



The True Costs of REACH

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Preface

This is an assessment of the economic impact of the proposed new chemicals legislation in the European Community, the Registration, evaluation and authorization of chemicals (the REACH proposal).

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Executive Summary

REACH, the European Union's proposed chemicals policy, is the subject of ongoing controversy -- focusing in particular on its potential costs. This study provides a bottom-up recalculation of the expected costs of the current (October 2003) version of REACH, estimating an 11-year total direct cost of €3.5 billion. A proposed variant, "REACH Plus," would restore some features of a previous version of REACH, while increasing the total direct cost only to €4.0 billion. The annual cost is around 0.06% of the chemical industry's sales revenue. Two standard economic models imply that total (direct plus indirect) costs should be no more than 1.5 – 2.3 times the direct costs. Economic analysis confirms that costs of this magnitude are unlikely to harm European industry, while several studies have suggested that the health and environmental benefits of REACH will be substantial.

I. Regulatory Scenarios

REACH should not be compared to a hypothetical, fully deregulated economy; no such alternative has existed, or will exist, in Europe. The relevant comparison is between REACH and the baseline of conditions and regulations existing in the EU today.

Current regulations distinguish between "existing" substances – ones on the market as of 1981 – and "new" substances that have been introduced more recently. New chemicals substances already face rigorous testing requirements, comparable to or greater than those called for by REACH. Existing substances, which account for almost all of the tonnage of chemicals used in Europe, face looser requirements, but are still subject to a range of EC demands. EC rules call for testing of existing substances, but that testing is occurring at an extremely slow pace. Hundreds, if not thousands, of years would be required to complete the testing of existing substances at the current rate.

REACH eliminates the distinction between new and existing substances, applying the same standards to all chemicals produced or imported in quantities above one tonne. Producers or importers are required to register all chemical substances and provide the results of tests of their safety. For high-volume new substances, REACH offers similar requirements to those under existing regulations. Since it was first proposed, REACH has been modified to make it less burdensome for industry; as a result, it now requires *less* testing than current regulations for low-volume (under 10 tonnes per year) new substances. However, the important category of high-volume existing substances faces increased requirements, as REACH sets up an 11-year schedule for completing the testing of all chemical substances on the market. In effect, REACH sets a time line for the completion of the testing agenda that is already called for by existing regulations.

REACH Plus is an alternative introduced in this report, restoring several features of a previous REACH proposal. Our REACH Plus scenario goes beyond the current version of REACH by adding testing requirements for new and existing substances used in quantities of 1-10 tonnes per year, calling for Chemical Safety Reports to be completed on all substances, and strengthening the testing and regulation of substances that are intermediates.

II. Direct Costs of REACH and REACH Plus

The direct cost of REACH consists of the costs imposed on industry for testing and registration. These costs can be calculated from the number of chemical substances, multiplied by the cost to test and register a single substance (differentiated by volume). The 11-year total direct cost of REACH is about €3.5 billion, while the cost of REACH Plus is €4.0 billion. The annual cost is just below 0.06% of chemical industry sales for REACH, or just above that level for REACH Plus. Although these percentages are quite low, our estimate for the cost of REACH is somewhat higher than the European Commission's latest estimate of €2.3 billion.

III. Indirect Costs of REACH and REACH Plus

Several standard, simplified economic models can be used to estimate the indirect cost impacts of REACH. A study for DG Enterprise analyzed indirect costs using a model of monopolistic competition. This model assumes that the chemical industry consists of numerous identical-sized firms, each selling a single product; the firms' products are close but not perfect substitutes for each other. Using this model, the total economic impact of REACH, including losses both to downstream users and to the chemical industry, is no more than 2.3 times the direct costs of registration and testing.

Another standard model, applied here, assumes that every firm in the chemical industry is selling the same product in a single, competitive market. This model implies that there will be a small price increase, and a small decrease in sales, as a result of REACH or REACH Plus. The overall loss of revenues to industry is projected to be 1.5 times the direct cost of REACH. The losses of consumer surplus and producer surplus, measures often used by economists to evaluate regulatory impacts, are of insignificant size relative to the industry. The costs passed on to downstream users will likewise be insignificant relative to the size of those firms.

Price changes of the same magnitude as the costs of REACH are commonplace in industry, and do not prevent profitable operation. The spot price of crude oil varies by a greater percentage in almost every week, while the EU-15 price index for all intermediate manufactured goods varies by a greater percentage in almost every month.

IV. Other Economic Impacts

Cost estimates by government agencies and NGOs generally find that the total direct and indirect costs of REACH will be no more than 2-6 times the direct costs of testing and registration. On the other hand, the widely cited "Storm" scenario in Arthur D. Little's original study for BDI, the German industry federation, implies that total costs are 650 times the direct costs. This is an implausible result, based on numerous errors and exaggerations (see Appendix 3 for a detailed critique of the Arthur D. Little model).

Some of the principal arguments about the economic impacts of REACH include:

Will REACH result in the loss of a chemical that is essential to the production and profits of downstream users? If the chemical industry stops selling a chemical that is essential to downstream users because it is not worth paying the costs of testing and registra-

tion under REACH, then the chemical is underpriced. If it is valuable to downstream users and there are no viable substitutes, it will be profitable for the users to pay a little more for the chemical -- which in turn will make it profitable for the chemical industry to continue production of the chemical. If the downstream users, or their customers, cannot afford to pay the very small cost increases due to REACH, then the chemical in question cannot be of great economic value to the downstream users or their customers.

On the other hand, a chemical that is essential to its users might be restricted or removed from the market because it is found to be hazardous. The provisions in REACH for the authorization or restriction of hazardous substances already contain explicit safeguards against economic harms to downstream users; in such cases, health and environmental risks are to be weighed against socioeconomic impacts.

Will REACH increase costs through multiple registrations and duplicative testing requirements? Business-oriented studies have exaggerated the likelihood of this problem; in fact, REACH is designed to encourage the formation of consortia and to make maximum use of available testing data.

Will REACH force disclosure of confidential business information? Fears of disclosure of confidential business information are overstated; REACH contains strong protection against such disclosures. In the United States, some state legislation already has more extensive public reporting requirements than REACH.

Will REACH delay new products coming to market? Innovation involving new chemical substances will not be delayed. Since regulatory requirements will be eased on small-volume new substances, REACH or REACH Plus should, if anything, accelerate their introduction, boosting innovation and improving the competitive position of European producers. There could be a modest delay in innovations involving new uses of existing substances; REACH or REACH Plus will create incentives to use those substances that can most quickly be tested. There will be a corresponding incentive to accelerate the development of safer alternatives, and a benefit in the future from avoiding the costs and liabilities associated with innovations that later prove to be hazardous.

Will any new regulatory costs be an unbearable burden due to worsening macroeconomic and foreign trade conditions? This argument flies in the face of recent experience; the chemical industry has been growing faster than the European economy as a whole, enjoying a large and rising trade surplus. If economic conditions do worsen for European industry, they must be met by appropriate macroeconomic and trade policies; no amount of environmental deregulation will do the job.

V. Benefits of REACH

REACH will have low, but not zero, costs. These costs will be incurred in order to achieve health benefits and environmental benefits, by identifying and controlling the use of hazardous chemicals. Several estimates of the monetary value of the benefits of REACH are much greater than the costs. In its latest impact assessment, the European Commission found that the total benefits over the next 30 years are worth at least €50 billion, far in excess of any credible estimate of the costs of REACH.

REACH will also help downstream users by increasing the incentives for the development of safer products and processes, and making more information available about the characteristics of chemicals in use. Under REACH, manufacturers and importers will

take greater responsibility for providing safe chemicals; early action on environmental hazards will lighten the burden on downstream users and create substantial savings in areas including worker safety, waste disposal, remediation, and liability claims.

Ultimately, REACH will provide the long-term benefit of helping to create sustainable industry and a healthy environment in Europe. As other parts of the world move to adopt similar standards in the future, European industry will gain the competitive advantage that comes from being the first to move toward cleaner and safer production and use of chemicals

Sammanfattning

REACH, den europeiska unionens förslag till ny kemikalielagstiftning, är ett omdebatterat ämne inte minst när det gäller vilka kostnader förslaget kan föra med sig. Denna analys omvärderar förväntade kostnader för det aktuella REACH-förslaget (från oktober 2003) och kommer fram till att de direkta kostnaderna blir 3,5 miljarder Euro under de första elva åren. Förslaget "REACH +", återinför några inslag från ett tidigare förslag och då ökar de sammanlagda direkta kostnaderna till 4 miljarder Euro. Den årliga kostnaden är omkring 0,06 procent av kemiindustrins totala försäljningsintäkter. Två ekonomiska standardmodeller visar att totalkostnaden (direkta och indirekta kostnader) inte bör bli mer än 1,5 - 2,3 gånger större än dessa direkta kostnader. Ekonomisk analys visar hur osannolikt det är att kostnader av denna omfattning skulle kunna skada europeisk industri. Samtidigt visar andra undersökningar att fördelarna med REACH blir betydande för människors hälsa och för miljön.

I. Regelscenarier

REACH bör inte jämföras med en hypotetisk, fullt avreglerad ekonomi. En sådan ekonomi har aldrig funnits och kommer heller aldrig att finnas i Europa. En relevant jämförelse är den mellan REACH och de förutsättningar och regler som redan gäller inom EU idag.

Nuvarande regler skiljer mellan "existerande" ämnen - sådana som fanns på marknaden 1981 - och "nya" ämnen som släppts på marknaden sedan dess. Nya ämnen omfattas redan av hårda testkrav, jämförbara med eller högre än dem som skulle införas med REACH. För existerande ämnen, som svarar för nästan hela kemikaliehanteringen i Europa, gäller mindre stränga krav men de är ändå också idag föremål för en hel rad EG bestämmelser. EG:s lagstiftning kräver testning av högvolymämnena men den väsentligaste delen av denna testning fullföljs i ytterst långsamt tempo. I nuvarande takt skulle det behövas hundratals år, om inte tusentals år, att slutföra testningen.

REACH tar bort distinktionen mellan nya och existerande ämnen. Det ställs samma krav när ämnena tillverkas eller importeras i mängder över ett ton. Tillverkare eller importörer måste registrera alla ämnen och lämna in testresultat som visar hur säkra ämnena kan anses vara. För nya ämnen med hög volym, ställer REACH liknande krav som dagens lagstiftning. Sedan REACH första gången presenterades, har förslaget ändrats för att avlasta industrin. Resultatet är att REACH för nya ämnen med låg volym (n (mindre än 10 ton per år)) ställer lägre krav än dagens lagstiftning. För den viktiga gruppen existerande högvolymämnena ställs däremot ökade krav. REACH sätter upp ett 11-årigt tidsschema för att fullfölja testningen av alla kemikalier på marknaden. I praktiken betyder det att REACH sätter en tidsgräns för att fullfölja den testning som fordrades redan för att klara krav i nuvarande kemikalielagstiftning.

REACH + är ett alternativ som presenteras i denna analys och som återinför flera punkter från ett tidigare REACH-förslag. REACH + scenariet går längre än nuvarande version av REACH genom att lägga till testkrav för nya och existerande kemikalier som

används i kvantiteter mellan 1-10 ton per år, krav att ta fram säkerhetsrapporter för alla kemikalier och högre krav på testning av intermediärer.

II. Direkta kostnader för REACH och REACH +

Den direkta kostnaden för REACH består av industrins kostnader för testning och registrering. Dessa kostnader kan beräknas utifrån antalet kemiska ämnen, multiplicerat med vad det kostar att testa och registrera ett enskilt ämne (med de krav som ställs beroende av ämnets volym). De sammanlagda direkta kostnaderna för REACH under de elva första åren blir då 3,5 miljarder Euro (32 miljarder svenska kronor) och kostnaden för REACH + blir 4 miljarder Euro (36 miljarder). Den årliga kostnaden för REACH hamnar strax under 0,06 procent av den kemiska industrins försäljningsintäkter. För REACH + kommer kostnaden att ligga strax över samma nivå. Fastän procenttalen inte alls är höga, hamnar ändå vår uppskattning av kostnaden något högre än vad Europeiska kommissionen kom fram till i sin senaste bedömning när den fann att kostnaden är €2,3 miljarder.

III. Indirekta kostnader för REACH and REACH +

Flera förenklade ekonomiska standardmodeller kan användas för att uppskatta indirekta kostnadseffekter av REACH. I en studie utförd för EG kommissionen (DG Industri) analyserades indirekta kostnader med hjälp av en modell som förutsätter monopolistisk konkurrens. I denna modell består den kemiska industrin av ett flertal lika stora företag som vart och ett säljer en enda produkt. Deras produkter är snarlika varandra men inte fullt utbytbara mot varandra. Enligt denna modell stannar den totala ekonomiska kostnaden för REACH på en nivå som ligger 2,3 gånger högre än de direkta kostnaderna för registrering och testning. Till den totala kostnaden har då lagts beräknade förluster för såväl nedströms användare som för den kemiska industrin.

En annan standardmodell är den som används i vår studie. Här är antagandet att varje företag säljer samma produkt på en gemensam och konkurrensutsatt marknad. Modellen för med sig små prisökningar och små försäljningsnedgångar som följer av såväl REACH som REACH+. Vad industrin totalt förlorar i intäkter hamnar då 1,5 gånger över de direkta kostnaderna för REACH.

Konsumentöverskottet, fördyringen av konsumentpriser jämfört med vad konsumenten kan anses beredd att betala och producentöverskottet, kostnadsökningen jämförd med det pris tillverkaren kan ta ut, är mått som ekonomer ofta använder när de bedömer effekter av lagstiftning. Minskningen av dessa överskott blir av obetydlig betydelse för industrin. De kostnader som kommer att övervältras på nedströms användare blir också obetydliga sett till företagens storlek.

Prisförändringar av motsvarande storlek som kostnaderna för REACH hör till vardagen inom industrin och lägger inte några hinder för fortsatt lönsam verksamhet. Förändringarna i priset på råolja på spotmarknaden brukar bli större än så nästan varje vecka. Prisindex för industriella insatsvaror (som produceras av ett företag och används av ett annat) inom EU-15 gruppen visar större förändringar än dessa så gott som varje månad.

IV. Andra ekonomiska effekter

De flesta kostnadsberäkningar som görs av nationella myndigheter och NGOs visar hur totala direkta och indirekta kostnaderna för REACH stannar på en nivå som ligger 2-6 gånger över de direkta kostnaderna för testning och registrering. Samtidigt säger det så kallade "Storm"-scenariot i Arthur D. Littles första och så ofta citerade studie för den tyska industrins räkning (BDI), att totala kostnader blir 650 gånger större än de direkta. Detta osannolika resultat bygger på en rad misstag och överdrifter (se Appendix 3 för en kritisk genomgång av Arthur D. Littles modell).

