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on the European Chemical Industry:
A Critical Review

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The REACH Directive and its Impact on the European Chemical Industry: A Critical Review

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Abstract:

The REACH Directive, requiring the registration and testing of more than 30,000 existing chemical substances prior to selling them in the European Union, has been very controversial from its initial draft in 2001 to its adoption in 2006. In the course of lobbying actions, various studies have been published to assess the implementation costs of REACH, but cost estimations range from \$ 500 million to \$ 150 billion. A recent survey by INSEAD shows that the chemical industry is still very pessimistic about the long-term impact of REACH on the competitiveness of the European manufacturing base. The objective of this article is to explore to what extent REACH will impact Europe's chemical manufacturing sector. For this purpose, we present the main characteristics of the legislation in a first section. We then review the impact assessment studies published in section two. Based on these studies, we investigate whether REACH could impact future product innovation as well as hurt Europe's cost competitiveness on global markets in section three. We conclude that the impact will most probably be minor but that more empirical evidence is required.

1. Introduction

“We are in effect going to de-industrialise Europe [with these proposals] [...] Several studies commissioned by the chemicals industry and by the commission show that the costs will go into billions of euros. On top of this there are likely to be significant GDP drops and correspondingly high job losses that are put at hundreds of thousands to up to two million.” (Osborn, 2003)

On the 15th of July 2003 the Guardian titled “2m jobs 'at risk' in chemicals sector” (Osborn, 2003). In the article it cites Eggert Voscherau, then president of CEFIC - the European Chemical Industry Council – with the above quote. Two years later on the 27th of April 2005 Günter Verheugen – Industry Commissioner of the EU – sums up after several years of debate:

“The argument that REACH, as it stands today, would ruin the industry, is now banished.” (ENDS Europe Daily, 2005)

And one member of the European Parliament finds even harsher tones:

“Too many in the chemicals industry, and particularly its German lobbying arm, seem to believe that if you are going to tell a lie, then lie big; the costs of REACH have been grossly exaggerated from beginning to end.” (UK Office of the European Parliament 2005)

The time between Verheugen’s and Voscherau’s statement and even the two years before it since the publication of the “White Paper on the Strategy for a Future Chemicals Policy” (European Commission, 2001), have been marked by intense discussion and lobbying around a new regulation for the chemical industry in Europe REACH (Registration, Evaluation, Authorization and Restriction of Chemicals), was finally adopted in December 2006. With this new legislation major changes in the marketing of chemicals in Europe are implemented. It requests the registration of all substances produced in or imported into the EU with volumes over 1 ton/year per producer or importer in order to collect basic information on their hazards and risks. In addition, the burden of proof is reversed – instead of state authorities having to prove the danger of a substance, producers or importers now have to prove the safety of their substances. Furthermore, an authorization procedure for the most hazardous substances is introduced and access to information for the public is eased. (Council of the European Union, 2006) A European Chemicals Agency (EChA), located in Helsinki, is to be founded in order to oversee the process.

However, the question remains whether the European chemical industry will be harmed because of REACH or whether it comes out stronger from the REACH implementation. While many impact studies have been published in the last six years, these were biased by the organization financing the investigations and by

the fact that the legislation scope was not fully set by that time. Now that the Directive has been passed, the objective of this article is to provide insights in the real impact of the REACH legislation on the European chemical industry.

The paper is organized in three sections. Section 2 presents the genesis and the basic principles of the REACH legislation. Section 3 provides an overview of more than 40 impact studies published between 2000 and 2007. We show that, according to these studies, the future costs of REACH may vary, according to the estimations, between € 500 million and € 150 billion. While the direct registration and testing costs are well defined for all studies and are very low, we note that the main difference lies in the assessment of the indirect costs and the underlying assumptions. In this context, section 4 provides insights into the legislation's impact on the competitiveness of the European chemical industry by analyzing the indirect costs of REACH. For this purpose, we address two central industrial assumptions:

- REACH slows down and hampers innovation
- REACH creates a cost disadvantage for European companies on world markets

After having put the costs of REACH in perspective, we conclude that there is very little reason to believe that REACH will have a significant negative impact on the European chemical industry. However, a quantitative validation is missing.

2. Genesis and basic principles of the REACH legislation

In this section, we describe the basic process toward the registration of chemical substances. We then trace the evolution of the legislation from the initial draft to the final text that has been passed in December 2006.

2.1. The REACH process

The REACH procedure consists of several steps, from the registration to the formal authorization to sell a product in Europe or restrict its use (see Figure 1). The first step is the registration of substances imported or produced in a quantity of more than one ton per year per producer by the respective producer or importer. A certain amount of testing is necessary to deliver basic safety information on a substance.

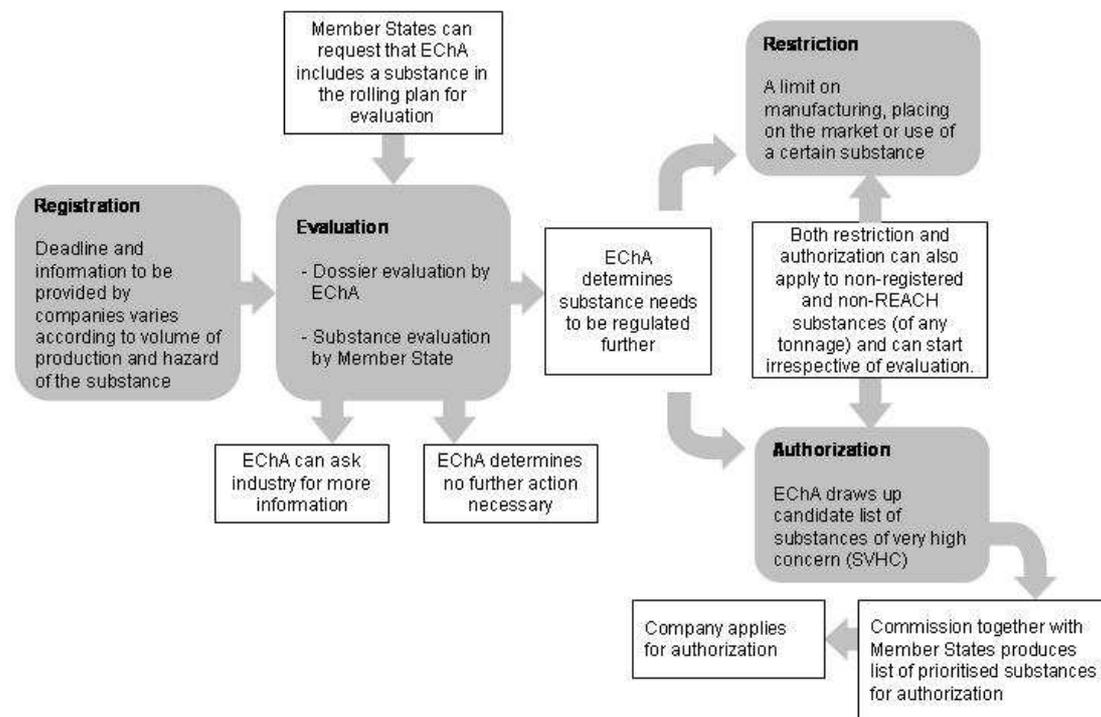


Figure 1: REACH-Process (adapted from Greenpeace, 2007)

The amount of information required for registration varies with the production volume of the substance: the more of a substance being produced, the more information has to be delivered. With the goal of preventing multiple tests of the same substance by different companies¹ a pre-registration phase has been introduced. Pre-registration allows for documenting basic information about substances as well as information about existing testing data in a central

¹ During the discussion of REACH, the OSOR-claim (One substance, One Registration) was proposed in order to avoid multiple testing of the same substance.

database. Thereby producers or importers intending to register the same substance in the registration phase can benefit from so-called SIEFs (Substance Information Exchange Forum) in order to build consortia for the required testing. The requested amount of data and the deadline for registration of a substance vary with its production volume and hazard. RPA (Risk Policy and Analysis Ltd) estimates that around 30,000 substances will need to be registered (RPA and Statistics Sweden, 2002).

