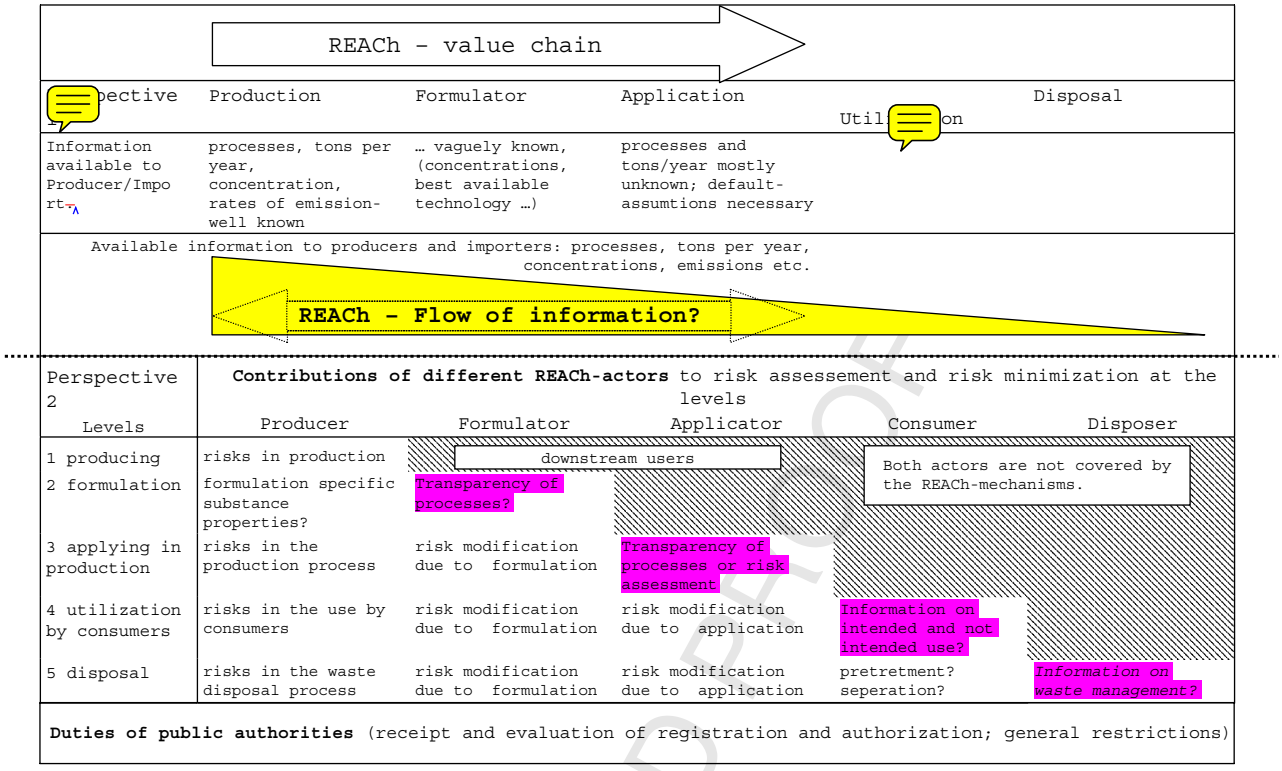

Fig. 2. Synopsis — actors and their informational contributions to the REACh-mechanisms; Information~~ell~~ sore spot (source: Martin Führ et al. [15,17], in the context of a study on behalf of the German EPA/Ministry for the Environment, FKZ 204 67 462/04).

substance. The informational demand serves to collect basic data on toxicology of the substances.

The next step involves the minimisation of risks. Again, the producer or importer of substances is obliged to assess risks and to develop measures of risk reduction (Art. 13 (6) REACh). REACh does not determine how the producer or importer fulfils this obligation.

3.2.2. Downstream-user

The situation of downstream users of a substance is marked by the application of the substance within a usually complex production process. Here the substance serves certain purposes. For the downstream-user it is important that these purposes are fulfilled. If there is an alternative with lower health and environmental risks, the downstream-user will change inputs as long as costs remain constant. As the downstream-user is frequently the link between producers of substances and the consumer market, any case of liability will bring him to public attention first. Environmental liability rules as well as civil law liability and criminal law are directed towards him, so that his incentive to reduce risks is rather high.