De främsta invändningarna mot de ekonomiska följderna av REACH reser följande frågor:

Innebär REACH att nedströms användare inte längre får tillgång till sådana kemikalier som fordras för att verksamheten ska kunna fortsätta och vara lönsam? Om den kemiska industrin på grund av REACHs test- och registreringskostnader skulle upphöra att leverera oundgängliga kemikalier till nedströms användare så är priset på dessa kemikalier för lågt satt. Om en kemikalie är värdefull för nedströmsanvändaren och det skulle saknas konkurrenskraftiga alternativ, blir det fortsatt fördelaktigt för användaren att betala det högre pris som tillåter tillverkaren att fortsätta sin produktion. Och om varken nedströms användare eller deras kunder skulle klara att bära de smärre kostnadsökningar som följer i spåren av REACH kan kemikalien i fråga knappast ha något större ekonomiskt värde för dem.

Däremot kan kemikalier av väsentlig betydelse för användarna komma att bedömas som så farliga att de inte längre blir tillgängliga på marknaden eller får användas endast inom vissa specifika användningsområden. REACHs regler om tillståndskrav och begränsning av farliga ämnen innehåller redan ett uttryckligt skydd för nedströms användare mot ekonomisk skada och i sådana fall ska hälso- och miljöriskerna måste vägas mot de socioekonomiska följderna.

Kommer REACH att öka kostnaderna genom parallella registreringar och upprepade tester? Näringslivsinriktade studier överdriver sannolikheten att detta problem skulle uppstå. REACH är i själva verket utformat så att det uppmuntrar företag att samarbeta i konsortier och använda tillgängliga testdata på bästa sätt.

Kommer REACH att tvinga företag att lämna uppgifter som borde få förbli konfidentiella? Farhågorna för avslöjande av konfidentiell företagsinformation är överdrivna. REACH innehåller redan ett starkt skydd mot utlämnande av sådana uppgifter. Vissa delstater i USA har redan idag mer långtgående krav på uppgiftslämnande än kraven i REACH.

Kommer REACH att försena marknadsföringen av nya produkter? Innovationer som bygger på användningen av nya ämnen kommer inte att försenas. Eftersom kraven sänks för lågvolumkemikalier, bör snarare både REACH och REACH + påskynda lanseringen av nya ämnen och förstärka den europeiska tillverkningsindustrins konkurrenskraft. Det kan dock bli smärre förseningar i utvecklingen av nya användningar av existerande kemikalier; REACH och REACH + kommer att gynna användningen av de ämnen som kan testas snabbast. Det kommer att finnas en motsvarande drivkraft att snabba på utvecklingen av säkrare alternativ. Därtill finns vinster att göra framöver, genom att undvika skadeståndsansvar och kostnader som föranleds av innovationer som senare visar sig vara farliga.

Kan försämringar av det ekonomiska läget i stort eller förutsättningarna för utlandshandeln göra att de nya kostnaderna blir en för tung börda att bära? Detta argument strider mot aktuella erfarenheter. Den kemiska industrin har vuxit snabbare än den europeiska ekonomin som helhet och har gynnats av ett stort och stigande handelsöverskott. Om de ekonomiska förutsättningarna för europeisk industri försämras måste det mötas med erforderliga ekonomiska styrmedel och handelspolitiska åtgärder, hur mycket miljökraven än sänks skulle det inte räcka.

V. Fördelarna med REACH

Kostnaderna för REACH kommer att vara låga, men inte obefintliga. Dessa kostnader för att identifiera farliga ämnen och kontrollera användningen, tjänar till att förbättra människors hälsa och skydda miljön. Det har gjorts flera uppskattningar som visar hur de ekonomiska fördelarna med REACH avsevärt överstiger kostnaderna. Europeiska kommissionen fann i sin senaste konsekvensbedömning att de sammantagna fördelarna under den närmaste 30-årsperioden kan värderas till minst €50 miljarder. Det är långt mycket mer än vad trovärdiga uppskattningar säger att REACH någonsin kommer att kosta.

REACH kommer också att hjälpa nedströms användare så att de får bättre förutsättningar att utveckla säkrare produkter och processer och får mer information om egenskaperna hos de kemikalier som de använder. Med REACH kommer tillverkare och importörer att ta ett större ansvar för att tillhandahålla säkra kemikalier. Tidiga åtgärder mot miljöriskerna kommer att underlätta för nedströmsanvändare och kunna leda till betydande besparingar inom områden som arbetsmiljö, hantering av avfall, sanering och skadeståndskrav.

I förlängningen kan REACH bidra till en bärkraftig industri och en hälsosam miljö i Europa. När omvärlden i framtiden börjar införa liknande krav kan europeisk industri skörda konkurrensfördelarna av att ligga först i utvecklingen mot en renare och säkrare produktion och användning av kemikalier.

1 Introduction

REACH, the European Union's proposed new chemicals policy, is an important new development in environmental protection. Rather than waiting for government or independent researchers to determine that chemicals are hazardous, REACH will make manufacturers, importers, and professional users responsible for providing evidence that chemicals are being used safely.

There is little doubt that REACH will produce health and environmental benefits, but there has been little agreement about the resulting costs. Will European manufacturers be crushed by the economic burden of chemicals regulation, as some industry sources have suggested? Or, as projected in some public sector studies, will there be only a minor cost impact, well within the ability of industry to absorb, and well worth the price? The controversy over the estimation of these costs, and their expected impact on one of Europe's largest and most important industries, has continued since the first proposal for REACH appeared in 2001.

This report, commissioned by the Nordic Council of Ministers, offers a new look at the costs of REACH. It begins in Section 2 with a comparison of existing EC chemical regulations, the current REACH proposal, and a somewhat stronger alternative proposal. The report then offers a bottom-up calculation of the expected registration and testing costs in Section 3, a new analysis of the indirect economic impacts of REACH in Section 4, an evaluation of some prominent arguments about the costs of REACH in Section 5, and a brief discussion of the expected benefits of REACH in Section 6. The appendices provide more detail on our registration and testing cost calculations, the formal derivation of our economic impacts analysis, and a detailed critique of the model and methodology employed in the best-known industry study of the costs of REACH.

2 Regulatory Scenarios

REACH is not being proposed in a regulatory vacuum. Europe already has an extensive system of chemical regulations; REACH will replace many regulations that are currently in force. The costs attributable to REACH, therefore, consist of the *increase* in regulatory costs when REACH takes effect, not the total costs of all European regulations related to chemicals. In this section, we compare the baseline of regulations currently in force, the October 2003 draft of REACH, and a new "REACH Plus" proposal, which would strengthen some key regulatory provisions.

2.1 Baseline of current regulations

Current EC rules distinguish between “existing” chemical substances – ones on the market as of September 1981 – and “new” substances that have been introduced more recently. At present, new substances face much more rigorous testing requirements than existing substances. REACH primarily changes the rules for existing substances; it is comparable to the status quo for high-volume new substances, and actually eases requirements on low-volume new substances.

New chemical substances

Under the current regime, industry must submit a dossier on each new substance, as defined in the Dangerous Substances Directive (67/548/EEC) and its amendments, particularly the 1992 amendment (92/32/EEC). The dossier includes information on basic chemical and physical properties, the results of tests for toxicity and ecotoxicity, proposals for classification and labeling, and a risk analysis.

Testing requirements begin at a threshold volume of 10 kilograms per year, and become more stringent for successive volume tiers. For example, looking just at toxicity testing, new substances produced at 10-100 kg per year are subject to acute toxicity testing, while substances produced at 100 kg to 1 tonne are also subject to eye and skin irritation, skin sensitization, and mutagenicity. The 1-10 tonne volume tier is subject to additional acute toxicity, additional mutagenicity, and repeated dose toxicity testing, as well as a range of ecotoxicological tests. Chemical substances produced in volumes above 10 tonnes are subject to even more extensive testing.

More than 6000 notifications of new chemical substances have been submitted since 1981, covering 3700 distinct substances.¹ Risk assessments have been required as part of notifications submitted since the 1992 amendment to the Dangerous Substances Directive. In that period, more than 1000 risk assessments have been submitted and accepted. Each risk assessment comes to one of four conclusions: the substance is of no

¹ European Chemicals Bureau web site, <http://ecb.jrc.it/new-chemicals/>, viewed August 2004

immediate concern; the substance is of concern and more data will be required when the next tonnage threshold is reached; more data are required immediately; or recommendations for risk reduction are required immediately.

Even when risk reduction measures are required, the measures range from classification and labeling changes in some cases, through voluntary agreements to withdraw a chemical from the market in other cases.²

New chemical substances are also subject to a number of regulations that apply to existing substances as well, as described below.

Existing chemical substances

While the regulations for new substances apply a high standard of testing for adverse effects on human health or the environment, these regulations cover only a tiny fraction of the total tonnage of chemicals produced each year. The vast majority -- up to 99% by volume -- of chemicals currently on the market fall into the category of "existing substances," those that were already in use before September 1981. Existing substances have been subject to much lower levels of testing, if any.

Council Regulation 973/93/EEC on the evaluation and control of the risks of existing substances (the "Existing Substances Regulation"), passed in 1993, establishes a four-step process for management of existing substances: data collection, priority setting, risk assessment, and risk management. This process is formally parallel to the treatment of new substances, but in practice there are no deadlines, and the stages beyond data collection have moved at a glacial pace for existing substances. In the data collection stage, companies are required to report production quantities, classification and labeling information, reasonably foreseeable uses for chemical substances produced or imported in quantities greater than 10 tonnes per year, and toxicological information on those produced or imported in quantities greater than 1000 tonnes per year.

In the next stage, chemical substances are prioritized for testing. Yet as of 2003, only 141 substances had been identified as priorities; they are included in four lists, based on high production, dispersive use, high toxicity, and lack of information on effects.³ The subsequent stages, the risk assessment and risk management measures called for in the Existing Substances Regulation, have moved at a pace that would require centuries, if not millennia, to reach all chemical substances.

² See <http://ecb.jrc.it/new-chemicals/>

³ Ken Geiser and Joel Tickner, "New Directions in European Chemicals Policies: Drivers, Scope and Status", Lowell Center for Sustainable Production, University of Massachusetts-Lowell, October 2003, p.70

Rules for new and existing substances

A range of other regulations affect both existing and new substances.

In addition to its requirements for new substances, Council Directive 67/548/EEC on dangerous substances (the “Dangerous Substances Directive”) and its amendments create classification and labeling requirements for both existing and new chemical substances. Companies are responsible for assessing whether a chemical substance is “dangerous” under the definitions established in the Directive.

Current EC legislation classifies dangerous chemicals into several categories including: very toxic, toxic, corrosive, harmful, irritant, sensitizing, carcinogenic, mutagenic, toxic to reproduction, dangerous to the environment, explosive, extremely flammable, highly flammable, or oxidizing. Chemicals in any of these categories must be labeled as such. To date the European Commission Working Group on Classification and Labelling of Dangerous Substances has decided on harmonized classifications for about 7000 individual substances.⁴ When a chemical substance or preparation has been classified as dangerous, manufacturers, importers, and distributors are responsible for providing a safety data sheet to professional users of the chemical. Upon request, they must also provide a safety data sheet for a non-classified preparation that contains a specified amount of either a substance posing health or environmental hazards, or a substance for which there are workplace exposure limits.⁵

Parliament and Council Directive 1999/45/EEC on dangerous preparations (the “Dangerous Preparations Directive”) applies to mixtures of two or more substances where one has been classified as dangerous. Like the Dangerous Substances Directive, it establishes rules for classification, packaging, and labeling.

Council Directive 76/769/EEC (the “Limitations Directive”) and subsequent amendments sets up a system for harmonizing restrictions on the marketing and use of hazardous chemicals. Depending on the type and severity of the hazard posed by a given substance, a chemical included in the Annex to the Limitations Directive may either be banned with exemptions, or designated for controlled use only. The Directive includes particularly important provisions related to substances and preparations available to consumers or included in consumer products. A 1994 amendment to the Directive prohibits the sale to the general public of chemical products if they contain substances that are known or probable carcinogens, mutagens, or reproductive toxicants (CMRs).⁶

Other important rules are contained not the least in the following directives:⁷

⁴ Sven Ove Hansson and Christina Ruden, *Better Chemicals Control Within Reach* (Stockholm US-AB Universitetsservice, 2004): 17-19

⁵ Downstream Consequences on other Community Legislation arising from the Classification and Labelling of Dangerous Substances under Directive 67/548/EEC,” ECBI/31/99 Rev. 5, November 1993, available at <http://ecb.jrc.it/classification-labelling/>, viewed August 2004.

⁶ Geiser and Tickner 2003: 72-75

⁷ All direct quotations in this legislative summary are drawn from Geiser and Tickner 2003

- The **Carcinogens at Work** directive (90/394/EEC) requires governments to assess workers' exposure to carcinogens, and requires employers to give governments the information necessary for such assessments. Employers are also obligated to minimize use of carcinogens and seek safer alternatives, and to keep manufacture and use of carcinogens within a closed system to the greatest extent possible. Employers must keep records on workers' exposures and health profiles for at least 40 years from the end of exposure.
- The **Chemical Agents at Work** directive (98/24/EC) requires employers to assess risks to workers' health. It sets forth a hierarchy of measures to minimize exposure, starting with substitution as the preferred option, and ranging down to use of personal protective equipment as a last resort. It allows total prohibition of some substances.
- The **Water Framework Directive** (2000/60/EC) protects water as well as sediment and biota. Under this directive, the European Commission is directed to establish a list of "priority substances" and a subset list of "priority hazardous substances." For each priority substance, the Commission is to propose EU-wide standards for emissions. For priority hazardous substances, the Commission is supposed to set up a plan for ending "discharges, emissions, and losses" within 20 years.
- The **Cosmetic Products Directive** (76/768/EEC of 1976, amended in 2003) "sets forward a general condition that cosmetic products may not be hazardous to health under normal and foreseeable use and that industry must ensure this." An important amendment to this Directive states that CMRs should be prohibited for use in cosmetic products.
- The directives on **Waste from Electrical and Electronic Products (WEEE)** (2002/96/EC and 2003/108/EC) and **Restrictions on Hazardous Substances (RoHS)** (2002/95/EC) address toxic substances in electrical and electronic products. Under WEEE, producers are required to begin taking back electrical and electronic products at the end of their useful life. Under RoHS, certain priority toxic substances are banned for use in electrical and electronic equipment.
- The **Biocides Directive** (98/8/EEC) provides a framework for authorization of biocides, listing of approved active ingredients, and listing of "low risk" products. It places restrictions on the use of biocides containing known or probable CMRs. In addition, approval can be denied for ingredients that present a health or environmental hazard or for which a significantly safer alternative is available. Similar provisions apply for pesticides used in agriculture, under Directive 91/414 on Plant Protection Products.

Thus, in order to control the risks of chemicals handling, the European Community has already made "existing" substances subject to extensive regulatory demands.

To summarize the baseline of existing regulations, the requirements for new chemical substances are, in fact, quite precautionary. However, the "existing" substances that

happen to have been on the market before 1981, accounting for the vast majority of chemical use, are subject to a patchwork of reactive measures, designed primarily to respond once a problem has been identified. Under this approach, enormous damage can occur before any regulatory action takes place.⁸

2.2 REACH

REACH eliminates the distinction between new and existing chemical substances, subjecting all substances to the same standards. The proposed legislation includes three main components: registration, evaluation, and authorization.