Once registered, two kinds of evaluation procedures can be applied: dossier evaluation through the newly installed European Chemical Agency (EChA), or, substance evaluation through one of the member states. The EChA evaluates the registration dossier for compliance to the registration requirements. Five percent of the registered substances will be evaluated through this procedure per year. A substance evaluation is conducted by one of the member states of the EU. This procedure consists of a more thorough review of substance hazard and exposure data.

Following evaluation, EChA can decide that a substance needs further regulation. Again, two procedures are available to EChA: authorization or restriction. The former procedure consists in the creation of a list of substances of very high concern (SVHC) through the European Commission.² Once a substance has been classified as SVHC, the producer or importer needs to apply for authorization. Authorization can be granted if the substance is either adequately controlled or there are no existing alternatives and the socio-economic benefits outweigh the risks (European Commission, 2006, Article 60). The restriction procedure allows for the imposition of restrictions upon the production or importation of substances if there are unacceptable risks arising from a substance.

2.2. A brief history of REACH

Although the first steps towards REACH started as early as 1998, its official birth might be seen in the publication in 2001 of the “White Paper on the Strategy for a Future Chemicals Policy” by the European Commission, which stirred a broad response by various stakeholders (Figure 2). As a reaction to this White Paper the two other European institutions involved in the legislation process - the Council and the European Parliament - proposed amendments aiming to design REACH stricter than in the White Paper (Schörling, 2004). Active involvement of all stakeholders has also been made possible through an internet consultation in June and July 2003 allowing the various stakeholders to express their opinions on a consultation draft, which was answered by more than 6,000 submissions.³ Thereafter, in October 2003, a legislation proposal was published by the Commission in which the co-decision procedure applied. In December 2006, the European Parliament adopted the Common Position of the Council in the second reading.

² Substances qualify for this list if they are: A) carcinogenic, mutagenic or toxic for reproduction (CMR) or B) persistent, bio-accumulative or toxic (PBT), or C) very persistent or very bio-accumulative (vPvB) or D) substances for which there is scientific evidence of probable serious effects to human health or the environment.

³ http://ec.europa.eu/enterprise/reach/consultation/contributions_en.htm

Non Governmental Organizations (NGOs) joined the discussion of the White Paper early on. Three major campaigns are especially noteworthy: the “Detox”-campaign⁴ by WWF, the “Chemicals out of control”-campaign⁵ by Greenpeace and the “Safer Chemicals”-campaign⁶ by Friends of the Earth Europe. The objective of these campaigns was to highlight the health and environmental benefits of the proposed legislation as well as taking a stand against arguments brought forward by industrial representatives.

“In what some European Commissioners say is the largest lobbying effort in the modern history of the EU, European and American chemical manufacturers orchestrated a multilayered and multipronged lobbying campaign that encompassed all the original 15 EU member states plus the 10 new ones, as well as countries outside the continent such as Japan, Mexico, and the USA. The American connection, in particular, has been among the most significant, as the Bush Administration engaged in a full-frontal assault on the proposed rules, threatening a trade war and warning of dire consequences for the European economy if the proposals were enacted.” (Loewenberg, 2006)

Industry was mainly organized through CEFIC, the European Chemical Industry Council, and their main concerns were the workability and cost-efficiency of the legislation (CEFIC, 2004). Further lobbying activities for the Chemical industry have been displayed by the German industry, represented through the BDI – Bundesverband Deutscher Industrie – and the French UIC – Union des Industries Chimiques. Both developed their main lobbying attempt in the form of studies concerning the impact of REACH, forecasting disastrous results for their respective economies as an effect of its implementation. Unexpected support in highlighting the costs created by REACH came from the ACC – the American Chemistry Council. They were backed by political efforts of the US government fearing trade losses due to market barriers created by REACH (Waxman, 2004). But also European governments tried to deploy pressure, most openly in the form of a letter by Tony Blair, Jacques Chirac and Gerhard Schröder in which they consider the proposal to be “too bureaucratic and unnecessarily complicated” (Présidence de la République, 2003).

4 http://assets.panda.org/downloads/detox__campaigning_for_safer_chemicals.pdf

5 <http://www.greenpeace.org/international/campaigns/toxics/chemicals-out-of-control>

6 http://www.foeeurope.org/safer_chemicals/Index.htm

25.04.1998	An informal meeting of EU Ministers in Chester, UK, submits a document outlining the current lack of action and the need for a completely new policy on chemicals
June 1999	EU Environment Ministers that met at the Environmental Council request a strategy for chemicals reform from the European Commission
13.02.2001	European Commission, White paper on the Strategy for a Future Chemicals Policy
07.06.2001	Council opinion on White Paper
15.11.2001	Adoption of European Parliament report on White Paper
May 2003	European Commission Directorate General for Environment and Directorate General for Enterprise jointly publish a draft proposal concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
16.06.2003	Beginning of 8 weeks public internet consultation on the full draft REACH text
29.10.2003	Commission publishes its proposal for a Regulation of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) and establishing a European Chemicals Agency
17.11.2005	The European Parliament votes its First Reading Opinion on REACH
13.12.2005	EU Member States in the Council of Ministers reach a political agreement for a common position on REACH
27.06.2006	EU Member States in the Council of Ministers formally approve a common position on REACH
13.12.2006	The European Parliament votes in Second Reading on REACH
18.12.2006	EU Member States in the Council of Ministers adopt the REACH regulation
01.06.2007	REACH enters into force

Figure 2: History of REACH (adapted from Greenpeace, 2007)

3. Impact assessment studies around REACH

Over 40 studies have been published attempting to assess the impact of REACH. As REACH is likely to impact multiple areas, a comprehensive overview of all the impacts analyzed in existing studies is a complicated task. A comprehensive assessment of the studies prior to October 2004 can be found in an overview prepared for a workshop held by the Dutch Presidency in 2004 (ECORYS and OpdenKamp Adviesgroep, 2004). Figure 3 displays some of the most relevant studies published and clusters them according to their focus and methodology.