The general interest of downstream-users to reduce risks does not imply to share all relevant information with producers or importers. The disclosure of sensitive information about the production processes always contains the risk of giving competing firms an advantage. A rational agent would take such a risk only, if the long-run advantages of environmental and health risk reduction clearly outweighs the possible competitive disadvantage.

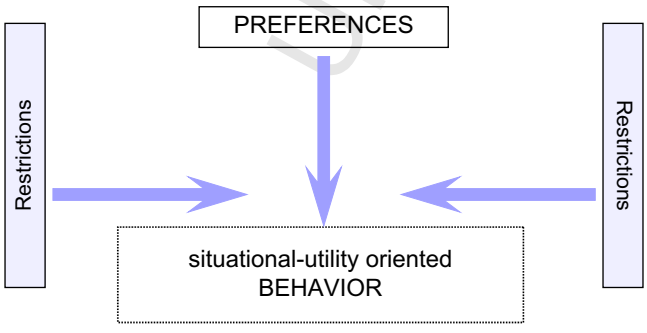

Fig. 3. Homo oeconomicus.

3.2.3. Formulators

The formulators have a key position in solving the information problems of REACh. More than producers or importers they are aware of downstream-users and the production chain. At the same time their interest in disclosing information is not great, as they want to save their market potential. The formulator will change substances as long as there are substitutes which are equivalent technically and costs remain at least constant. In the absence of transaction costs, formulators will switch to substances with lower risks.

As usually transaction costs exist, it is possible that formulators will look for institutional arrangements to exchange information up and down the production chain. REACh actually reduces barriers to such an exchange and thereby lowers transaction costs for risk minimisation strategies. Producers might

have an incentive to share information with formulators in order to obtain more knowledge about downstream demands, downstream-users might be interested in improving their products by providing information to formulators and producers. Even though such a constellation is depending on restrictive conditions (trust, exclusiveness of information, etc.), it shows the crucial role formulators play in REACh.

3.3. Prognosis with homo oeconomicus institutionalis

The model of institutionally embedded homo oeconomicus involves several modifications.[14] Not all of these modifications are relevant to the implementation of REACh, but two of them should be looked at more closely: rational rule adherence as well as cognitive limits (Fig. 4).

3.3.1. Simple rules in uncertain environments

The substitution of hazardous substances is connected with many uncertainties regarding the production process as well as future benefits from a reduced risk situation. This can give rise to behave according to simple rules.[15] Frequently such rules confirm the status quo as any change can involve the need for justification. Such simple rules reflect also the psychological desire to block out possible risks, as no manager likes to perceive him- or herself as someone risking the health of co-workers or the environment (dissonance reduction). REACh in its complexity takes little into account that managers will look for such simple rules as it does not confront managers with explicit obligations.

3.3.2. Cognitive limits

It is also possible, that technical and organizational alternatives are not considered because they are outside the focus of the responsible manager. If the manager is a chemical engineer he might not be aware of possible organizational changes to allow information sharing. If the manager is schooled in business he might not realize the importance of new tech's. Both cases display cognitive limits caused by the complex environments and limited capabilities of individuals to assess all relevant decision options.

There seems little scope to change cognitive limits by changing legal requirements within REACh. But the impact of cognitive limits may be reduced, if communication and information is improved between agents. For this reason it might be useful to enlarge the perspective given by REACh: currently REACh concentrates along the production chain but neglects consumers. The inclusion of consumers will force responsible agents to identify relevant concerns beyond work place safety even though it might involve an explicit communication management with consumers. Generally speaking, it is possible to overcome cognitive limits by implementing communication processes. In this respect, improved REACh

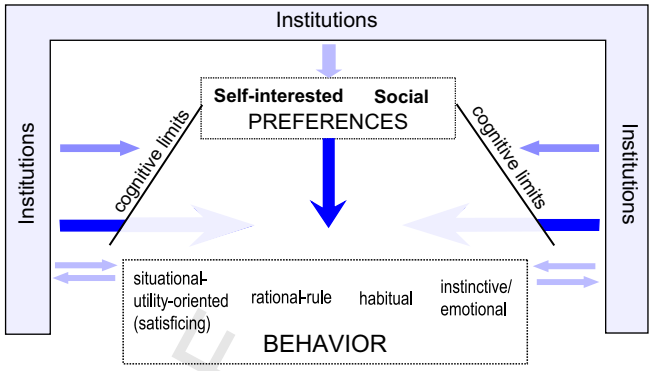

Fig. 4. Homo oeconomicus institutionalis.

communication processes are demanded in an implicit manner. A comprehensive registration dossier could not be compiled without interaction along the value chain; but up to now it is open to question how insufficient dossiers are sanctioned. Those actors who, due to their cognitive limits or other restriction, are not able to identify the benefits or to cover the transaction costs of communication processes face no substantive incentives to change their attitude.