In the registration phase, manufacturers and importers must compile a dossier of information on each substance produced at or above 1 tonne per year. Among other things, this dossier will include information derived from the specific testing protocols that are defined for each volume tier.

Once the basic data have been provided on a chemical substance, an individual member state will be designated to carry out a so-called “dossier evaluation” of substances produced at high volumes, as well as those that have intrinsic properties of concern, such as persistence, mutagenicity, or high toxicity. In the evaluation stage, decisions can be made about whether to require further testing. Substances that appear to require further attention may be subject to a deeper analysis, referred to as a substance evaluation. Following this, a member state may put forward a proposal for marketing and use restrictions.

Under the authorization provision of REACH, firms must request authorization before selling or using substances of very high concern, such as substances known to be carcinogenic, mutagenic, or reproductive toxicants, persistent bioaccumulative toxins or very persistent / very bioaccumulative substances (PBTs or vPvBs). Chemical substances subject to authorization will be listed in Annex XIII of REACH. In order to receive authorization for a given use of such a substance, firms must show that the use is safe or that no practical alternative is available.

REACH was not motivated by a desire to change the regulation of new substances. A previous version of REACH proposed roughly the same level of testing for *all* chemical substances as is currently required for new substances. Subsequent compromises, incorporated in the October 2003 version have reduced the requirements for low-volume substances. The REACH Plus proposal, introduced below, would roughly restore the

⁸ The huge monetary costs of a reactive, rather than proactive, approach to regulating environmental and human health hazards are documented in the retrospective overview commissioned by the European Environment Agency: Paul Harremoes et al., *The Precautionary Principle in the Twentieth Century: Late Lessons from Early Warnings* (London: Earthscan Publications, 2002).

current level of testing requirements for new substances in the 1-10 tonne volume tier, while making no change to REACH on substances below 1 tonne per year.

This has important implications for the analysis of costs: both REACH and REACH Plus would reduce costs for new substances. We have not attempted to incorporate the cost savings on new substances into our calculations; in that regard, our cost estimate for REACH is an overestimate. Likewise, there are implications for innovation involving new chemicals: both REACH and REACH Plus would reduce the regulatory burden on low-volume new substances.

In contrast to the treatment of new substances, existing substances will face stiffer requirements, as REACH sets up an 11-year schedule for completing the testing of all chemical substances on the market.

Different, and far less strict, rules apply to intermediates, the chemical substances created in production processes but not intended for final sale. There is more uncertainty and less hard data about the numbers and categories of intermediates than in the case of new or existing substances. For regulatory purposes, intermediates are classified by whether they are ever isolated (vs. only existing in chemical mixtures in reactions), and whether they are transported to another site (vs. only used on-site where they are created). Under REACH, transported intermediates must be tested only when they are produced in the top volume tier, above 1000 tonnes/year; but they are only required to comply with Annex V, the list of tests required for substances in the 1-10 volume tier. All other intermediates are exempt. In other words, transported intermediates are to be tested only at the highest production volumes, and are subject only to the lowest tier of tests.

2.3 REACH Plus

The current REACH proposal, as described above, is significantly weaker than the baseline of current legislation for new chemical substances. In other words, REACH improves treatment of the 30,000 or so existing substances that are not currently subject to systematic testing; but it also creates gaps in the regulatory structure for new substances. According to some experts, the requirements under the current version of REACH will not even provide enough information for existing and new substances under 10 tonnes per year to be labeled correctly under the classification and labeling systems currently used in the European Union.⁹

In this context, we describe and analyze an enhanced “REACH Plus,” including three revisions to REACH that would strengthen protections for human health and the environment. Even with these revisions, the regulatory burden on industry would still be lower than it is at present for new substances.

⁹ See Hansson and Ruden 2004: 32.

Our REACH Plus scenario goes beyond REACH in the following respects:

- Testing requirements for substances used in quantities of 1-10 tonnes per year are increased to the level applied to the 10-100 tonne volume tier in the proposed REACH legislation. This means that in place of the minimal set of tests applied to the lowest volume tier under REACH, this large class of chemicals would be subjected to a somewhat more extensive testing regime.
- Chemical Safety Reports (CSRs) are required for all chemical substances produced in volumes above 1 tonne per year. This contrasts with the requirement under the proposed legislation, in which CSRs are required only for substances categorized as hazardous above 10 tonnes, and are not required at all in the 1-10 tonne volume tier. In general, a CSR demonstrates that a "chemical safety assessment" has been performed, and presents the results of that assessment. A chemical safety assessment includes a hazard assessment covering available physicochemical, human health and environmental data; an assessment of whether the substance is a persistent bioaccumulative toxin; an exposure assessment for the main uses of the chemical; and a risk characterization.¹⁰
- Testing and regulation of intermediates is expanded and strengthened. Under the proposed REACH legislation, the only requirement is that transported intermediates produced above 1000 tonnes/year are tested at the minimal level required for substances in the 1-10 volume tier (technically, at the Annex V level). Under REACH Plus, that category is subject to the REACH requirements for 10-100 tonne substances (Annexes V and VI), while transported intermediates in the 100-1000 tonne range and on-site intermediates produced above 1000 tonnes are subject to Annex V testing.

Many other proposals could be made; this is far from an exhaustive list of suggestions that have appeared in the debates over REACH. However, these three steps would be important moves in the direction of strengthening REACH, greatly improving testing of 1-10 tonne substances, making a useful form of information (CSRs) generally available, and expanding the testing of high-volume intermediates. As we will see in the next section, they can be added to REACH at quite moderate cost.

Our REACH Plus proposal is, in fact, similar in many respects to the May 2003 version of REACH, the so-called "Consultation Document". However, REACH Plus differs from the Consultation Document in several important provisions: in particular, REACH Plus exempts polymers, and substantially streamlines the requirements for CSRs. (In the

¹⁰ RPA, "Revised Business Impact Assessment for the Consultation Document: Working Paper 4: Assessment of the Business Impacts of New Regulations in the Chemicals Sector, Phase 2." Prepared for the European Commission Enterprise Directorate-General, October 2003. At <http://www.rpaltd.co.uk/tools/downloads/reports/reachrevisedbia.pdf>, viewed April 2004.

Consultation Document, some categories of polymers were subject to REACH, and many more CSRs were required).

3 Direct Costs of REACH and REACH Plus

Government agencies, independent consultants, and industry sources have developed estimates of the likely magnitude of direct costs resulting from REACH. We review these estimates briefly below, and then explain our own calculations. In each approach, there is broad agreement that the total estimated direct costs are a tiny fraction of annual sales revenues in the chemicals industry. As we will discuss in later sections, the large differences between government- and industry-sponsored studies of the total costs of REACH result not from their minor differences in estimates of direct costs, but rather from enormous differences in their analyses of indirect costs.

3.1 Existing estimates

Analyses of different versions of REACH have estimated direct costs ranging from €2 billion to €13 billion. One study, done by the consulting firm RPA and Statistics Sweden for the European Commission, estimated a direct cost of €3.7 billion for the original (2001) version of REACH.¹¹ Another estimate by the European chemical industry association, CEFIC, put the direct costs of the same version at €7 billion.¹²

More recently, RPA completed a revised Business Impact Assessment for the European Commission, estimating costs for the more demanding May 2003 draft of REACH (the Consultation Document). This study estimated total direct costs of almost €13 billion.¹³

The Commission's assessment of the October 2003 version of the regulation started with that estimate, and proceeded by subtracting cost savings expected to result from changes in the latest REACH proposal, resulting in an estimate of only €2.3 billion.

All such estimates are totals over the 11 year period for testing existing chemical substances. When converted to annual costs (i.e., divided by 11), they amount to very small fractions of the chemical industry's annual sales, which totaled €556 billion for the EU-25 in 2003.¹⁴

¹¹ RPA and Statistics Sweden, *Assessment of the Business Impact of New Regulations in the Chemicals Sector*. Prepared for the European Commission Enterprise Directorate-General, June 2002. Available at http://europa.eu.int/comm/enterprise/chemicals/chempol/bia/bia_report_06-2002.pdf, viewed April 2004.

¹² This is CEFIC's interpretation of an unspecified RPA study, as described in <http://www.cefic.org/Files/Publications/Barometer2002.pdf>, viewed August 2004.

¹³ This omits the study's estimates involving high numbers of polymers, since polymers are not regulated in the current REACH proposal. See RPA 2003.

¹⁴ CEFIC web site, <http://www.cefic.org/factsandfigures>, viewed August 2004.

3.2 Our calculations

Using information from a variety of sources, we have estimated the direct costs of REACH and REACH Plus from the bottom up, in the manner of earlier Commission analyses. Our estimates are somewhat higher than the Commission's latest figure for REACH -- about 50% higher for REACH, and about 70% higher for REACH Plus.

The direct costs of REACH consist of the costs imposed on industry for testing and registration. These costs can be estimated from the number of chemical substances, multiplied by the cost to test and register a single substance (differentiated by volume, and adjusted for other factors that affect costs per substance). In this section we develop cost estimates for REACH and REACH Plus based on individual test and registration cost figures. In the following two sections, we examine the implications of such costs for industry more broadly and for the European economy as a whole.

How many chemical substances are subject to REACH?

REACH will initiate systematic testing and registration of about 30,000 "existing" substances.¹⁵ There are at least two important adjustments to make to this raw figure:

- *Rationalization.* Some chemicals are likely to be withdrawn in the face of new regulatory requirements. These chemicals, as we discuss further in Section IV, will be withdrawn only if their usefulness is very limited, leading manufacturers and importers to decide it is not worth the cost of complying with the new testing and registration requirements. In addition, some manufacturers and importers may decrease production volumes in order to fall within a low volume tier. In an analysis of an earlier version of REACH (the Consultation Document, or May 2003 version), RPA estimated that 15% of the lowest volume substances, 10% of the 10-100 tonne volume tier, and 5% of the 100-1000 tonne volume tier would be withdrawn.
- *Repeat registrations and formation of consortia.* The adjustment for likely withdrawals is counterbalanced by an adjustment to reflect the likelihood of repeat registrations (in which several manufacturers or importers register a single product), and formation of consortia (in which manufacturers or importers collaborate to register a given product). According to RPA's estimates, the combination of these two effects is expected to produce a 6% to 12% increase in the total number of registrations.

For our calculations, we use the number of registrations estimated by RPA in its calculation of the costs of the Consultation Document version of REACH.¹⁶ These figures

¹⁵ In its 2001 White Paper that outlined the purpose and structure of REACH, the European Commission noted that there were about 2,700 new substances, but that "existing substances amount to more than 99% of the total volume of all substances on the market." The Commission noted further that "the number of existing substances reported in 1981 was 100,106, [and] the current number of existing substances marketed in volumes above 1 tonne is estimated at 30,000." About 140 existing substances "have been identified as priority substances and are subject to comprehensive risk assessment carried out by Member State authorities." See Commission of the European Communities, *Strategy for a Future Chemicals Policy* (White Paper), February 27, 2001 [COM(2001) 88 final].

include the adjustments for expected rationalizations, repeat registrations, and consortium formation. As shown in Table 3.1, there are over 18,000 expected registrations in the 1-10 tonne volume tier, with much smaller numbers in the higher volume tiers. In total, these add up to nearly 32,000 registrations; the total number of expected registrations is slightly larger than the number of existing substances due to repeat registrations.¹⁷ We draw the estimated number of downstream users affected from the same source. For the number of intermediates potentially affected by legislation, we use estimates that are similar but not identical to the figures in RPA’s final calculation.¹⁸

	<i>Volume Tier (tonnes/year)</i>			
	1-10	10-100	100-1000	> 1000
Substances: phase-in full registration	18,696	5,846	2,953	3,685
Substances: phase-in “less onerous”	0	0	61	653
Type 2 intermediates: on site	8,500	14,000	3,500	2,600
Type 3 intermediates: transported	5,000	2,300	1,500	1,700
Downstream Unintended Uses	1,520	1,661	3,302	3,021

Sources: Calculations described in Appendix 1, using data from RPA 2003.

The figures discussed above describe only those substances that are currently categorized as “existing,” i.e., those that have been on the market since before September 1981. We do not include those “new” substances that have come on the market since 1981, since they have already been tested to an equal or higher standard than that required under REACH.

In addition, the European Chemicals Bureau estimates that about 350 new substances come onto the market each year. For these substances, industry will experience a net

¹⁶ RPA 2003: 27, Table 3.8: “End Estimates of Numbers of Registrations, Total Unintended Uses and Chemicals Going Out of Production.”

¹⁷ Following RPA, we show the figures separately for phase-in full registration chemicals (i.e. existing chemicals for which a full registration process will be required) and phase-in “less onerous registration” chemicals (i.e. existing chemical substances that have already undergone some systematic testing, for example under the High Production Volume [HPV] program, or that are exempt from REACH).

¹⁸ We have drawn the number of type 2 and type 3 intermediates from RPA 2003: 12, Table 3.2: “Extrapolation of Number of Intermediates by Tonnage Class,” omitting type 4. In its calculations, RPA includes type 4 but makes adjustments to reflect the possibility of overlap between the category of type 4 intermediates and the category of chemical substances placed on the market. Our calculations for REACH costs are applied only to type 3 intermediates in the >1000 tonne volume tier; our calculations for REACH Plus costs are applied to type 2 intermediates in the >1000 volume tier, and to type 3 intermediates in the 100-1000 and >1000 volume tiers. While our categories differ somewhat from those in RPA, the total number of intermediates to which we apply cost figures for REACH does not differ substantially from that used in RPA.

savings under REACH, compared with the costs it would face under baseline regulations. The great majority of them fall into the low volume tiers for which REACH requirements are lower than the baseline. In fact, 88 % of the new substances fall into the 1-10 tonne volume tier or lower. Table 3.2 shows the size distribution of new substances.

Volume Tier (tonnes/year)	Percentage of New Substances
0.01 - 0.1	12.7%
0.1 - 1	17.5%
1-10	57.8%
10-100	8.5%
100-1000	2.9%
>1000	0.6%

Source: European Chemicals Bureau
(<http://ecb.jrc.it/new-chemicals/>)

Turnover in chemical usage

It is extremely unlikely that all 100,000 existing chemical substances registered in 1981 are still available on the market. Back in 1981 there was an incentive for industry to register the largest possible number of chemicals as already existing, in order to avoid having to test them under the new requirements. Some chemicals substances may have been registered "just in case", but never actually used. Moreover, new substances are constantly being introduced, and old ones removed from the market; thus chemicals that were in use in 1981 may no longer be in production. Some chemicals disappear for awhile, then reappear, making it even more difficult to obtain a reliable census of chemicals in use.