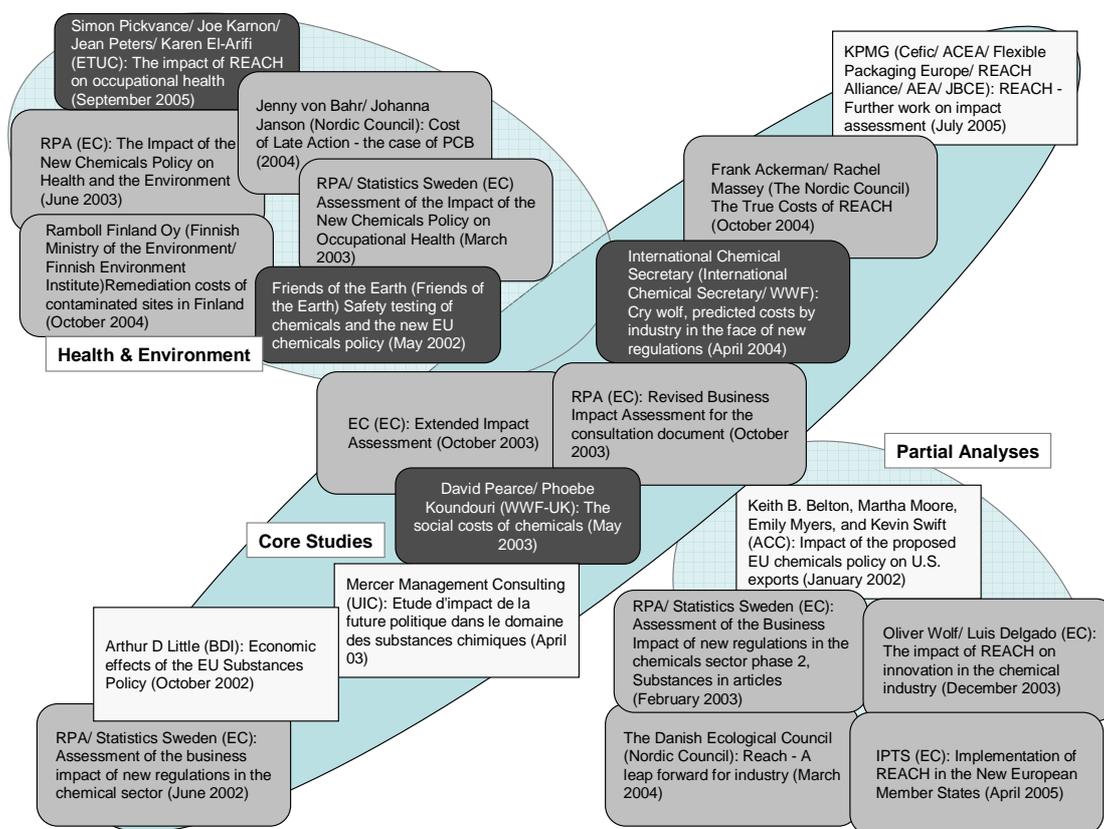


Figure 3: Impact Assessment Studies (own illustration)

Since industrial and civil society opinion leaders have heavily influenced the debate, Figure 3 mentions specifically both author and commissioner of respective studies⁷. The core studies – collected in the central oval – are those being most referred to. They mostly cover more than one field of discussion. The studies labeled “Health & Environment” focus more specifically upon arguments concerning health or environmental aspects of REACH. The cluster “Partial

⁷ The commissioner is referred to in the bracket after the author(s). In addition, studies commissioned by industry have been colored light grey and are put in rectangles with corners, studies commissioned by political institutions are grey and studies commissioned by civil society actors are painted dark grey with white letters.

Analyses” covers studies concerning specific countries or impacts in fields other than health and environment.

Especially worth mentioning are the two studies “Economic effects of the EU Substances Policy” (Arthur D Little, 2002) and “Etude d’impact de la future politique dans le domaine des substances chimiques” (Mercer Management Consulting, 2003) which have both been commissioned by industry. Both have been heavily criticized for methodological flaws and implausible assumptions. With regard to the first study concerning the development of the German economy, the German Federal Environment Agency concluded in a detailed analysis of methodology and assumptions of the study: “On the whole the discussion made it clear that a bottom-up method of the type chosen by ADL is not a suitable methodology for arriving at absolute magnitudes via macro-economic aggregates. The data contained in the ADL Study for losses in gross value added and for job losses resulting from the implementation of REACH cannot be validated and cannot therefore constitute a sound basis for the macro-economic evaluation of EU chemicals policy.” (Federal Environmental Agency [Germany], 2003) Nevertheless these have been frequently cited both in an affirmative and a disapproving way.

The arguments can roughly be divided into the costs and benefits that arise for society and those that arise for industry. A variety of studies have been written during the discussion processes covering all these topics. These studies shall be mentioned where appropriate. Before looking closer at benefits and costs for industry, the benefits and costs for society are discussed.

One of the major aims behind the introduction of REACH has been to gain benefits for health and environment. Fewer diseases are to be expected and less pollutants in the environment due to the testing requirements of REACH. It is brought forward that REACH could lead to the marketing of more environmentally friendly products (EEB and WWF, 2003). Based on one health study, a report estimates that REACH might result in benefits between € 18 and € 54 billion, mainly due to a decreased risk of cancer (RPA and Statistics Sweden, 2003). Another study – basing their estimate on disability-adjusted life years – arrives at benefits between € 4.8 and € 283.5 billion (Pearce and Koundouri, 2003). Further evidence regarding environmental benefits is assessed by a study summing up the costs for remediating contaminated sites in Finland between 2005 and 2025 at € 1.2 billion (Järvinen and Salonen, 2004). An estimation based on the case of PCB in Sweden assesses the cost saving potential for the EU with respect to chemical accidents as ranging from € 7 to € 27 billion (von Bahr and Janson, 2004). Other studies analyze a variety of such cases (RPA and BRE Environment, 2003).

One concern connected to REACH was that it might lead to excessive animal testing which has been the impetus in discussions on alternative testing methods such as (Quantitative) Structure-Activity Relationships (QSARS). For the legislation as proposed in the “White Paper on the Strategy for a Future Chemicals Policy” an amount of 8.4 million mammals and 4.4 million fish has been estimated to be necessary for testing (Institute for Environment and Health, 2001). Alternative testing methods might lead to significant cost savings

as well as to a significant reduction in the amount of necessary animal tests (Pedersen et al. 2003). Because of the benefits of alternative testing methods further research into these alternatives is necessary (Friends of the Earth, 2002).

Further concerns were brought up with respect to the costs REACH would create for society. Two kinds of costs for the EU-population can be identified. On the one hand, the administrative burden will have to be paid through taxes (if not covered by fees from the industry). On the other hand, increasing costs for the industry will probably result in increased prices for the consumer. The costs for a central entity (which are to be partly covered by fees) are estimated to range between € 287 and € 483 million over a ten year period (Deloitte & Touche, 2002). Other assessments come to similar results (RPA and Statistics Sweden, 2003b). Total costs per citizen in the EU per year are nevertheless estimated to be less than one euro (WWF, 2004). The price increase for the final consumer depends upon the extent to which the industry can pass on its costs, i.e. the competitiveness of the sector.

Despite industry's critics about REACH, some benefits have also been discussed. These can mainly be found in four areas: a stronger tendency to innovate with respect to safer chemicals, better health of employees, a common standard within the EU decreasing transaction costs for companies operating in more than one country and improving the reputation of European chemicals. All these benefits are hard to quantify compared to the costs arising from the introduction of REACH.