In this context, the actors "beyond REACh", such as the retailers, the consumers and the disposers could offer valuable input in the cooperations processes along the value chain.

4. Conclusion

The REACh proposal is bringing about a paradigm shift towards self-responsibility of agents and responsive regulation. The shift accepts the difficult situation of regulatory agencies in a highly complex environment with limited information about substances and their risks. REACh is highly demanding in requiring basic toxic information and explicit risk minimisation strategies along the production chain. At the moment, the regulation nonetheless falls short in changing the incentives for all relevant agents to act according to the objectives of REACh.

According to the pay-off maximising strategy of *homo oeconomicus*, it should be expected that agents withhold information in order to keep business secrets from competitors. The pressure for substituting hazardous substances will come from downstream-users and formulators facing more stringent liabilities than producers.

According to the modified version of *homo oeconomicus institutionalis*, agents can suffer from cognitive limits. Such cognitive limits can be broken by installing extensive communication and information processes along the chain of production. Such processes are of crucial importance for reducing risks in order to bring out the tacit knowledge hidden between the agents along the production chain. In order to induce such communication processes, agents must be moved from habitual communication behaviour to enlarge their perspective. It can be helpful to organize the exchange between producers, formulators and downstream-users up to the final consumer in order to change the perspectives of individual

[14] See Refs. [13], p. 281), [7].
[15] Such behaviour can take the form of rational rule adherence or as habitual behaviour. See Ref. [6].

agents. Assistance in organizing such processes can be given in different forms of support, including a vade-mecum addressing both technical questions as well as procedural aspects.

Such communication and information processes can hardly be made mandatory in the sense of strict legislative rules. Therefore it is reasonable to shift to self-responsibility and an approach of responsive regulation. At the same time it is important to focus on additional economic incentives in order to bring agents to full cooperation and compliance with the objectives of REACh. It would be naïve to expect agents to comply simply for the sake of reducing risks to health and the environment.

The REACh-Regulation should be embedded in the legislative context. Legislative interfaces are to be developed ensuring the transfer of REACh results in the implementation of sectoral environmental law such as Directives on industrial installations, water quality and waste management. The instruments laid down in these Directives could support risk minimisation under REACh. Legislative organs should also consider integrating substances with identified risk in the various monitoring systems. Finally the implementation of risk-reduction measures could be supported by guiding documents, focused on the specific interest and cognitive orientations of the different groups of actors, both on the side of private actors and the competent authorities within the Member States.

~~Uncited references~~

~~Refs. [2,11]~~

Acknowledgments

The authors are grateful for helpful comments from Lars Koch and Nicholas Ashford but are, of course, responsible for all remaining errors.