To explore the rate of turnover in chemical usage, we have examined records of chemical substances that were on the market in Sweden in recent years. The Swedish products registry, founded in the 1970s, has expanded over the years and is thought to have achieved relatively complete coverage of chemicals in use in Sweden by the mid-1990s. For the five year period from 1997 to 2002, when there was little change in the total number of chemical substances in use in Sweden, there was nonetheless rapid turnover. Of the 11,694 substances registered in Sweden in 1997, more than a quarter, or 3,312, had dropped to less than 10% of their former usage within five years, and 1,789 were no longer registered for current use five years later, as shown in Table 3.3. Slower, but still significant, rates of turnover occurred among chemicals substances used in larger vol-

umes, as the table also shows.¹⁹ Roughly the same number of chemical substances were used in Sweden in both years, but they were not, in all cases, the same substances. While this information unfortunately does not lead to a quantitative prediction for turnover in chemical use in the European economy as a whole, it does suggest that industry may already be accustomed to rapid change in the chemicals in use. And it emphasizes the uncertainty about the number of "existing" (pre-1981) substances.

Table 3.3: Change in Usage of Chemicals in Sweden, 1997-2002

	Substances registered, 1997	-----of which:----- 2002 usage less than 10% of 1997 usage		Not registered in 2002
All chemical substances	11,694	3,312		1,789
Usage > 0.5 tonnes, 1997	6,461	1,244		366
Usage >1000 tonnes, 1997	525	58		14

Source: Swedish Products Registry; data supplied by Margareta Östman, Kemi.

Testing and registration costs

To calculate the total costs to industry of complying with REACH and REACH Plus, we estimate a cost per substance for testing and registration in each volume tier, and multiply this by the total number of chemical substances expected to be affected. The principal data sources for this calculation are the 2003 Research and Policy Analysts (RPA) Business Impact Assessment (2003), which estimated costs of implementing the version of REACH described in the Consultation Document,²⁰ and the European Commission's revised impact assessment, which estimates costs of the October 2003 version of REACH.²¹

¹⁹ Information extracted from the Swedish registry and supplied to the authors by Margareta Östman, Kemi.

²⁰ RPA 2003.

²¹ Commission of the European Communities, *Proposal for a Regulation of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restrictions of Chemicals (REACH)*, Volume II: Annexes I to IX to the Proposal for a Regulation. Brussels, October 29, 2003. [COM(2003) 644; 2003/0256(COD); 2003/0257(COD)].

We have also drawn on Finn Pedersen et al., "Assessment of Additional Testing Needs Under REACH: Effects of QSARs, Risk Based Testing and Voluntary Industry Initiatives" (September 2003), available at http://europa.eu.int/comm/enterprise/reach/docs/reach/testing_needs-2003_10_29.pdf.

To estimate testing costs under REACH, we used costs per test estimated in RPA's 2003 assessment. We combine these costs with information on the tests required under REACH. This information is further adjusted to account for the fact that for any given category of required tests, some chemical substances have already been tested through existing government or industry programs. Thus, for example, the cost is somewhat under €2000 for testing a chemical substance for acute oral toxicity, but the majority of substances in each volume tier already have acute oral toxicity data. For a given test and a given volume tier, the cost is equal to (number of substances) * (percentage not yet tested) * (cost per test).

We then adjust the testing costs to reflect an assumption that some animal tests will be replaced by *in vitro* testing or quantitative structure-activity relationship (QSAR) analyses within several years after the legislation goes into force. Specifically, we assume that 30% of animal tests in each volume tier will be replaced by QSARs, *in vitro* tests, use of substance-tailored testing requirements, or other analytical approaches that minimize the need for animal testing. Experts have estimated that up to 60% of tests could be eliminated or replaced in this way, beginning seven years after REACH goes into effect.

We also adjust our registration costs to account for the possibility that downstream users may have to submit additional registrations for a modest number of unintended uses. We assume that this adds 10% to the total registration cost for intended uses.

As shown in Table 3.4, these calculations (described further in Appendix 1) result in an 11-year total testing and registration cost for REACH of €3.46 billion, or €315 million per year for 11 years. While these costs are well within the range of published estimates, they are higher than the European Commission's 11-year total direct cost estimate of €2.3 billion.

<i>Volume tier (t/y)</i>	1-10	10-100	100-1000	>1000	Total
Testing	110	203	978	1,712	3,003
Registration	152	66	84	155	457
11-Year Total	261	269	1,063	1,867	3,460
<i>Cost per year</i>					315

Source: See Appendix 1.

The estimated direct costs of REACH Plus are €3.97 billion over 11 years, or €361 million per year, as shown in Table 3.5.

<i>Volume tier (t/y)</i>	1-10	10-100	100-1000	>1000	Total
Testing	317	203	1,004	1,761	3,285
Registration	248	88	121	232	689
11-Year Total	565	291	1,125	1,993	3,974
<i>Cost per year</i>					361

Source: See Appendix 1.

Since the European chemicals industry has annual sales of €556 billion, as noted above, our estimated annual costs represent just under 0.06% of the industry sales revenues for REACH, and just over 0.06% for REACH Plus

4 Price Impacts of REACH

What will be the economic impacts of the increased cost for registration and testing of chemical substances under REACH or REACH Plus? On the one hand, prices of chemicals will increase and sales of chemicals will presumably decrease. This section examines the conventional economic effects of a price increase. On the other hand, many other pathways have been suggested whereby REACH might also cause economic harm, beyond the ordinary effects of price changes. Those other effects are discussed in the next section.

New regulations such as REACH often mean that industry's costs are increased for any given quantity of output. Standard economic models represent this as an upward shift in the industry supply curve. The interaction of supply and demand then usually leads to a reduction in sales and industry revenues. Meanwhile, prices paid by the industry's customers, or downstream users, are increased. (This type of analysis covers only the short-run responses to price changes, and does not take account of dynamic effects such as innovative cost-cutting measures or development of substitutes that may result from the incentives created by regulation.)

How large are the short-run price effects in the case of REACH? Two analyses of the price impact, based on differing models of the chemical industry's structure, both imply that the indirect impact of price changes is very small. Both models make simplifying assumptions about industry structure in order to facilitate quantitative estimates of the effects of regulation.

4.1 Monopolistic Competition

One analysis, done by Joan Canton and Charles Allen for DG Enterprise, applies a model of monopolistic competition to the chemical industry.²² Monopolistic competition is a market structure based on product differentiation, in which many small firms sell similar, but not identical, products. Canton and Allen apply a standard model, which assumes that the industry consists of numerous identical-sized firms whose products are close but not perfect substitutes for each other. Much of the expansion or contraction of output in response to regulation and price changes occurs through firms entering or leaving the industry.

In this model, as costs rise, a few firms leave the industry and a few chemical products cease to be available. Downstream users face increased costs and must use substitutes, often other chemicals. Canton and Allen develop two scenarios, one based on "normal

²² Joan Canton and Ch. Allen, "A Microeconomic Model to Assess the Economic Impacts of the EU's New Chemicals Policy," DG Enterprise, November 2003.

expectations” and the other assuming that downstream users face somewhat higher costs of substitution. Some of the key results for these two scenarios are shown in Table 4.1; note that these figures are based on the European Commission estimate that the direct testing and registration costs of REACH will be a total of €2.3 billion over 11 years. The annual costs to downstream users, including both the registration and testing costs that are passed on through higher prices on chemicals and the costs of substituting higher-priced alternatives, are less than half a billion euros. Changes in output, prices, and numbers of firms resulting from REACH are less than half of one percent, in some cases much less.

Table 4.1: Canton-Allen estimates of impacts of REACH

Scenario	Annual costs to downstream users	<i>Change in:</i>			
		Number of firms	Price of chemicals	Output per firm	Industry output
Normal expectations	€0.3 billion	-0.5%	0.0%	0.3%	0.0%
Higher substitution costs	€0.4 billion	-0.4%	0.1%	0.0%	-0.2%

Source: Canton and Allen, pp.28, 31.

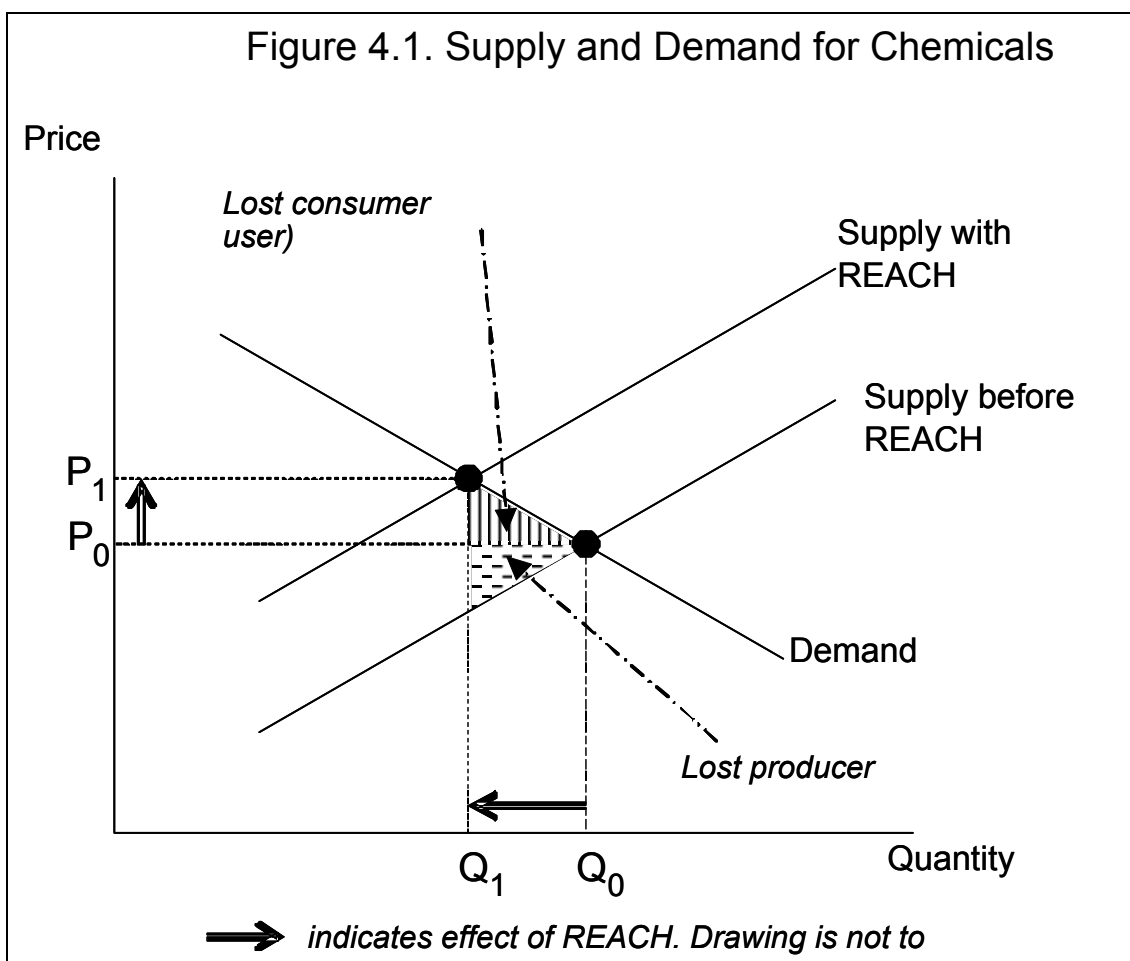
Canton and Allen also present estimates of the present value of the cumulative costs to downstream users of REACH for each of their scenarios, under either of two assumptions about the rate of adjustment. The estimates of cumulative costs range from €2.8 billion to €5.2 billion, or from 1.2 to 2.3 times the direct costs.²³ As they note, their estimates already include the majority of the direct costs, which have been passed through to downstream users, so they should not be added to those costs.

In summary, the Canton-Allen model, focused on product differentiation, finds only modest cost impacts, barely exceeding twice the direct costs in their most “expensive” variant.

4.2 Single-Market Model

An alternative approach is to apply the standard economic analysis of an increase in regulatory costs on a single market, as shown in Figure 4.1 (next page). Use of this analysis in effect assumes that all chemicals are sold in a single market. Before REACH, the market equilibrium is at price P_0 and quantity Q_0 . REACH increases industry costs, shifting the supply curve upward; the new equilibrium is at a higher price, P_1 , and lower output, Q_1 .

²³ Canton and Allen 2003: 33.



Appendix 2 derives the formulas and numerical estimates for the effects of REACH in this model. The decisive factor shaping these estimates is that the direct costs imposed by REACH are a very small fraction of chemical industry annual revenues: 0.00057 for REACH, or 0.00065 for REACH Plus, as seen in Section 3.

In the single-market model, REACH would increase prices by almost 0.03%, and decrease output by almost 0.06%. The industry's total sales revenue would decline by almost 0.03%; the net received by the industry (after subtracting the costs of REACH) would decline by 0.085%. Consumer and producer surplus, for the entire European chemical industry, would each decline by €45,000 per year.

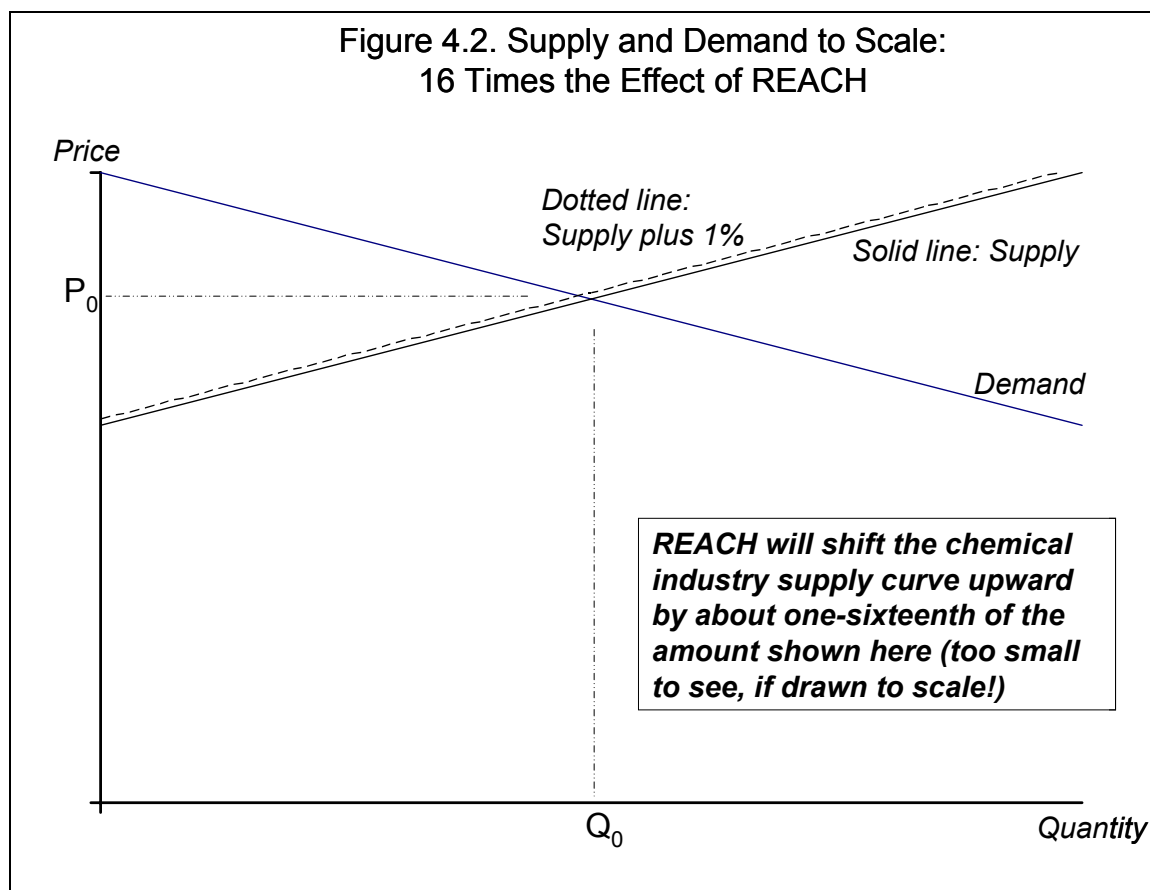
REACH Plus would increase prices by just over 0.03% and decrease output by just over 0.06%. The industry's total sales revenue would decline by just over 0.03%; the net received by the industry would decline by about 0.1%. Industry-wide consumer and producer surplus would each decline by €59,000 per year. See Appendix 2 for details.