The effect of REACH upon innovation has been extensively discussed. Whereas NGOs mainly claim an encouraging effect of REACH towards the development of safer chemicals, industry claims that it allows for less innovation due to increased costs. In more detail, NGOs proclaim that as REACH sets a common standard and does not prescribe specific processes to be used but allows for industry to cope in its own way with the new regulation it is to be considered an innovation-friendly regulation (EEB and WWF, 2003). Berkhout et al. (2003) argue that REACH might lead to a decrease in the number of innovations but nevertheless lead to a positive change in the direction in which it is being innovated. In addition, Fraunhofer ISI and Oekopol (2004) argue that the requirements for low-volume-production chemicals (smaller than 10 ton per year) would be less constraining compared to the pre-REACH-system. Weaknesses of the pre-REACH-system are addressed through exemptions for R&D, for isolated intermediates and polymers with the intention to ease innovation (Wolf and Delgado, 2003). Although uncertain about the exact extent of the effect, other studies are predominantly pessimistic with respect to the impact of REACH on innovation (CEFIC, 2002). The costs and delays caused by REACH might lead to a delocalization of R&D competencies and more innovation outside the EU (Mercer Management Consulting, 2003). Furthermore the resources necessary for fulfilling the testing requirements of REACH might be drawn away from R&D (Wolf and Delgado, 2003).

A clearer benefit for industry is seen in safer working environments for the employees. REACH might lead to healthier employees resulting in fewer days on sick leave. The main benefit is seen in a decrease in the occurrences of cancer

(RPA and Statistics Sweden, 2003). Further benefits are seen in the reduction of skin and non-malignant respiratory diseases caused while working which are estimated to sum up to between € 0.66 and € 6.2 billion within the first ten years after the introduction of REACH or between € 21.2 and € 160.7 billion in the first thirty years (Pickvance et al., 2005).

The benefits for industry from a common standard within the EU and from reputation are especially hard to quantify. A better reputation might improve recruitment, employee morale, investor support, acceptance by the host community and the management's self-respect (EEB and WWF, 2003). A common standard in the EU would ease operations for companies acting in more than one market within the EU (The Danish Ecological Council, 2004).

Apart from the impact upon R&D the main issues brought forward by industrial representatives nevertheless regard the effect of REACH in the areas of competitiveness, exports and SMEs as well as the direct costs imposed upon industry. In addition product withdrawal due to economic and safety reasons is feared. Our analysis proceeds in two steps, first the estimates of direct costs are assessed before turning towards the indirect costs.

3.1. Direct costs estimations for REACH

Several studies have been conducted with the aim of assessing the direct costs connected to REACH (see Figure 4). In order to evaluate these studies it is necessary to keep in mind which version of the REACH proposal has been used to estimate the impact as well as the scope for which the impact has been assessed. The type of commissioner (NGO, Politics or Industry) is marked through the color of the respective row.⁸ Industry has to bear the burden of two types of direct costs: the costs for testing substances and the costs for registering or even applying for authorization that are segregated in the following.

⁸ For an industry study the row is colored in dark grey, for governmental studies it is colored in light grey. No civil society actor has estimated direct costs.

Date	Author/Event	Ordering Party	Title	Direct Costs for industry		Underlying legislation	Scope
				Registration/Authorisation	Testing		
May 01	RPA	UK Department of the Environment, Transport and Regions	Regulatory Impact Assessment of the EU White Paper: Strategy für a Future Chemicals Policy	87 £ million	463 £ million	White Paper	UK only
Jan 02	Belton et al.	ACC	Impact of the proposed EU chemicals policy on U.S. exports	400 \$ million		White Paper	US only
Jun 02	Deloitte & Touche	EC	Feasibility study on the resource requirements for a central entity	215.4 - 429.4 € million		White Paper	EU
Jun 02	RPA/ Statistics Sweden	EC/ DG Enterprise	Assessment of the business impact of new regulations in the chemical sector	370.4 - 1020.9 € million	1.9 - 5.1 € billion	White Paper	EU
Sep 03	Pedersen et al.	EC DG JRC	Assessment of additional testing needs under REACH, Effects of (Q)SARS, risk based testing and voluntary industry initiatives		1.2 to 2.4 € billion	Consultation Draft	EU
Oct 03	RPA	EC DG Enterprise	Revised Business Impact Assessment for the consultation document	2.0 - 6.2 € billion	10.1 - 20.5 € billion	Consultation Draft	EU
Oct 03	EC	EC	Extended Impact Assessment	900 € million	1.5 € billion	Consultation Draft	EU
Oct 04	Ackerman/ Massey	The Nordic Council	The True Costs of REACH	0.5 € billion	3.0 € billion	Legislation Proposal	EU
Dec 04	RPA	DEFRA, UK	REACH - One Substance, One Registration	0.5 - 0.8 € billion	1.3 - 1.7 € billion	Legislation Proposal	EU
May 06	DEFRA, UK	DEFRA, UK	REACH Partial Regulatory Impact Assessment after Common Position	403 £ million		Common Position	UK only

Figure 4: Estimates of direct costs

In May 2001, RPA assessed the costs of the policy regarding chemicals as lined out in the White Paper with regard to the UK (RPA, 2001). It considers several scenarios: the existing legislation, the US legislation and the legislation according to the White Paper. For the existing legislation, it calculates £ 107 million total present value costs, for the US chemical strategy total present value costs of £ 197 million would arise whereas the legislation according to the EU White Paper would cause total present value costs of £ 620 million. Their costs for registration and authorization as displayed in Figure 5 (£ 87 million) consist of £ 34.4 million for the preparation of data sets according to OECD's Screening Information Data Set (SIDS) Programme and £ 52.2 million for the preparation of dossiers. The costs for testing would come to a total of £ 463 million with the biggest share caused by high production volume chemicals. Testing and registration under the legislation prior to REACH would have amounted to £ 86 million. This significant difference in costs of the regulation prior to REACH and the costs arising under REACH is being contradicted by Fraunhofer ISI and Oekopol (2004).

The American Chemistry Council (ACC) has also assessed the costs of REACH for the US chemical industry (Belton et al., 2002) and estimates that US exporters

will have to pay \$ 400 million for registration and face a reduction of their annual exports by \$ 171 million to \$ 918 million for the chemicals subject to authorization.

Deloitte & Touche (2002) assess the resource requirements of a central entity responsible for fulfilling the REACH obligations which depend on the amount of substances to fall under the responsibility of this entity. Therefore four scenarios are being developed with respect to the amount of substances. Between 220 and 420 people would be required for the entity in these scenarios with total costs over a 10-year period of € 287.2 to € 482.5 million. These costs do not include any financial compensation in form of fees paid by industry.

RPA and Statistics Sweden (2002) develop scenarios with respect to the number of chemicals being placed on the market and the number of intermediates that have to be registered. The study provides quantitative estimates, indicates the cost distribution upon SMEs and large enterprises and identifies other impacts on competitiveness, innovation and intellectual property. According to the authors, the costs of testing substances would amount to € 1.9 to € 5.1 billion whereas the costs of pre-registration, dossier preparation, authorization and Accelerated Risk Management (ARM) could range between € 370 million and € 1 billion.