References

[1] Ayres I, Braithwaite J. Responsive regulation. Transcending the deregulation debate. Oxford: Oxford University Press; 1992.
[2] ~~Bäuerle Michael, Wallrabenstein Astrid. "Haben wir wirklich Recht?" – Kolloquium anlässlich des 60. Geburtstags von Brun-Otto Bryde. Neue Zeitschrift für Verwaltungsrecht 2003;22:694–6.~~
[3] Becker, Dopfer. Electronic Public Participation (ePP), Projektbericht, Darmstadt (~~i.V.~~; ~~siehe auch unter~~ <www.sofia-research.com>); 2005.
[4] Bizer K, Hüttig C, Führ M, editors. Responsive Regulierung – Beiträge zur interdisziplinären Institutionenanalyse und Gesetzesfolgenabschätzung, ~~Hrsg. von Kilian Bizer, Martin Führ, Christoph Hüttig,~~ Tübingen; 2002.
[5] ~~Bizer Kilian, Hüttig Christoph, Führ Martin. Responsive Regulierung. Tübingen: Mohr Siebeck; 2002.~~
[6] Bizer Kilian. Steuervereinfachung und Steuerhinterziehung – eine experimentelle Analyse zur Begründung von Steuereinfachheit, Habilitationsschrift an der Technischen Universität Darmstadt. Berlin: ~~erscheint demnächst;~~ 2003.
[7] Bizer Kilian. Das Verhältnis von Komplexität und Steuerehrlichkeit – experimentelle Evidenz. In: Bizer K, Falk A, Lange J, editors. Am Staat vorbei. Berlin: Duncker and Humblot; 2004. p. 59–90 (Hrsg.).
[8] Calliess Christian. Zur Maßstabswirkung des Vorsorgeprinzips im Recht – Dargestellt am Beispiel der geplanten Reform des europäischen Chemikalienrechts durch das Weiß-buch der EU-Kommission zur zukünftigen Chemikalienpolitik. VerwArch 2003;389.
[9] Enquête-Kommission. Enquête-Kommission des Deutschen Bundestages "Schutz des Menschen und der Umwelt" (Hrsg.), Die Industriegesellschaft gestalten – Perspektiven für einen nachhaltigen Umgang mit Stoff- und Materialströmen [BT-Drs. 12/8260], Bonn (Economica); 1994.
[10] Environmental Defense Fund. (David Roe, William Pease, Karen Florini, Ellen Silbergeld): Toxic ignorance: the continuing absence of basic health testing for top-selling chemicals in the United States, 06/01/1997 (<http://www.environmentaldefense.org/pdf.cfm?ContentID=243&FileName=toxicignorance.pdf>); 1997.
[11] European Commission. European Governance – a white paper. COM 2002; 2002. 428 final.
[12] European Commission. Regulation, Evaluation and Authorization of Chemicals (REACh). COM 2003; 2003. 644 final.
[13] Führ Martin. Eigenverantwortung im Rechtsstaat. Berlin: Duncker and Humblot; 2003.
[14] Führ Martin. Proaktives unternehmerisches Handeln – Unverzichtbarer Beitrag zum präventiven Stoffstrommanagement. ZfU 1994;17:445–72.
[15] Führ Martin, et al. Risikominderung für Industriechemikalien unter REACh – Anforderungen an eine Arbeitshilfe für Hersteller, Importeure und Stoffanwender, Darmstadt/Hamburg/Köln/Frankfurt (<www.sofia-research.com>); 2005.
[16] Führ Martin, Bizer Kilian, Gebers Betty, Roller Gerhard. Institutionelle Bedingungen zur Förderung proaktiver Strategien Vergleichende Analyse internationaler Ansätze im Bereich des Umweltverhaltens von Unternehmen, in: Enquête-Kommission "Schutz des Menschen und der Umwelt" (Hrsg.), Umweltverträgliches Stoffstrommanagement, Bd. 2: Instrumente, Bonn 1995 (Neudruck: Sofia-Studien zur Institutionenanalyse Nr. 99-1); 1995.
[17] Führ Martin, Merenyi Stefanie, et al. Interface Problems between EC Chemicals Law and sector specific Environmental Legislation (IPPC/WFD), study on behalf of the German EPA/Ministry for the Environment, FKZ 360 12 008, Berlin 2005 download: <http://www.umweltbundesamt.de/uba-info-medien/index.htm>; 2005.
[18] Hansjürgens Bernd, Lübbe-Wolff Gertrude (Hrsg.). Symbolische Umweltpolitik. Frankfurt am Main: Suhrkamp; 2000.
[19] International Chemical Secretariat. What we need from REACH, Göteburg, <http://www.chemsec.org/antologi.htm>; 2005.
[20] Koch Lars, Ashford Nicholas A. Rethinking the role of information in chemicals policy: implications for TSCA and REACH. Journal of Cleaner Production; 2005.
[21] Köck Wolfgang. Das System "Registration, evaluation and authorisation fo chemicals" (REACH) – Rechtliche Bewertung am Maßstab des Gemeinschaftsrechts, in Renge-ling (Hrsg.); 2003.
[22] Massachusetts Precautionary Principle Project (Estabrook, Tom, Tickner, Joel): Facing our toxic ignorance, <http://sustainableproduction.org/precaution/back.brie.faci.html>; 2000.
[23] Nonet P, Selznick P. Law and society in transition – towards responsive law. New York: Harper & Row; 1978.
[24] North Douglass C. Institutions, institutional change and economic performance. Cambridge: Cambridge University Press; 1990.
[25] Stewart Richard B. The reformation of American Administrative Law. Harvard Law Review 1975;88:1669–813.
[26] Winter Gerd, editor. Risk assessment and risk management of toxic chemicals in the European community. Baden-Baden; 2000.