From some perspectives, it is difficult to visualize cost impacts this small. Figure 4.1, like many economics diagrams, intentionally exaggerates the size of the expected effect in order to allow clarity of explanation. In fact, the figure as drawn shows roughly a

25% change in quantity and a 20% change in price -- hundreds of times greater than the actual effects of REACH. An attempt to produce a similar diagram, with the shift in the supply curve drawn to scale, fails because the shift is too small to be seen; the supply curves before and after REACH are, to the naked eye, identical.

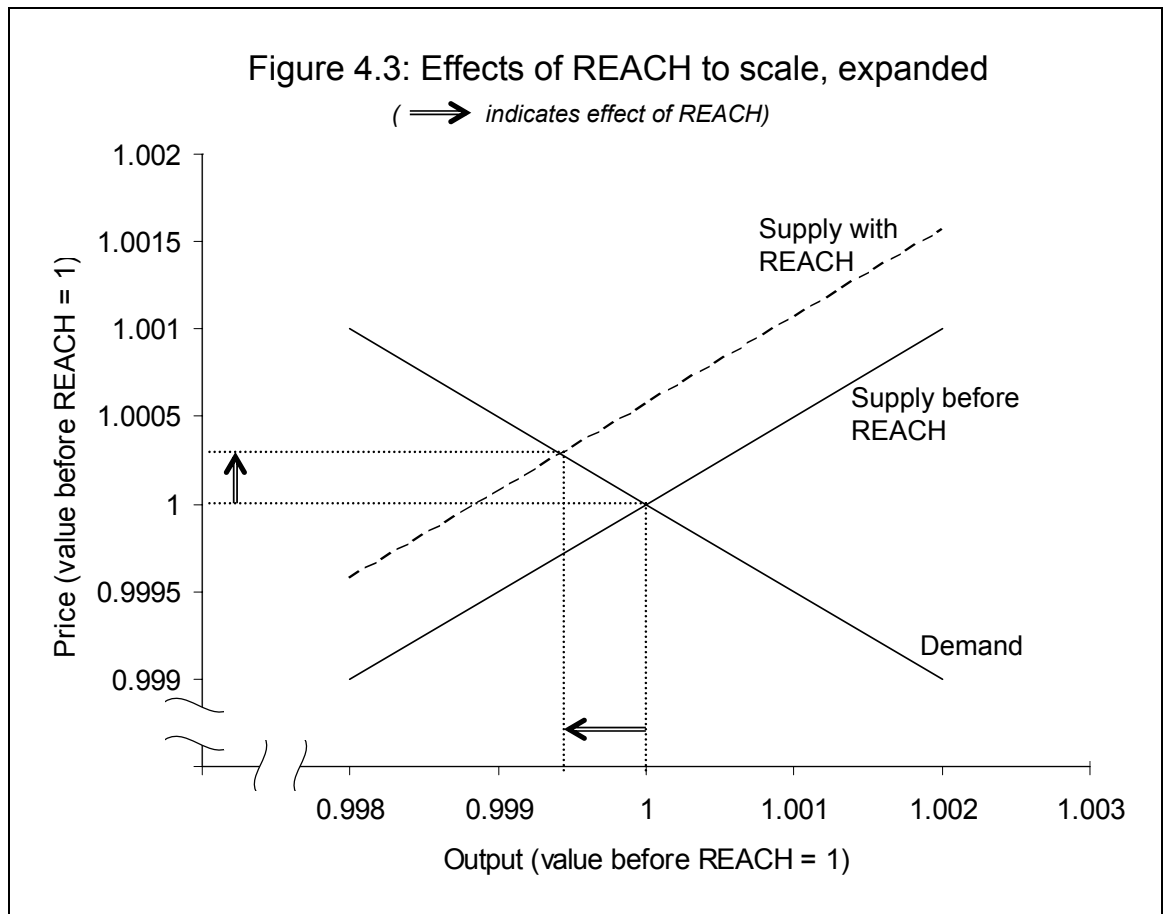
Figure 4.2 shows the impact of a cost increase that is smaller than in Figure 4.1 but still much larger than the effects of REACH, involving a full one percent upward shift in the supply curve. The dotted supply curve is exactly one percent above the solid supply curve, measuring vertically at the equilibrium quantity, Q_0 . In other words, Figure 4.2 would be the appropriate picture for the above analysis, drawn to scale, if the ratio of new regulatory costs to industry revenues were equal to 0.01 (1%). Since the ratio is in fact much smaller, as we have seen, the shift shown in Figure 4.2 is about 16 times as large as the effect on the supply curve caused by REACH or REACH Plus.

A shift in the supply curve of one-sixteenth of the amount shown in Figure 4.2 is very small. It should be obvious that large impacts on the chemical industry or its customers would not be expected from a change of this magnitude.



To show the effects of REACH to scale, it is necessary to "zoom in" on the area around the intersection of the supply and demand curves. Figure 4.3 represents such a graph,

with the area around the intersection of the curves greatly enlarged. In Figure 4.3, the equilibrium price and quantity prevailing in the market before REACH are represented as 1; the other numbers on the axes can be interpreted as ratios or fractions of the pre-REACH price and quantity. The dotted supply curve, representing the effects of REACH, is shifted up by 0.0006 above the original supply curve, reflecting our estimate of the costs of REACH.²⁴ As this figure illustrates, REACH will move the market in the expected direction -- toward lower output and higher price -- but by a *very* small amount.



4.3 Similar Changes in Costs Are Commonplace

Other analyses, using different data and earlier versions of REACH, have come to broadly similar estimates of the costs of REACH – implying similarly small price impacts. For example, an analysis by the German Advisory Council on the Environment (known by its German acronym, SRU) examines two of the estimates discussed in the

²⁴ As explained in Appendix 2, the supply and demand curves are drawn with price elasticity equal to 2.

previous section: the Commission estimate of €3.7 billion and the CEFIC estimate of €7 billion for the direct costs of the 2001 version of REACH.

CEFIC points out that the impact of REACH will fall disproportionately on the fine and specialty chemicals sector. This sector represents about 25% of the industry but may bear as much as 80% of the costs of REACH. Thus the relative impact on this sector is a little more than three times as great as on the industry as a whole. The European Commission and CEFIC studies, applied to the chemical industry as a whole and to fine and specialty chemicals, imply the range of annual costs as a percentage of sales shown in Table 4.2.²⁵

Table 4.2: Annual Costs of REACH as Percentage of Chemical Industry Sales

	European Commission	CEFIC
Total chemical industry	0.06%	0.12%
Fine and specialty chemicals	0.20%	0.39%

Source: SRU 2003, p.13.

Our results are remarkably similar to the Commission's estimates, albeit calculated for a newer version of REACH. We also found the costs of REACH to be 0.06% of chemical industry sales. Scaled up to reflect the differential impact on fine and specialty chemicals, our estimates would imply ratios of 0.18% for REACH and 0.21% for REACH Plus.

How disruptive is it for industry to experience cost increases of the magnitudes shown in Table 4.2, roughly speaking between 0.06% and 0.4% of annual sales? Two examples demonstrate that cost changes larger than this are routinely encountered in the business world, and do not prevent the profitable operation of industry.

²⁵ From German Advisory Council on the Environment (SRU), "On the Economic Impact of the Planned Reform of European Chemicals Policy", July 2003: 13.

First, from 1997 through 2003, the weekly change in the world spot price for crude oil exceeded 0.4% (in absolute value) 90% of the time (47 weeks per year); it exceeded 0.06% more than 98% of the time (51 weeks per year).²⁶

Second, from 1999 through 2003, the EU-15 price index for all intermediate manufactured goods (products of one industry used by another industry), an index averaging many price changes in many industries across 15 countries, had a month-to-month change exceeding 0.4% (in absolute value) 12% of the time, more than one month per year on average; it exceeded 0.06% in 85% of the cases (10 months per year).²⁷

Some of these changes in input prices turn out to be temporary, and are soon reversed; other changes are much more long-lasting. However, businesses frequently cannot tell in advance which price changes will last, and which will not. Unexpected changes in price are part of normal life in the marketplace, and successful businesses manage to thrive despite this uncertainty. The cost of REACH is already anticipated, years in advance, and moreover is small compared to normal changes in input prices.

In short, if the chemical industry fully passed on to its customers the direct costs of REACH, by our estimates or by any of the estimates in Table 4.2, the resulting price increases would be well within the range of price changes routinely experienced by business. The conclusion that the total costs of REACH are too small to cause noticeable economic harm remains true across several studies, regardless of which of the cost estimates and methodologies are chosen.

²⁶ Authors' calculation from data downloaded from US Energy Information Agency, http://www.eia.doe.gov/oil_gas/petroleum/info_glance/prices.html, January 28, 2004, data series WTOTWORLD ("All Countries Spot Price FOB Weighted by Estimated Export Volume").

²⁷ Authors' calculation from data downloaded from Eurostat, January 28, 2004, for EU-15 index of domestic output prices for intermediate goods, data series dop-is040idx.

5 Other Economic Impacts

Estimates of the costs of REACH fall into two groups. Studies sponsored by industry groups have frequently found that the costs will be enormous, potentially devastating the European economy. Other studies have frequently found that the costs will be quite small, similar to the estimates presented in the previous section. This section considers the economic arguments presented in the industry studies, exploring the causal pathways that are said to lead to enormous costs. Although the industry studies raise important issues that deserve discussion, they ultimately fail to make the case that immense economic damage will result from REACH.

The divergence between industry-sponsored and other studies of REACH is not primarily due to the direct costs of testing and registration. Most studies have estimated the 11-year direct costs at between €2 billion and €13 billion; the differences within that range reflect changes between versions of REACH as well as differing study methodologies. For any one version of REACH, estimates of direct costs have rarely differed by as much as 3 to 1.

The divergence between estimates arises almost entirely in the calculation of the indirect consequences of REACH. The magnitude of these consequences can be summarized by the ratio of total to direct costs. For example, the Canton-Allen model, described in Section 4, yields total cost estimates of no more than 2.3 times the direct costs. The single-market model, as presented in Section 4, can be interpreted as implying that total costs are about twice the direct costs.²⁸ One of the highest such ratios among studies sympathetic to REACH is implicit in the analysis by economists David Pearce and Phoebe Koundouri for World Wildlife Fund-UK. Based on a literature review, they estimate the direct costs at €3.6 billion and indirect costs at €20 billion; thus their total costs are €23.6 billion, or 6.6 times the direct costs.²⁹ In contrast, in the original Arthur D. Little study for BDI, the German industry federation, the widely cited “Storm” scenario used only the European Commission’s estimates of testing costs, yet projected that the resulting losses would amount to 2.4% of German GDP. If this per-

²⁸ As Seen in Section 4, the loss of revenue to the chemical industry is 1.5 times the direct costs of REACH. The price to the customers (downstream users) increases by a percentage equal to half the costs of REACH; if this is loosely interpreted as a cost to downstream users of 0.5 times the direct costs, then the total cost is 2.0 times the direct costs of REACH. An alternative interpretation, more rigorously grounded in economic theory, would say that the losses of consumer and producer surplus are the valid measures of indirect costs; hence the total costs of REACH amount to the direct costs plus the lost consumer and producer surplus. As we have seen, the lost consumer and producer surplus are inconsequential fractions of industry revenue, or even of the direct costs of REACH. Thus on this interpretation of the single-market model, the ratio of total to direct costs of REACH is only trivially greater than 1.0.

²⁹ David Pearce and Phoebe Koundouri, “The Social Cost of Chemicals: The Costs and Benefits of Future Chemicals Policy in the European Union,” World Wildlife Fund-UK, May 2003, p.24.

centage applied to the whole EU-15 economy, the Arthur D. Little (ADL) Storm scenario would project losses of 650 times the direct costs of REACH.³⁰

Is the ratio of total costs to direct registration and testing costs in the range of 2-6, or is it more like 650? The higher number is hard to believe, *a priori*: there is no evidence that modern industrial economies are hypersensitive to regulations, experiencing indirect damages of hundreds of times the direct regulatory costs. Nonetheless, we will examine the models and methods behind the high estimates, to determine whether any of the individual cost components are cause for concern.

Although there have been several newer industry-sponsored studies, the original (2002) ADL study remains the most important and most carefully documented piece of this literature. As REACH has been revised, ADL has repeatedly released brief updates of its estimates, relying on the same methodology. Mercer Management, a consulting firm working for the French industry association, has done two studies of the cost of REACH that evidently use similar methodology and reach similar conclusions; however, Mercer has released only the Powerpoint summaries of its work, making it difficult to review in any detail. One recent study from CEFIC adopts a fundamentally different approach, as described later in this section.

ADL models the impacts of individual cost categories as percentage reductions in output; it then multiplies these reductions, allowing them to cumulatively worsen each other's impacts. For example, if one cost category were thought to reduce output by 10%, and another by 20%, the ADL model would show that the output surviving after the imposition of both costs was $90\% \times 80\% = 72\%$ of the original amount. The model includes many inappropriate calculations for losses in output due to the regulation of new chemical substances under REACH, ignoring the fact that regulation of new substances will be eased, not tightened. And it includes other errors of poor judgment and exaggeration, all of which multiplicatively intensify each other. A detailed critique of the ADL model methodology is presented in Appendix 3.

Despite its multiple errors in calculation, the ADL model is worth studying; it is virtually a database of possible cost impacts. In this section we review the following categories of possible costs of REACH; all but the last can be found in the ADL model:

- Costs to downstream users of loss of essential chemical inputs
 - Due to unprofitability
 - Due to authorization or restriction of hazardous substances

³⁰ On the registration and testing costs used in the Storm scenario, see Arthur D. Little, "Economic Effects of the EU Substances Policy," December 2002: 48. The calculation of losses equal to 650 times direct costs is based on assumed 11-year total registration and testing costs of €3.7 billion (or €340 million per year), an accepted estimate for the then-current version of REACH, and EU-15 GDP of €9.2 trillion. The Storm scenario "bottom line" of 2.4% of GDP loss then implies a loss of €220 billion, or 650 times the annual direct cost.