The impact of alternative testing methods upon costs is analyzed in a study by Pedersen et al. (2003) who deliver a detailed assessment of various testing needs discriminating for tonnage bands. The impact of the use of (Q)SARs, grouping and read-across is analyzed and considered to have major effects. Estimated direct testing costs are ranging from € 1.2 to € 2.4 billion with a best estimate of € 1.6 billion. CEFIC's claim (CEFIC, 2003) that fine and specialty chemical producers would have to bear 80 % of direct costs of testing and administration is denied.

Another RPA study updates the prior estimation of the costs according to the version of REACH published for the internet consultation (RPA, 2003). The biggest difference to earlier estimates is caused by the inclusion of polymers into the REACH legislation. Further differences are caused by a varying treatment of intermediates, the need to prepare CSRs for additional substances and new exemptions. The cost estimates range from € 13 billion to € 27 billion depending on whether polymers fall in the scope of REACH. This estimation comprises registration, testing, CSR provisions for downstream users, preliminary CSR provisions, authorization, benefits and ARM. Whereas the costs for registration and authorization vary between € 2.0 and € 6.2 billion, costs for testing are estimated to lie between € 10.1 and € 20.5 billion.

The European Commission (2003) estimates this assessment to be too high. The € 13 billion costs, which have been computed for a low number of polymers in the study generated by RPA, have to be decreased to 2.3 € billion direct costs because of the following measures: Major reduction in requirements for CSRs, exclusion of polymers, increased usage of QSARs, reduced requirements for chemicals with a production volume between 1 and 10 tons and looser requirements for transported intermediates.

The Nordic Council offers a bottom-up calculation of the expected registration and testing costs, a different analysis of the indirect economic impacts of REACH and an evaluation of some prominent arguments about the costs of REACH (Ackerman and Massey, 2004). It estimates a total testing and registration cost of € 3.46 billion. € 460 million can be attributed to registration efforts while € 3 billion are attributed to testing activities.

RPA (2004) examines the influence of the number of consortia for substance testing and registration on the resulting costs. Key parameters of the study are therefore the number of consortia breaking up and the percentage of members leaving a consortium. It estimates € 1.9 billion as the lowest possible scenario for costs of testing and registration and € 2.5 billion as the highest. Applying OSOR (One Substance, One Registration) would lead to costs ranging from € 1.9 to € 2.0 billion.

The report “REACH Partial Regulatory Impact Assessment after Common Position” quantifies the financial burden of three different options: Option 1 (Do nothing) would incur lost benefits of around € 50 billion, option 2 (Commission's proposal of October, 2003) would incur costs of £ 515 million over the eleven-year phase-in, option 3 (Common position of May, 2006) will result in savings of £ 112 million compared to the Commission's proposal (DEFRA, 2006).

From the studies it can be concluded that the direct costs for registration and authorization should not exceed € 1 billion, costs for testing should – exempting polymers – not be higher than € 3 billion. Given that the European chemical industry (including non EU members) achieved € 563 billion revenues in 2006 (CEFIC, 2007), € 3-4 billion registration costs spread over the thirteen years of adoption are a modest amount. In fact, the main fears on REACH concern the indirect costs and their impact upon the competitiveness of the European industry. These will be analyzed below.

3.2. Indirect costs estimations for REACH

Several types of indirect costs have been discussed: Costs arising through loss of business, costs arising from the necessity to replace formulations including substances withdrawn from the market as well as costs arising from a weakened tendency to innovate. Figure 5 displays the major studies in that category as well as the estimated indirect costs.

Date	Author/ Event	Ordering Party	Title	Indirect Costs	Underlying legislation	Scope
Jan 02	Belton et al.	ACC	Impact of the proposed EU chemicals policy on U.S. exports	8.8 \$ billion	White Paper	US
Oct 02	Arthur D. Little	BDI Germany	Economic effects of the EU Substances Policy	9.2 - 147.2 € billion	White Paper	Germany
Apr 03	Mercer Management Consulting	UIC	Etude d'impact de la future politique dans le domaine des substances chimiques	55 € billion	White Paper	France
Oct 03	EC	EC	Extended Impact Assessment	2.8 - 5.2 € billion	Consultation Draft	EU
Nov 03	Canton/ Allen	EC/ DG Enterprise	A Microeconomic Model to assess the economic impacts of the EU's New Chemicals Policy	2.8 - 5.2 € billion	Legislation Proposal	EU
Jul 04	Arthur D. Little	BDI Germany	Economic effects of the EU Substances Policy - Supplement to the Report on the BDI* Research Project	61.1 - 75.9 € billion	Legislation Proposal	Germany
Apr 05	Ministry of economic affairs and labour Poland	Ministry of economic affairs and labour Poland	Results of the polish impact assessment of implementation of the REACH system (Registration, Evaluation and Authorisation of Chemicals) on the Polish chemical industry and downstream users	344 - 416 € million	Legislation Proposal	Poland

Figure 5: Estimates of indirect costs⁹

Belton et al. (2002) – commissioned by the American Chemistry Council – estimate that in addition to the loss of exported chemicals worth between \$ 200 and \$ 900 million for the US industry further exports of final products worth \$ 8.8 billion are at risk because the products contain chemicals that might need authorization.

Probably the most famous study in the discussion of the REACH legislation was the study “Economic effects of the EU Substances Policy” authored by Arthur D Little and commissioned by the BDI (Arthur D Little, 2002). It assesses the impact of REACH upon industry based on data gained through 50 interviews and 20 workshops. Three industries - the automotive industry, the textile industry and the electrical engineering and electronics industry are analyzed with regard to their key success factors. Building upon these, three scenarios are derived: "clouds", "storm" and "hurricane". In the scenario "clouds" a reduction of the German gross value added of 0.4% and a loss of 150,000 jobs are predicted, in the scenario "storm" a reduction of 2.4% and a loss of 900,000 jobs. In the scenario "hurricane" a reduction of 6.4% is predicted as well as a loss of 2.35 million jobs. These jobs are not only lost in the chemical industry which employed in Europe a total of around 1.9 million people in 2006 (Eurostat, 2006)

⁹ Again the commissioner of a study is marked. For an industry study the row is colored in dark grey, governmental studies are colored in light grey.

but in subsequent industries as well. Drawing upon the German GDP of 2006 with 2300 € billion this would lead to costs ranging from € 9.2 to € 147.2 billion.

The fundamental critique of the Federal Environment Agency of Germany has already been cited. Further critique has been formulated by the German Advisory Council on the Environment which also criticized the study by Mercer Management Consulting (Mercer Management Consulting, 2003) to be presented below: “For the following reasons, however, the study [Mercer Management Consulting, 2003] shows similar fundamental and methodological irregularities to those in the Arthur D. Little study. These include the absence of a business-as-usual scenario, the extrapolation of production losses via input-output calculations, and the neglect of positive benefit outcomes.” (SRU, 2003 p. 18-19)

Mercer Management Consulting (2003) develops a macro-economic model out of 14 pilot segments, which have been selected with regard to products, manufacturers and value chains. Based on 120 interviews the costs of testing, reformulating and substituting are assessed. It is estimated that 74 % of the testing costs will be paid by fine and specialty chemical producers. 10 to 40 % of their portfolio will stop to be produced. Formulators run the risk of delocalizing 10 to 15 % of their production. For the whole economy a reduction of GNP of € 55 billion and a loss of 670,000 jobs in 2012 is estimated.

The European Commission (2003) estimates a sum of costs for the chemical industry and downstream users ranging from € 2.8 to € 5.2 billion.

Canton and Allen (2003) assess the costs of the initial phase of REACH (registration, testing) with regard to substitution effects for downstream users. They base their estimation on a microeconomic model of monopolistic competition with differentiated products and economies of scale and assume first-tier costs of € 2.3 billion for registration and testing. Their calculations range from € 2.8 - € 5.2 billion including the first-tier costs.

Arthur D Little (2004) updates (Arthur D Little, 2002) with respect to the legislation draft. It estimates a loss of 2.7% to 3.3% of gross value added and a loss of between 1 and 1.23 million jobs. Absolute figures based again on the German GDP of 2006 would amount to a loss of business worth between € 61.1 and € 75.9 billion.

A study of the Polish Ministry of Economic Affairs and Labour focuses on the impact of REACH on innovation and competitiveness of small and medium sized enterprises in the Polish chemical industry (Ministry of Economic Affairs and Labour Poland, 2005). It draws upon 78 enterprises with 50 employing less than 250 workers. The total cost of implementing REACH for the Polish chemical industry and downstream users ranges from € 344 to € 416 million.

Compared to the direct costs, the estimates of the indirect costs show a broader spectrum of estimates, ranging from € 2 to € 150 billion, and depending on two core assumptions: REACH will hurt Europe’s competitiveness and hinder future innovation that will take place elsewhere. In the next section, we will investigate to what extent these assumptions underlying the indirect costs might hold.

4. Impact of REACH on the long term competitiveness of the European chemical industry

A recent study performed by INSEAD and Management Engineers points out that a large majority of European chemical executives still think that REACH is a major threat to their business (Figure 6). This state of mind is, in our opinion, due to the overexposure to the AD Little (2002) and Mercer (2003) studies presented in the previous section and to a lack of knowledge around REACH. In fact, if the cost predictions of the 2 studies above would turn out to be true, the competitiveness of the European chemical industry would be seriously threatened. In order to get a better assessment of the competitive impact of REACH, it is necessary to investigate two core assumptions made by the AD Little and Mercer studies that are also widely shared by chemical actors. This is confirmed by INSEAD and Management Engineers (2007), who show that most of the 47 top executives interviewed are very negative about the long-term impact of the legislation.

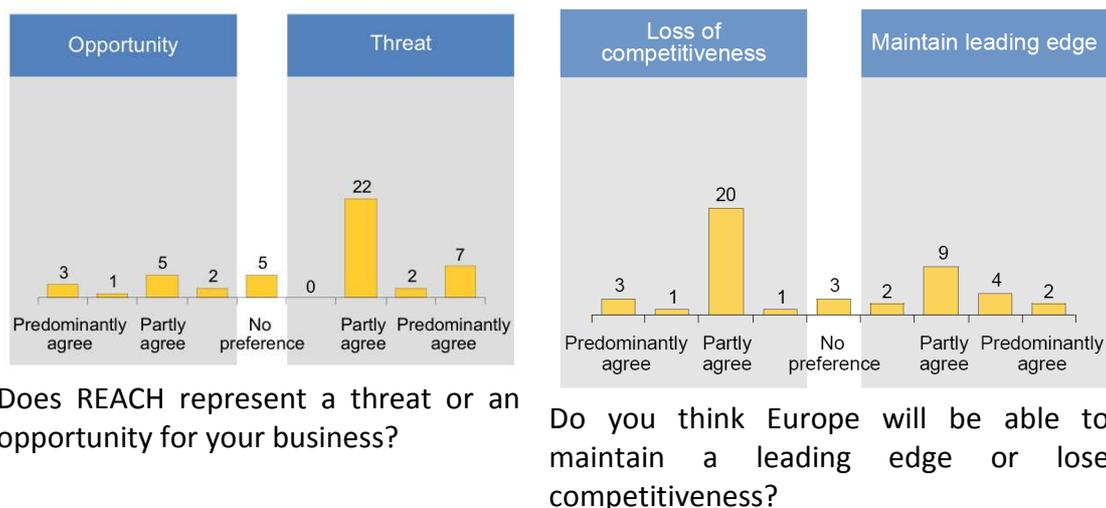


Figure 6: European Executives are still very negative about REACH (INSEAD and Management Engineers, 2007), based on 47 interviews

First, the industry still expects REACH to reduce the innovation capability of the European industry. Hence, the European chemical industry would forego future revenues that would be generated elsewhere. Second, the European industry would face a competitive disadvantage against other world regions that do not have to carry the burden of REACH and could therefore lose market shares worldwide. This section will investigate empirical evidence supporting this.

4.1. Impact on new product development

One main assumption underlying the indirect costs assessment for REACH is that this legislation will hamper the innovativeness of the European chemical industry and thus preempt future revenues. These lost revenues are accounted as opportunity costs of REACH (AD Little, 2002). Since REACH deals with the

registration of substances, only product innovation (i.e. new substances) is in its scope while process innovation (i.e. new processes to obtain substances) is not.

As depicted in Figure 7, product innovation represents a main source of innovation for the chemical industry (CEFIC, 1997). Nevertheless, experts agree on the fact that base chemicals are unlikely to be significantly impacted due to the high quantities sold (base chemicals are supplied to all chemical manufacturers downstream) and the very narrow range of products to be tested (see CEFIC, 2002 or Pollak, 2007).

Sector	Product innovation	Process innovation
Base chemicals	31%	65%
Agrochemicals	63%	38%
Paints, varnishes & perfumes	66%	33%
Soap & detergents	52%	47%
Other chemical products	44%	52%
Man-made fibers	16%	80%

Figure 7: Product and Process Innovation in the Chemical Industry (adapted from CEFIC, 1997)

Since product innovation is a much greater concern for fine and specialty chemicals manufacturers (among others: agrochemicals, paints, varnishes and perfumes) than for base chemical manufacturers, we investigate in the following the additional costs for new product introductions caused by REACH compared to the former environmental legislation in place.

REACH as an improvement of previous environmental legislation

Frohwein and Hansjuergens (2005) state that REACH will delay market entry for new products and presents therefore a burden for product innovation. Nevertheless, this argument would mostly hold in the case environmental legislation would not have existed before REACH, which is not the case. The European Community already passed a directive in 1967 on classification, packaging and labeling of dangerous substances, 67/548/EEC – then only requiring a labeling of a substance with respect to the risks posed by it - and modified it later compelling manufacturers to test products if they were put on the market after 1981.

Two inventories of chemical products have been created: EINECS in which substances that have already been marketed before 1981 had to be registered, and ELINCS in which substances marketed after 1981 had to be registered. The registration of substances marketed after 1981 required information on toxicity, ecotoxicity and physico-chemical properties if marketed in a volume of more than 1 ton/year. Since the requirements posed to manufacturers have been softened (Norbeck and Faust, 2003) and the legislation between countries has been streamlined during the development of the REACH directive, the rules concerning the testing and registration of new substances are now clearer and only request one registration process for 27 countries (instead of 27 registrations). Furthermore, new substances selling below 1 ton/year are now

completely excluded from the registration process, unlike in previous EU legislation (Directive 92/32/EEC Annex VII B). Hence, the REACH version that has been passed in 2007 simplifies and reduces the scope of the previous environmental legislation.