- Expenses of multiple registration and duplicative testing of chemicals
- Losses due to disclosure of confidential business information
- Loss of competitive advantage due to delays in bringing new products to market
- Intensification of small regulatory impacts due to worsening macroeconomic and international trade conditions (the argument of the new CEFIC study)

5.1 Costs to downstream users due to loss of chemical inputs

REACH or REACH Plus will not increase the regulatory burden on new chemical substances. Thus there is no reason to expect any loss of new substances from the market. Either scenario will, however, increase the regulatory obligations for producers of existing chemical substances. If the use of an existing substance is subject to authorization or restriction, or if it is withdrawn from the market altogether in response to REACH, then downstream users of that chemical could potentially experience economic harms.

There are two reasons why downstream users might lose access to chemicals under REACH. A chemical could vanish from the marketplace for economic reasons: producers and importers could decide that a chemical's sales volume and profits are too small to justify the registration and testing costs. Or the chemical substance could be restricted or denied authorization under REACH because it is found to be a health or environmental hazard. The two versions of this problem raise very different issues.

Loss of profitability

The average cost burden of REACH will be very small, as demonstrated in previous sections. On average, it will be far more profitable for industry to pay for registration and testing in order to continue production, rather than shutting down to avoid the modest regulatory costs. But could the reverse be true for an individual chemical substance? Are there cases where the costs of REACH will tip the balance against continuing production of a chemical? There could be such cases, but a brief examination of the economic issues involved suggests that they are unlikely to be important ones. If an important chemical is unprofitable under REACH, a price adjustment will generally be in order -- which will restore its profitability.

If a chemical is withdrawn for economic reasons, it must be of limited economic importance; otherwise, its volume and profits would justify the costs of registration and testing. Presumably the threat of economic withdrawal is primarily relevant to the lowest-volume and least profitable existing substances. However, REACH imposes very low costs on low-volume substances. If a chemical is withdrawn because it is unprofitable for the chemical industry to keep producing it, but its loss is of great importance to downstream users, then the market is not doing its job. The prevailing price is not sending the chemical industry the correct signal about the value of this substance to its customers.

If a chemical is important but unprofitable, the price can be adjusted to reflect the chemical's importance; the downstream users will realize that it is in their interest to pay more to maintain access to this essential substance. (If this makes the chemical unaffordable to the downstream users, or drives them to use substitutes, then the chemical can be replaced, implying that it was not so important after all.) With a higher price, more accurately reflecting its economic importance, the producer of the chemical will be able to pay for registration and testing. A market economy continually "solves" problems of this sort by adjusting prices, and there is no reason why it should fail to do so after REACH is adopted.

Moreover, there is a noticeable ongoing rate of turnover of chemicals substances on the market, even in the absence of REACH, as suggested by data from the Swedish products registry (see Section 3). Not every low-priced chemical is worth paying more for; many chemicals do have usable substitutes, or are replaced by improved alternatives as chemical technology advances. That is, in many cases the market was not mistaken when it declared a low-volume substance to be low in price and profits as well. Such chemicals often leave the market for reasons that have nothing to do with health and environmental regulations. Only the increase above the background rate of chemical turnover should be attributed to REACH, not the total turnover observed after it is enacted.

Limitations on health or environmental grounds

The more difficult case concerns chemical substances that are restricted or denied authorization because they are found to be hazardous, or are voluntarily withdrawn because they are suspected to be hazardous. On the one hand, this is a success in protecting health and the environment; identification and control of hazardous chemicals is the goal of REACH. On the other hand, it could potentially impose costs on downstream users, if the hazardous chemical is economically important and there are no viable substitutes. The critical question is: Are there existing chemical substances that will be found to be hazardous under REACH or REACH Plus, which are economically important to downstream users, and for which there are no close substitutes?

There is no way to estimate the frequency of this problem in advance; indeed, there is not even any solid information on the number of existing chemical substances that will be subject to authorization. (Estimates have ranged from 1% to 5%, but appear to be purely speculative. The number of problem cases will be smaller, since for most substances and uses for which authorization has been denied, there will be feasible substitutes.) According to the proposed provisions, a substance subject to authorization can be used if it can be demonstrated that its use occurs under safely controlled circumstances. However, it remains theoretically possible that essential uses of a chemical substance would fail to meet the standards for authorization. It is also possible that an essential chemical substance would simply be withdrawn from the market, either because it is hazardous enough to be subject to restriction under REACH, or because the producer suspects that it will be subject to authorization if tested and does not want to deal with the higher level of regulatory requirements for authorized substances.

Concerns about such impacts on downstream users have been widely discussed, and have been addressed in the process of modifying and amending REACH. Some of the original advocates of REACH, in fact, have recently complained that the current proposal has been so weakened by industry objections that it now protects business more than the environment.³¹ Title VII of REACH, governing authorization, allows a showing of economic benefits from using a substance to outweigh the finding of risks. Even if the use of a hazardous substance would not qualify for authorization on health and environmental grounds, Article 57 states that

...an authorization may be granted if it is shown that socio-economic benefits outweigh the risk to human health or the environment and if there are no suitable alternative substitutes or technologies. (REACH draft of October 29, 2003, p.112.)

The factors to be considered in granting such an authorization include “the socio-economic benefits arising from its use and the socio-economic implications of a refusal to authorize as demonstrated by the applicant or other interested parties” (*ibid.*, 112).

Likewise, in Title VIII, on restriction of the most hazardous substances, Article 66 establishes two bodies, a Committee for Risk Assessment and a Committee for Socio-Economic Analysis, that are involved in decisions on restrictions (*ibid.*, 120). Article 68 describes the role of the latter body, saying that

...the Committee for Socio-Economic Analysis shall formulate an opinion on the suggested restrictions, based on its consideration of the relevant parts of the dossier and the socio-economic impact. It shall prepare a draft opinion on the suggested restrictions and on the related socio-economic impact... (*ibid.*, 120)

The same article goes on to state that when any member state or the Commission disagrees with the opinion of the Committee for Risk Assessment, the decision may be delayed for up to 90 days to await the opinion of the Committee for Socio-Economic Analysis (*ibid.*, 120-121).

In short, REACH as currently proposed does not ignore economic considerations. Concerns for possible economic harms due to restriction or denied authorization, and mechanisms for addressing those harms, are built into the apparatus of REACH. The greater risk may be in the opposite direction: the provisions for pleading economic necessity are so readily available that it may be possible to overturn too many regulatory decisions with allegations of immense downstream impacts.

³¹ Inger Schörling et al., “REACH – The Only Planet Guide to the Secrets of Chemicals Policy in the EU. What Happened and Why?”, Brussels, April 2004.

5.2 Expenses of multiple registration and duplicative testing

ADL assumes that different companies might duplicate expensive tests on the same substance, and that many registrations are required for a single product or substance used in many different ways. This is an incorrect reading of the regulations, which encourage companies to work together, form consortia, and submit available results of tests already performed. Studies done by RPA for the European Commission (which we relied on in our calculations in Section 3) include more measured estimates of multiple registrations and of consortium formation. Only limited cases of multiple registrations are anticipated by RPA, and by most observers.

5.3 Losses due to disclosure of confidential business information

The fear of disclosure of confidential information, much discussed by business commentators, is also based on a misreading of the regulations. ADL's original study asked business representatives how great they believed the dangers of excessive disclosure would be, and reported their alarming numerical estimates of potential losses.³² In fact, REACH contains substantial protection for confidential business information that is shared with regulators.³³ Moreover, the public sector already collects substantial amounts of information in the regulation of new chemical substances, without any great losses due to unauthorized disclosure.

Fears of such disclosures may be exaggerated in general. In the United States, the state of Massachusetts has a Toxics Use Reduction Act, in effect for more than 10 years, that requires disclosure of more information about industry's chemical use than REACH.³⁴ A state agency uses the information to help small and medium-sized enterprises develop plans for reducing their use of toxic chemicals, a program that has won wide acceptance and praise in the business community.

5.4 Losses due to delays in bringing new products to market

The ADL study inappropriately assumes that REACH will cause a large delay in bringing all chemical products to market (6-12 months for every product, depending on scenario), then applies an arbitrary and unsubstantiated model that translates such delays into huge economic losses. Delays in coming to market, if they occurred, would be important for innovation and development of new chemicals. Yet since REACH lightens the regulatory burden on new chemicals, it should be seen as helping, not hindering, in

³² Appendix 6 of the ADL study (pages 154-155) presents the topics for discussion in the industry interviews. Responses can be found in Appendix 8 (pages 175-180).

³³ See Title XI (pages 142-145) of the REACH proposal of October 2003.

³⁴ Under the Toxics Use Reduction Act (TURA), Massachusetts firms that use more than a certain amount of specified toxic chemicals must (a) examine their toxics use and evaluate alternatives, and (b) report the quantities of toxic chemicals used or generated. For an overview, see <http://turadata.turi.org/WhatIsTURA/OverviewOfTURA.html> (viewed September 2004). Companies' data on toxic chemical use and generation are open to the public, with exceptions for companies that file a special confidentiality request. For data reported under TURA, see <http://turadata.turi.org/report.php> (viewed September 2004).

this respect. If anything, it should be credited with speeding the introduction of new chemical substances and boosting the competitive position of innovative European producers.

Existing substances remain on the market pending the completion of testing; thus there is no new delay created for existing uses of existing chemical substances.

New regulatory requirements could be encountered if existing substances expand into higher volume tiers, and/or if new uses are introduced for existing substances.

One potential problem along these lines concerns formulators of new preparations that mix a number of existing substances; depending on the interpretation of the regulations for them, they could face some added delays. Thus the regulations for formulators should be carefully implemented in order to avoid this problem.

In this and other areas, there will be a need for flexibility in identifying regulatory bottlenecks and developing appropriate modifications. The simulation study carried out in the German state of North Rhine-Westphalia by public and private sector participants in late 2003 highlights a number of such issues, while finding implementation of REACH to be generally quite feasible.³⁵

While bureaucratic bottlenecks in the regulatory process should be identified and minimized, even the most streamlined new regulations will inevitably have an impact on chemical use. That impact should not be thought of as uniformly delaying all innovation; rather, it intentionally favors safer options. Either REACH or REACH Plus will create incentives to use those chemical substances that can most quickly be tested and approved, in place of those that will require a lengthy testing process. There will likewise be an incentive to accelerate the development of safer alternatives to chemicals that might be hazardous. Any delays experienced today will be offset by avoiding the future costs, liabilities, and delays associated with innovations that later prove to be hazardous.

Macroeconomic and international trade conditions

This final argument, made in a recent CEFIC study³⁶, assumes a complete reversal of recent trends. For more than a decade, as CEFIC notes, the European chemicals industry has been a success in domestic and international markets, growing more rapidly than the European economy as a whole, and enjoying a large and growing trade surplus with the

³⁵ "Testing of Selected Elements of the REACH Procedures in Practice by Authorities and Companies in North Rhine-Westphalia (Germany)", December 2003.

³⁶ "Horizon 2015: Perspectives for the European Chemical Industry," CEFIC, March 2004, available from www.cefic.org.

rest of the world. Yet CEFIC claims that the industry's growth will soon give way to stagnation, and that new chemical producers in Asia and elsewhere are about to enter world markets and erode European exports. In this climate, even small regulatory costs are said to be too much to allow industry to prosper.

The negative factors identified by CEFIC are worth considering, even though they appear to be exaggerated in the study. But if the outlook for the industry was as bad as CEFIC claims, then no amount of deregulation could solve the problem. Macroeconomic and foreign trade problems require solutions in the realm of macroeconomic and trade policy, not the destruction of health and environmental protection.

In addressing these significant problems, their severity should not be exaggerated. It is worth remembering that regulatory costs and their anticipated economic impacts are routinely overstated in advance, as both European and American studies have shown.³⁷ There is little evidence of job loss due to environmental regulations.³⁸ A growing academic literature is increasingly rejecting the once-popular "pollution haven" hypothesis – the claim that corporations flee from high-cost developed countries, shifting production to developing countries with lax, low-cost regulations.³⁹ While production might move overseas in response to sufficiently large cost differences, the actual costs of health and environmental regulations are simply not great enough to be a primary factor in business location decisions; this will remain true even after the small increase in regulatory costs due to REACH.

³⁷ International Chemical Secretariat, "Cry Wolf: Predicted Costs by Industry in the Face of New Regulations," April 2004; Frank Ackerman and Rachel Massey, "Prospering With Precaution", available at http://www.ase.tufts.edu/gdae/policy_research/PrecautionAHTAug02.pdf; and numerous sources cited in both of those publications.

³⁸ For a review of American evidence on this point, see Eban Goodstein, *The Trade-off Myth: Fact and Fiction about Jobs in the Environment* (Washington DC: Island Press, 1999).

³⁹ See the review of this literature in Kevin P Gallagher, *Free Trade and the Environment: Mexico, NAFTA, and Beyond* (Stanford, California: Stanford University Press, 2004), chapter 3.

6 Benefits

Although the costs of REACH will be much lower than many critics have suggested, there still will be costs. These costs are incurred in order to achieve the benefits of REACH, including both direct health and environmental benefits and indirect economic benefits. A full assessment of the benefits of REACH is beyond the scope of this report; here we briefly mention two analyses that conclude that the benefits far exceed the costs, and draw on US experience to suggest that there are important benefits for downstream users.

6.1 The Commission's Analysis of Benefits

In its October 2003 Extended Impact Assessment of REACH, the European Commission offers an overview of possible benefits of REACH. The Commission's discussion touches on occupational health, public health, and environmental health impacts of REACH.

To illustrate the possible magnitude of benefits of REACH, the Commission's study employs a World Bank analysis of the total amount of disease attributable to harmful chemical exposures. Drawing from the conservative end of the range of World Bank estimates, the study assumes that 1% of all disease is attributable to chemical exposures. It estimates, further, that 10% of these impacts could be addressed by REACH, implying that 4,500 lives could be saved each year by REACH.

The study sets the value of a statistical life at €1 million, and assumes that public health benefits would begin 10 years after REACH goes into effect and continue for only 20 years. As a result, it finds that the present value of total benefits over the next 30 years is around €50 billion. The Commission emphasizes that “[t]his is *not* an estimate of the benefits of REACH, but rather an illustration of their potential scale.”⁴⁰

There are good reasons to think that the potential scale of benefits is even larger. The adverse effects of hazardous chemicals often last more than 20 years, so the benefits of reducing exposure would last longer as well. Some cancers associated with chemical exposure have a latency period of 20 years or more, so the benefits of reduction would not be visible within a 20-year window. Toxic exposures to a developing fetus, infant, or child often have lifelong effects, such as brain damage caused by lead; in this case,

⁴⁰ Commission of the European Communities, “Regulation of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restrictions of Chemicals (REACH), establishing European Chemicals Agency and amending Directive 1999/45/EC and Regulation (EC) on Persistent Organic Pollutants: Extended Impact Assessment.” (October 29, 2003). [SEC (2003) 1171/3; COM (2003) 644 final]: 30.

the effects may last for 70 years or more. The legacy of past use of hazardous chemicals may be difficult or impossible to remove from the environment; despite our contemporary understanding of the risks they pose, we are still suffering from the aftereffects of the use of lead paint, asbestos, and PCBs in the middle years of the 20th century.