Nordbeck and Faust (2003) underline that the directive 67/548/EEC was in fact penalizing product innovation by not requiring manufacturers to document substances introduced before 1981. The authors observed that innovation was shifted from product to process innovation, thus spending research efforts on improving existing products rather than introducing new ones. By enforcing the registration and testing of historical substances, REACH improves the attractiveness of new substances against old ones. In order to assess the effects of REACH compared to the older legislation, its impact will in the following be analysed in three dimensions: time, cost and quality (see Figure 8).

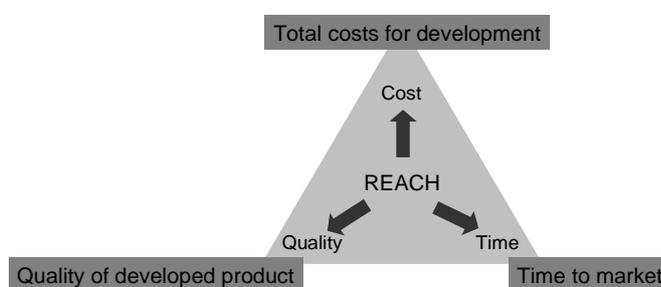


Figure 8: Time, cost and quality as dimensions to assess REACH impact

Having to fulfil testing requirements for every new substance ensures that every substance brought onto the European market satisfies quality criteria regarding health and environment. Annex VII of the REACH legislation describes the necessary testing for new substances produced in volumes of less than 10 ton/year. In addition to physical properties, information about the effect upon skin and eyes, mutagenicity, toxicity as well as information on degradability and biotic properties has to be delivered. By making this mandatory the **environmental compliance of the developed product** is theoretically assured.

After having seen that REACH should positively affect the quality of the developed product, the **total costs of development** REACH will create per substance are to be analyzed. For substances produced in volumes between 1 and 10 ton/year an amount of € 28,000 per substance is estimated to be necessary (Arthur D Little 2004). Given this, the registration costs under REACH are lower than the costs which arose for the notification of a new substance under the legislation prior to REACH (see Hansjürgens and Nordbeck, 2007). The argumentation that REACH will pre-empt the development of innovation because of high introduction costs (CEFIC, 2002) is surprising. Product innovations are motivated by the hope for higher returns and additional sales. In this context, would additional costs of less than € 30,000 per substance seriously change the economics of new product development?

As new substances had to be notified already under Directive 67/548/EEC no significant increase in the time to market can be perceived. Nevertheless, an overload of the industrial R&D departments due to the registration of existing substances might lead to prolonged development times for new substances (KPMG, 2005). Through the implementation of long periods for the phase-in of substances produced in low volumes (Substances produced or imported in volumes below 10 ton/year do not need to be registered until 2018) the legislator has mitigated this problem. To conclude, **additional delays** in the commercialization of new chemical substances **are not expected** after the introduction of the REACH directive. Let us now take a look at the second argument behind the high opportunity costs of REACH: worse competitiveness of European manufacturers on global markets.

4.2. REACH's impact on the cost competitiveness of the European chemical industry

During the debates on REACH, industry frequently claimed that European exports would be threatened by the new legislation (AD Little, 2002 or Mercer, 2003). As we have seen at the beginning of this section, this fear still remains intact five years after the publication of the two aforementioned studies. Rather than analyzing exclusively the impact of REACH on exports, we will in the following take a broader approach by investigating the impact of REACH on the trade balance of the European Union. First, we observe that REACH might improve to a modest extent the competitiveness of European products against imports. Second, given the low registration costs for specialty and fine chemicals, we question the assumption whether fine and specialty chemicals will really face a significant disadvantage in foreign markets.

REACH as a potential trade barrier against imports

REACH does not only impact European companies but also companies from abroad intending to sell on the European market. Gurtoo and Antony (2007) review several studies on environmental regulations and derive the insight that environmental regulation can indirectly lead to so-called “green” trade barriers.

Nevertheless, the European Union imported € 80 billion of chemical goods in 2006 (Eurostat, 2007) and thus represents the main foreign market after the US for chemicals (US Census Bureau, 2007)¹⁰. For manufacturers of advanced but also high priced goods such as fine and specialty chemicals neglecting the European market because of the registration costs would be a costly option, especially for small Far East manufacturers that cannot fully rely on their local markets to support their growth.

Two scenarios are possible: either a company decides to leave the European market and thus makes Europe-based manufacturers better off than before, or it decides to register its products in Europe, together with its competitors and then contributes to reduce the registration burden that is already low (see above). In both cases, European firms will not lose competitiveness on imports.

¹⁰ category 325 – chemicals including pharmaceutical products

In addition, REACH has been strongly opposed by one of the main competitors of the European chemical industry, the American chemical industry. As Waxman (2004) develops, the American Chemistry Council used its influence on the US government and US federal agencies to organize orchestrated opposition to the European efforts to regulate the chemical industry. Bearing in mind the widespread opinion of the European chemical industry that REACH would negatively influence its competitiveness, the position of the ACC is surrounded by question marks. Why should it oppose a burden to its competitor? Especially if, as Ackerman et al. (2006) show, the costs of complying with REACH compared to the exports at stake are very low (one time \$ 1 compliance cost for \$ 100 sales per year) and considering the negative trade balance with respect to chemicals of the US against the EU (Figure 9). Given this, the opposition to REACH could have been caused by the fear of a spillover leading to stricter regulation of the chemical sector in the US as well rather than by its impact on US exports.

REACH as a burden for competitive exports?

On the short term, European companies exporting will have to align to the local prices to achieve their growth expectations. Given that the registration costs are low for each fine and specialty substance, the margin loss is not significant because most of the overseas competitors will face the same costs to have the right to export to Europe.

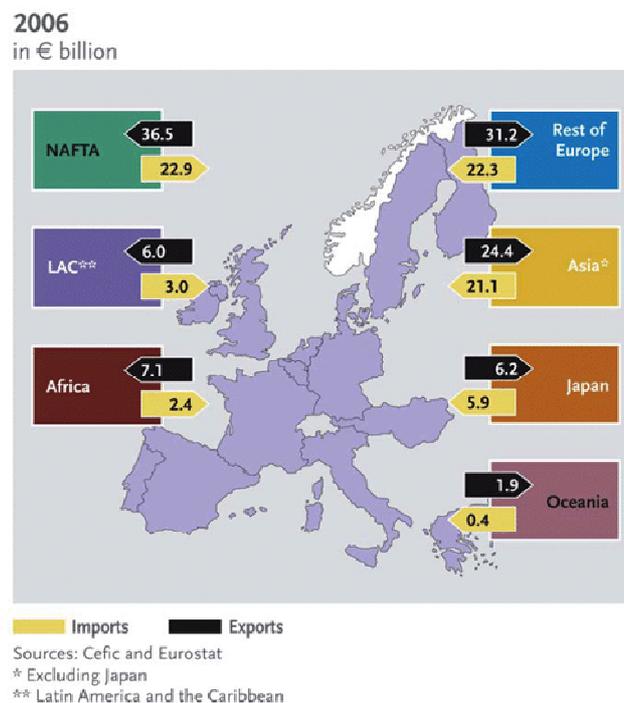


Figure 9: Europe trade flows 2006

Mirroring a common opinion in the chemical industry, Fleischer (2003) compares the Japanese, European and American legislation on chemicals to conclude that Europe faces tighter regulation with respect to new product introductions. This complaint is recurrent among chemical managers (INSEAD and Management Engineers, 2007). Interestingly, the tighter environmental legislations cannot explain why Europe achieved a trade surplus in fine and specialty chemicals of more than € 15.3 billion in 2006 (Eurostat, 2006) while the US and Japan show a trade deficit against Europe (Figure 9).

Apparently, legislation is not a main explanation of positive or negative trade balances in the chemical industry. Since Rothwell's (1980) complaint that environmental legislation is a burden for the industry, very little empirical evidence has been delivered to support this hypothesis. The European trade figures might even lead us to the opposite conclusion.

In fact, REACH might turn out to provide manufacturers falling under REACH a competitive edge in the case that other world regions would decide to adopt similar legislation. This diffusion process, also known as the "trading up" effect (Vogel, 1997) has been observed recently with the worldwide diffusion of the European WEEE (Waste Electrical and Electronic Equipment) and the RoHS (Restriction of Hazardous Substances) directives. Both legislations react upon the growing stream of "e-waste" and the resulting health hazards. WEEE regulates the recycling of electronic products, whereas RoHS restricts certain usages of some very hazardous substances, such as lead. Both have led to the implementation of similar legislation in other countries upon their adoption. In China, China-RoHS entered into force in March 2007, South Korea adopted Korea-RoHS on April 27th 2007. The adoption of the WEEE directive is observed in Asia as well as several US states. Figure 10 displays the progress of legislation similar to WEEE and RoHS throughout the world.

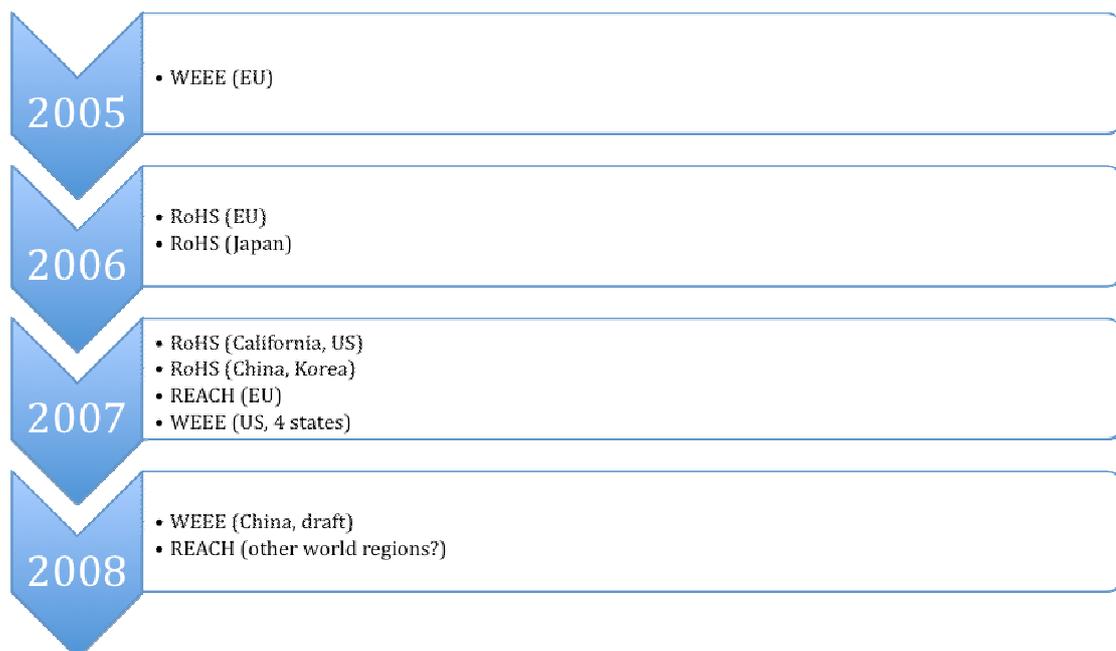


Figure 10: Diffusion of environmental regulation

We expect a similar diffusion process for REACH as companies outside the EU will have to be REACH-compliant in order to have access to one of their main markets. For instance, China revamped its rules on chemicals assessment even as the European Commission's second REACH proposal was published. First signs of the effect of REACH in the US can be seen in (Baldacci, 2007): The Governor of Maine, US, set up a task force to promote safer chemicals in consumer products, which takes note of REACH. Another study (Wilson et al., 2006) analyzing policy for green chemistry in California discusses REACH. Several experts agree that the introduction of REACH in Europe has had a major influence upon the discussion of legislation in the US, where an extended federal Chemicals Management and Assessment Program (CHAMP) has just been introduced. REACH-compliant companies will be able to reuse their registration documentation for regimes in other countries as well. Given the limited registration and testing costs as well as the expected adoption of REACH-like legislation in other world regions, REACH should not create a significant competitive disadvantage on exports either.

Another emerging trend is that those European companies that are well prepared for REACH, e.g. Ciba and BASF create new commercial opportunities through the creation of 'expert services' selling their knowledge and know-how to others, including non-European firms. Charging other firms for access to toxicological data they possess through REACH registration consortia and other such groups is regarded also by some as an opportunity to offset the costs of REACH at the very minimum. Chemical trade associations in several EU countries have also set up commercial service providers – REACHReady, REACHCentrum - to reap dividends from the expertise gained through lobbying and participation in technical guidance development processes.

As companies recognise the business impacts of REACH, some are also realigning their corporate structures and supply chains to minimise risks, sometimes through 'localisation' to Europe and tougher supply contracts – activities that are thought likely to make them more competitive and stable in the long run.

Indeed, in contrast to the pessimistic perspective of the CEOs in our survey, European chemical industry opinion leaders feel that REACH could provide a "once in a lifetime opportunity" to rebuild public confidence in its products and so enhance sales. François Cornélis, CEFIC president concluded in his keynote address to the AGM in October 2007 that the reputation of the chemical industry will largely depend on the success of REACH implementation. (CEFIC, 2007)

5. Conclusion and outlook

This paper provides an overview of the studies assessing the financial impact of REACH on the European chemical industry. Although the studies show a similar level of direct costs (registration and testing), indirect costs have been varying from several hundred million to more than a hundred billion Euros. As seen from the analysis, these indirect costs were based on given assumptions such as REACH preempting innovation or REACH reducing Europe's competitiveness in global markets. We have shown in the second part of this article that most of the allegations against REACH (which led, in some studies to extremely high indirect cost estimations) do not resist serious scrutiny.

It is interesting to note that, despite the numerous impact studies on REACH, two of them (Mercer Management Consulting 2003 and Arthur D Little 2002) have left the impression that REACH would do major harm to the European chemical industry and the European economy in general. Despite their documented methodological flaws, these studies have become a steady reference in the industry and their published figures are still in the minds of chemical executives.

As REACH has been adopted late 2006, chemical firms should now have a better understanding of their registration and indirect costs. Future research work should empirically validate the true costs of REACH in practice and close the discussion around the impact of REACH. In a second step, we intend to analyze empirically which factors from environmental legislation, education and demography are the main drivers influencing chemical innovation and competitiveness.

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