In a different vein, the €1 million valuation of life, while common in European studies, is well below the equivalent American estimates: for the purposes of cost-benefit analysis of regulations, a life was worth almost €5 million (\$6.1 million in 1999) under the Clinton administration, and up to €3 million (\$2.6 - \$3.7 million) under the Bush administration.⁴¹ Even the Bush administration figures would substantially boost the Commission's estimate of the monetized value of the benefits of REACH.

6.2 The Pearce-Koundouri (WWF) Study

In a study for World Wildlife Fund-UK, David Pearce and Phoebe Koundouri developed detailed estimates of the monetary value of the benefits of REACH.⁴² They used a 20 year time horizon, and a value of life of €1.6 million. In a technical analysis applying a range of different methods used by economists to estimate health benefits, Pearce and Koundouri developed three different models. Their Model I, valuing health benefits only at the cost of avoided health expenditures, found cumulative benefits of REACH between €5 billion and €20 billion. (They describe this as a "worst case" estimate, not their best guess at true benefits.) Two versions of their Model II, adding estimates of willingness to pay for life and health, found cumulative benefits ranging from €12 billion to €93 billion. Finally, Model III, based on a combination of medical costs and lost productivity resulting from disease, puts the cumulative benefits of REACH at between €57 billion and €283 billion.

Pearce and Koundouri used a relatively high estimate for the costs of REACH, €23.6 billion. Thus they concluded that under Model I, costs exceed benefits; the same was true for the bottom of the range for Model II. In contrast, for most of their Model II estimates, and clearly for all of Model III, the benefits outweighed the costs. Their evaluation would have been even more favorable if they had used a longer time horizon, a higher value of life, or the lower costs of REACH calculated in this report. In particular, with the lower estimated costs of REACH that now seem appropriate, even Model I benefits exceed the costs.

6.3 Benefits to Downstream Users

Extensive discussion of the costs of REACH conceals the fact that downstream users of chemicals are likely to benefit from some aspects of the new regulations. Downstream users currently bear the burden of the on-going, "everyday" costs of worker protection,

⁴¹ This issue is discussed in Frank Ackerman and Lisa Heinzerling, *Priceless: On Knowing the Price of Everything in the Value of Nothing* (New York: The New Press, 2004), chapter 4.

⁴² Pearce and Koundouri 2003.

pollution control, risk management, and waste management. By increasing the incentives for the development of safer products and processes, REACH would decrease this burden. In addition, the greater availability of information due to REACH would mean that worker safety and pollution control systems could be better tailored to match known characteristics of the chemicals in use. REACH imposes one-time costs, but is likely to reduce significantly the continuing stream of everyday costs associated with using dangerous chemicals for which safety information is incomplete.

In the United States, the benefits to downstream users of adopting safer substitutes are illustrated in the experience of Massachusetts firms that have benefited financially as they comply with the Toxics Use Reduction Act (TURA). Under TURA, a state law passed in 1989, the state government cooperates with Massachusetts industries to promote cleaner production processes. State assistance is particularly important for smaller enterprises, which may lack the research and planning capability to find and introduce cleaner alternatives on their own. The Massachusetts Office of Technical Assistance has compiled a set of case studies that show how companies have saved money by reducing their use of toxic chemicals.⁴³ These companies have enjoyed savings from increased production efficiency, reduced worker safety expenses, reduced fees for toxic chemical use, and reduced expenses for hazardous waste disposal. In the 42 case studies examined by the Massachusetts Office of Technical Assistance, all but one company saved money by limiting toxics in the workplace. Most companies were able to recoup the costs of new equipment within two years, and annual savings ranged from \$5,000 to over \$250,000 per year.

In the long run, the goals of building a strong economy and a healthy environment are complementary, not contradictory. By creating incentives for environmentally sound chemical choices and technologies, REACH will help to promote sustainable industry and reduce exposure to toxic chemicals in Europe. As other parts of the world move to adopt similar standards in the future, European industry will gain the competitive advantage that comes from being the first to move toward cleaner and safer production and use of chemicals.

⁴³ Massachusetts Office of Technical Assistance Toxics Use Reduction Case Studies. Available at <http://www.state.ma.us/ota/casep2.htm>, viewed January 2004.

Appendix 1: Methodology for Cost Calculation

To find the total costs to industry of complying with REACH and REACH Plus, we estimate a cost per substance for testing and registration in each volume tier, and multiply this by the total number of chemical substances expected to be affected. Here we describe the details of our calculations and the judgements we have made in developing them. We focus first on the costs of complying with REACH; the calculation of costs for REACH Plus requires just a few additional adjustments.

We have drawn on a range of resources for this calculation, of which two are particularly important: the 2003 Research and Policy Analysts (RPA) Business Impact Assessment (2003), which estimates costs of implementing the version of REACH described in the Consultation Document;⁴⁴ and the European Commission's revised impact assessment, which estimates costs of the October 2003 version of REACH.⁴⁵

For both testing and registration costs, REACH distinguishes between requirements for chemical substances in general and requirements for isolated intermediates (substances that are produced only in the course of making another product, and are not sold as products themselves). Thus each of the calculations described here has been carried out separately for chemical substances placed on the market and for intermediates.

Testing Costs

To estimate testing costs, we used costs per test estimated by RPA for the May 2003 version of REACH, combined with information on the tests required under the current version of REACH, drawing the test requirements directly from Annexes V through VIII of the proposed legislation.⁴⁶

Occasional ambiguities in the testing information required a series of judgements about what to include. The consequences of these judgements are small; each affects the esti-

⁴⁴ RPA 2003.

⁴⁵ Commission of the European Communities, *Proposal for a Regulation of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restrictions of Chemicals (REACH)*, Volume II: Annexes I to IX to the Proposal for a Regulation. Brussels, October 29, 2003. [COM(2003) 644; 2003/0256(COD); 2003/0257(COD)].

⁴⁶ In our reading of the REACH requirements, we worked primarily from the left-hand column of testing requirements in the Annexes: "Standard Information Required." We did not attempt to adjust for all the information in the second column, "Specific rules for adaptation from column 1," because many of these are chemical-specific, depending on the outcome of tests listed in column 2.

mated cost for just one test category. For example, the list of testing requirements for the top volume tier, above 1000 tonnes, includes a test for “long term toxicity to sediment organisms” (Annex VIII, item 7.5). The legislation states that such testing “shall be proposed by the registrant” when other, short-term test results suggest a need for it. In the absence of information on this question, we have simply assumed that 50% of the chemicals in the top volume tier will be subject to this requirement. This test costs €76,000 per substance.

For any given category of required information, it is likely that a certain percentage of chemical substances have already been tested. Some tests are routine and have already been performed for most substances on the market. In addition, some high production volume substances have already been tested extensively under a voluntary government-industry partnership. Both RPA and the Commission have estimated the total percentage of chemicals substances still in need of testing for each category. We have used RPA’s percentages in our calculations.⁴⁷ RPA’s percentages are not always the same as those shown in the Commission’s calculations; in some important cases, such as the expensive “developmental toxicity” test, our estimated costs would have been lower if we had used the Commission’s percentages.

The following illustrates how we calculated testing costs, looking at just one test item as an example. The list of tests in RPA and in the text of the REACH legislation includes “Eye irritation” (Annex V, item 6.2). This test is required for substances in all volume tiers, and costs €948 according to both RPA and the Commission. We multiplied this test cost by the estimated percentage of substances in each volume tier for which data are not already available on eye irritation. According to RPA, this turns out to be 60% for the lowest volume tier, and 0 for the other three volume tiers. In other words, chemical substances produced or imported at more than 10 tonnes per year are assumed to have been tested already for ability to cause eye irritation. Taking 60% of the €948 cost per test, we record this test as adding a total of €569 to the estimated cost per substance in the lowest volume tier. This figure is then multiplied by the total number of chemical substances in this volume tier.

Under REACH Plus, the 1-10 tonne volume tier is subject to the same requirements as the 10-100 tonne volume tier. Thus, in our calculation of testing costs for REACH Plus, all substances between 1 and 100 tonnes are subject to the testing requirements that apply to the 10-100 volume tier under REACH.

We calculate a total testing cost (for substances on the market plus intermediates) of €3.0 billion for REACH and €3.3 billion for REACH Plus.

⁴⁷ Specifically, we use the percentages listed in RPA 2003, Annex 1: “Testing costs for substances requiring test data under no acceptance of negative QSAR endpoints and limited acceptance of negative QSAR endpoints scenarios.” The table within this annex, “Table A1.a(a),” is labeled “No acceptance of positive QSARS (applies for no acceptance scenario and years 1-6 of QSAR scenario.)”

Registration Costs

Under REACH, manufacturers and importers must register all chemical substances manufactured or imported at or above 1 tonne/year. Substances in articles must also be registered in some cases. Each registration must include a “technical dossier” including a summary of testing results. In addition, a Chemical Safety Report (CSR) is required for chemical substances manufactured or imported at or above 10 tonnes/year. The CSR documents that a chemical safety assessment (CSA) has taken place; this includes a human health hazard assessment, an environmental hazard assessment, and assessments for persistence and bioaccumulation in the environment (PBT and vPvB assessments).⁴⁸

REACH also requires registration for both on-site and transported isolated intermediates at or above 1 tonne/year. The registration requirements for on-site isolated intermediates, and for transported isolated intermediates below 1000 tonnes/year, are minimal; they are based only on existing test results, and no new testing is required. At or above 1000 tonnes/year, transported isolated intermediates are subject to the same testing requirements as manufactured substances produced in the 1-10 volume tier (Annex V of REACH).

We draw figures for costs of registration from RPA.⁴⁹ We then reduce all cost figures to reflect the fact that RPA appears to have used unrealistically high salary figures. Specifically, we reduce the estimated daily pay rate from €1000 to €750.⁵⁰

Beyond this adjustment, we make a series of additional assumptions, as follows.

- Percent dangerous: Under REACH, registration requirements vary depending on whether a chemical substance is categorized as “dangerous” or not. Following RPA, we assume that 40% of all substances covered by REACH are dangerous.⁵¹
- Registration costs for intermediates: For intermediates in the lower three volume tiers, we assume that the minimal registration required⁵² would be completed in a single professional day; thus, we estimate a cost of €750. For

⁴⁸ REACH legislation, October 29, 2003, pp. 74-81.

⁴⁹ We take information on costs of full registration from RPA's table of “costs of full registration for phase-in substances.” RPA 2003, Table 5.6, p. 60. We draw figures on “less onerous registration” for phase-in substances from RPA's Table 5.5 (RPA 2003, Table 5.5, p. 58).

⁵⁰ While the Commission has adopted a daily rate of €875 for its calculation (Fabio Leone, European Commission staff, personal communication), €750 appears to be a more reasonable independent estimate. We applied the 25% reduction to 80% of the registration costs, assuming that 20% of the registration costs consist of nonlabor expenditures.

⁵¹ RPA 2003: 59. A similar result can be arrived at by using the statistics provided by the European Chemicals Bureau at <http://ecb.jrc.it/new-chemicals/>. According to the information provided there, risk assessments for new chemicals have found that about 56% were “of no immediate concern,” leaving 44% potentially dangerous.

⁵² REACH proposal of October 2003: 82.

the top volume tier, we assume that four professional days of work will be necessary, with a cost of €3000.

- Consortium formation: REACH provides firms with the option to form cost-saving consortia, in which several firms would collaborate to produce testing data on substances they all produce. Forming a consortium implies some administrative costs; according to RPA's calculations, forming a consortium is cost effective if three or more firms take part for substances in the lower volume tiers, or if two or more participate for substances in the higher volume tiers. For nondangerous substances, which are subject to lower registration requirements, forming a consortium is cost effective if four or more firms participate. In our calculations, we have made no adjustment to account for consortium formation. This is a conservative approach; adjusting for consortium formation would lower estimated costs. It is worth bearing in mind that firms will have strong incentives to form consortia, since this will be a cost-saving measure.
- Number of intermediates: Again, we have been conservative. We begin with RPA's 2003 figures for the total number of intermediates, and subtract from this the number of intermediates that RPA classifies as type 4. This approximates, but does not precisely match, an adjustment performed by RPA to compensate for possible double counting of certain substances in the chemicals and the intermediates category.⁵³ Our adjustment produces a similar final number to RPA's calculation.
- The Commission carries out a further adjustment that lowers registration costs, moving 5900 chemicals substances into the "intermediates" category, and treating them as having equivalent testing and registration costs to "type 3" intermediates (although they are type 4). We do not make this adjustment.

To find registration costs for REACH Plus, we make the following adjustments to the calculation for REACH. First, we apply the registration cost per substance for the 10-100 volume tier (€11,536) to the 1-10 volume tier as well. Second, we apply the REACH costs for dangerous substances to all substances, because REACH Plus requires the same registration information for all substances, whether they are categorized as dangerous or not. As a result, the REACH Plus registration totals are about 50% greater than the REACH registration totals.

We also adjust our registration costs to account for the possibility that downstream users may have to submit additional registrations for unintended uses. We assume that this adds 10% to the total registration cost for intended uses.

We calculate a total registration cost of €457 million for REACH and €689 million for REACH Plus.

⁵³ RPA 2003: 27, Table 3.8.

Comparison to Commission Estimates

Our combined testing and registration cost estimate of €3.5 billion for REACH is significantly greater than the Commission's latest estimate of €2.3 billion. It is difficult to make a direct comparison of these two estimates since the methodologies employed are so different. The Commission's estimate was obtained by subtraction and adjustment from the estimate of €13 billion for the previous, more demanding May 2003 version of REACH. Our estimate, in contrast, rests on a bottom-up calculation comparable to those used by the Commission in earlier studies. The largest subtraction from the €13 billion estimate was for the reduction in the required costs of Chemical Safety Reports (CSRs); we suspect that the Commission may have overstated the cost and complexity of these reports, and therefore subtracted too much in calculating the costs of the latest version of REACH.

Our REACH Plus scenario restores some of the features of the May 2003 REACH proposal (the Consultation Document), yet our total cost estimate of €4.0 billion for REACH Plus is €9 billion less than the Commission's €13 billion cost estimate for May 2003 version. Of this difference, €3 billion is due to the fact that some categories of polymers were covered by the Consultation Document, while all polymers are exempt under the current version of REACH and REACH Plus. The remaining €6 billion difference appears to be based on the costs of CSRs: the Consultation Document required more CSRs (for example, there were more requirements for filings by downstream users); and it also may have overstated the average cost per CSR.

Appendix 2: Formal Analysis of Single-Market Model

This model, as discussed in Section 4 of the text, assumes that the chemical industry represents a single market; we analyze the response of that market to a cost increase that shifts the supply curve upward, following standard microeconomic theory. As shown in Figure 4.1 in the text, the equilibrium price and quantity before the cost increase are P_0 and Q_0 respectively, while the new equilibrium price and quantity after the increase are P_1 and Q_1 . The industry's total sales revenue is P_0Q_0 before the increase, and P_1Q_1 after the cost increase is in effect.

For small percentage changes in costs – as in the case of REACH – the new equilibrium price and quantity can be calculated in terms of three parameters:

- the price elasticity of demand⁵⁴, e_D ;
- the price elasticity of supply, e_S ; and
- the ratio of regulatory costs to industry revenues, r . (If R is the total direct cost of REACH, then $R = rP_0Q_0$.)

Formally, the solution to the model is as follows:

The definition of the price elasticity of demand implies that, for P near P_0 , the demand curve can be written as (note that by convention, the sign is reversed so that $e_D > 0$)

$$(1) \quad e_D = - \left(\frac{\frac{Q - Q_0}{Q_0}}{\frac{P - P_0}{P_0}} \right)$$

Likewise, the definition of the price elasticity of supply implies that, for P near P_0 , the supply curve before the cost increase can be written as

⁵⁴ Strictly speaking, the price elasticity of demand is negative. We adopt the common convention of referring to its absolute value as “the price elasticity”; thus $e_D > 0$ throughout our discussion.

$$(2) \quad e_s = \left(\frac{\frac{Q-Q_0}{Q_0}}{\frac{P-P_0}{P_0}} \right)$$

These equations can be rearranged to express the value of P, so that (1) becomes

$$(3) \quad P = \frac{-P_0}{e_D Q_0} Q + P_0 \left(1 + \frac{1}{e_D} \right)$$

Similarly, (2) becomes

$$(4) \quad P = \frac{P_0}{e_S Q_0} Q + P_0 \left(1 - \frac{1}{e_S} \right)$$

The cost increase shifts the supply curve upward by rP_0 , so (4) becomes

$$(5) \quad P = \frac{P_0}{e_S Q_0} Q + P_0 \left(1 - \frac{1}{e_S} + r \right)$$

The new equilibrium, after the cost increase, is found by solving equations (3) and (5), i.e. the demand curve and the shifted supply curve. The solution is

$$(6) \quad P_1 = P_0 \left(1 + \frac{r}{1 + \frac{e_D}{e_S}} \right)$$

$$(7) \quad Q_1 = Q_0 \left(1 - \frac{r}{\frac{1}{e_D} + \frac{1}{e_S}} \right)$$

To make use of this solution, numerical estimates are needed for the elasticities, and for r . In the study of REACH for DG Enterprise, Canton and Allen estimate that $e_D = 2$, based on a study of UK manufacturing exports.⁵⁵ If $e_S = 2$ as well, then (6) and (7) reduce to the simple forms

$$(8) \quad P_1 = P_0 (1 + r/2)$$

$$(9) \quad Q_1 = Q_0 (1 - r)$$

Although these results are based on an arbitrary value for e_S , it is impossible for the changes in P and Q to be more than twice this large, whatever the value of e_S .⁵⁶ With the assumption that both elasticities are 2, the new total sales revenue, for small values of r , is approximately

$$(10) \quad P_1 Q_1 = P_0 Q_0 (1 - r/2)$$

That is, at the new equilibrium half of the cost increase is passed on in higher prices; sales volume (Q) decreases in proportion to the cost increase; and sales revenue (PQ) decreases by about half as much as volume. The chemical industry's revenue, net of the direct costs of REACH, decreases by $(3r/2) P_0 Q_0$ – because the industry loses both the direct costs that it must pay, $r P_0 Q_0$, and the effect of the price increase, $(r/2) P_0 Q_0$.

Economists measure the change in welfare resulting from a regulatory cost increase by the loss of consumer and producer surplus. These are the areas of the triangles in Figure 4.1 – consumer surplus is the triangle filled with vertical lines, while producer surplus is the triangle with horizontal dashes. As the figure shows, the area of the consumer surplus triangle is

$$(11) \quad \Delta CS = \frac{1}{2} (P_1 - P_0)(Q_0 - Q_1)$$

⁵⁵ Canton and Allen 2003: 23. The original source is Michael Landesmann and Andrew Snell, "The Consequences of Mrs. Thatcher for U.K. Manufacturing Exports," *Economic Journal* 99 (March 1989), 1-27. Landesmann and Snell estimate a long-run price effect of 1.671 for chemicals, higher than for several other manufacturing exports (Table 4, p.17); this was apparently rounded off to 2.0 in Canton and Allen.

⁵⁶ In the theoretical extreme, the greatest changes in P and Q would occur if supply became perfectly price-elastic, implying an infinite value for e_S . With $e_D = 2$ and $1/e_S = 0$, equations (6) and (7) would become

$$(8a) \quad P_1 = P_0 (1 + r)$$

$$(9a) \quad Q_1 = Q_0 (1 - 2r)$$

The extreme outcome of (8a) and (9a) is implausible in reality, since major industries do not have perfectly elastic supply curves.

If the supply and demand elasticities are equal to each other, the loss of producer surplus will be equal to this amount as well. Substitution of the general solutions, (6) and (7), into (11) shows that the loss of consumer surplus is proportional to $r^2 P_0 Q_0$; continuing the assumption that both the supply and demand elasticities are equal to 2, equation (11) becomes

$$(12) \quad \Delta CS = \frac{1}{4} r^2 P_0 Q_0$$

All that remains is to substitute the actual values of r , from Section II of the text, into equations (8), (9), (10), and (12). For total industry revenue before the cost increase (i.e., $P_0 Q_0$), we use the recent figure of €556 billion.

For REACH, $r = .00057$, or 0.057%. Thus REACH would increase prices by 0.028%, and decrease output by 0.057%. The industry's total sales revenue would decline by 0.028%; the net received by the industry (after subtracting the costs of REACH) would each decline by 0.085%. Consumer and producer surplus would each decline by €45,000 per year.

For REACH Plus, $r = .00065$, or 0.065%. Thus REACH Plus would increase prices by 0.032% and decrease output by 0.065%. The industry's total sales revenue would decline by 0.032%; the net received by the industry would decline by 0.097%. Consumer and producer surplus would each decline by €59,000 per year.

It should be clear that these losses of consumer and producer surplus are of insignificant size when compared to the industry's revenues, let alone the GDP of the European Union.

Appendix 3: Critique of Arthur D. Little Model

At 205 pages, the original Arthur D. Little (ADL) study for BDI is by far the most extensive industry-oriented critique of REACH, and offers the most detailed case for huge cost estimates. Later ADL studies use the same methodology without repeating its explanation. Mercer's similar-sounding studies for French industry may have used the same methodology, although it is impossible to tell from the Powerpoint summaries, which are all that Mercer has released to date. Thus in understanding the methodology of the industry-sponsored studies that yield huge cost estimates, there is almost nowhere else to turn. The discussion here focuses on the intermediate or "Storm" scenario, the most widely discussed set of results from the ADL model.

ADL presents four categories of "primary effects" of REACH (pp.46-47):

- costs of registration and evaluation (mainly *testing*);
- economic losses due to *delays* caused by registration and evaluation;
- data disclosure (*transparency*) requirements; and
- *authorization* of dangerous substances

Of these categories, authorization never accounts for a large cost impact, perhaps because ADL assumes that only 1% of chemicals will require authorization (p.45). Thus the large costs projected by ADL emerge from the remaining three categories. ADL identifies a number of potential subcategories, particularly for the registration/evaluation costs (pp.60-63), and then identifies the three most important, as well as three second-tier, specific cost factors influencing their scenario results.

The most important factors are:

- costs for registration of substances and uses
- multiple registration of substances (by multiple manufacturers and importers)
- time lost in registration of substances

Factors of intermediate importance include:

- costs for registration of additional use categories, beyond the 5 in the basic regulation
- extent of the duty of registration for intermediate products
- implementation of transparency requirements

ADL model structure

The model concentrates most of its effort on representing losses of manufacturing output. Then the final stage assumes that losses in non-manufacturing sectors are proportional to their sales to manufacturing (p.59). Finally, GDP loss is the sum of manufacturing and non-manufacturing losses. The result is that GDP loss, in percentage terms, is just under 1/3 of manufacturing losses, e.g. the Storm scenario finds 7.7% loss in manufacturing, and 2.4% loss in GDP.

The analysis examines three industries in depth – textiles, automobiles, and electronics – and the rest of German industry in more summary fashion. For many variables, including several discussed here, ADL presents data (Appendix 8, pp.175-180) on 35 industries: 20 narrow subcategories within textiles, automobiles, and electronics, and 15 broader categories representing the rest of German industry.

The model structure is represented by 16 equations in Appendix 10 (pp.191-201). It calculates percentage losses in manufacturing separately for what it calls Phase 1 (registering and testing the 30,000 existing chemicals) and Phase 2 (addressing new chemicals only). The reported figures for losses include both – that is, the percentages of output surviving Phase 1 and Phase 2 are multiplied to find the percentage surviving both (Equation 2, p.192).

Industry Factor

Most components related to registration and authorization costs, in both Phase 1 and Phase 2, are multiplied by an “industry factor” (IF) that ranges from 0 to 12, supposedly reflecting the competitiveness or monopoly power of the industry (p.53; also Equation 6, pp.194-95). This may be the worst single feature of the model; it is based on a casual and inaccurate understanding of economic theory, combined with arbitrary judgments about the magnitude of this crucial factor.

The IF is supposed to represent the degree of competitiveness in the industry. Cost increases are multiplied by the IF to estimate production losses; a more competitive industry has a bigger IF and loses more for the same level of cost increases. At one extreme, a perfect monopoly is said to be able to pass on all cost increases to customers, with no losses in production, implying an IF of 0. At the other extreme, a perfectly competitive industry is said to be unable to pass on any cost increases to customers. The profit margin for German industry averages about 8%; so if it were impossible to pass on any cost increases in higher prices, an 8% cost increase would wipe out all profits, forcing the industry to shut down – a loss of output equal to about 12 times the underlying cost increase, or an IF of 12 in ADL’s terms.

Neither extreme is a reasonable deduction from economic theory. A monopolist facing a cost increase will, in general, sell somewhat less; as in elementary textbook diagrams, the cost increase shifts the supply curve upward, increasing the equilibrium price and decreasing the quantity sold. That is, the IF for a monopoly should be greater than 0; the

exact value depends on the price elasticities, or the slopes of the supply and demand curves. On the other hand, if every producer in a perfectly competitive industry faces a cost increase, the industry supply curve also shifts upward, causing an increase in price. A firm in a competitive industry is unable to pass on cost increases only in the special case where no other producer experiences the increase, so that no one else's price rises.

However, a policy like REACH affects all firms in Europe, and all firms that want to sell their products in Europe. Thus cost increases due to REACH will be passed on to customers, at least in part, even in very competitive industries. As a result, a hypothetical 8% cost increase (which is far above any credible estimate of REACH costs) would not all come out of profits, and the industry would not shut down – meaning that the IF should be less than 12. Again, the exact value depends on price elasticities of supply and demand.

Ignoring these considerations, ADL accepts 0 for perfect monopoly and 12 for perfect competition as the potential extremes of the IF. The study reports IFs for 35 industries (Appendix 8), with a median value of 9, apparently based on a complex, ad hoc process of interviews and judgments. In effect, ADL assumes that on average German industry is three-fourths of the way from monopoly power toward small, powerless firms in competitive markets – which is not necessarily an accurate portrait of Europe's leading industrial nation. For the purposes of the model, the result of this controversial judgment is that all costs of registration and evaluation are multiplied by an industry factor, averaging 9.

Phase 1 Loss Estimates

The production losses due to registration costs are calculated as a product of many factors, a method that amplifies any errors, uncertainties, or overestimates. Judgment errors that inflate individual factors are multiplied by other factors, allowing a cascading process of overstatement to begin from small errors.

In ADL's own words, the registration cost burden is the product of "the number of substances to be registered multiplied by the costs of a registration, by the number of multiple registrations and by the number of intermediate products (assuming identical registration costs)." (Appendix 10, p.191) This cost burden is expressed as a percentage of industry sales, and then multiplied by the IF to obtain the resulting loss of production.

For Phase 1, the large one-time costs of registering the 30,000 existing chemicals are also divided by the number of years over which these costs will be amortized, assumed to be 7 (Table 10, pp.50-51). In contrast, other studies have more appropriately spread these costs over the entire 11-year transition period. Thus ADL's amortization process effectively multiplies Phase 1 costs by an unwarranted factor of 11/7.

The underlying cost per registration is also scaled up to reflect the number of uses, assuming that only 5 uses are covered by the basic registration. The Storm scenario as-

sumes 2 additional, or 7 total, uses per chemical, with costs varying by size class. Each additional uses adds 18% to the basic registration cost for 1-10 tonne/year chemicals, 11% as much for 10-100 tonne/year chemicals, and less for larger-volume ones, as shown by comparison of pp.181, 183. Thus, incorporating two additional registrations increases the cost per registration by at least 25% (probably more) of the basic, 5-use cost.

The number of multiple registrations is used only in the Hurricane scenario (where it helps to inflate the huge estimated losses reported there), but does not enter the Storm scenario. The other relevant factor is the cost of registering intermediate products. In the Storm scenario there are three intermediate products per chemical, each requiring 1/3 the registration cost of the chemical itself. In other words, intermediate product registration doubles the reported cost of registration (p.185).

In Phase 1, the registration cost, as inflated, is essentially the only cost (ignoring authorization cost, which turns out to be unimportant in ADL's scenarios) (Equation 3, p.192). However, in comparison to other studies, ADL has multiplied Storm scenario Phase 1 registration costs by factors of

- 9, on average, for the industry factor;
- 11/7 for accelerated amortization;
- 1.25 or more for additional use registration; and
- 2 for intermediate product registration.

The combined result (product of the four factors above) is a factor of 35 or more. That is, given an underlying estimate of registration and testing costs, the ADL Storm scenario multiplies the transition period costs by at least 35 in calculating its Phase 1 losses on existing chemicals.

Phase 2 Loss Estimates

As noted above, the ADL model multiplies the Phase 1 percentage losses on existing chemicals by the separately estimated Phase 2 losses on new chemicals, to estimate the combined loss in a year in which both categories of costs are experienced. ADL estimates that there will be 1000 new chemicals per year, about three times the number reported in recent years by the European Chemicals Bureau. Since REACH eases the regulatory requirements on new chemicals, one might expect ADL's methodology to project an increase in output; yet in their model, Phase 2 also causes substantial losses.

Phase 2 losses are calculated as the product of losses due to registration cost, time delay, authorization cost, and transparency requirements (Equation 7, p.196). The estimated authorization losses again can be safely ignored in practice.

Registration costs. The registration costs are calculated much as for Phase 1, with all the same factors except the one related to accelerated amortization. (Phase 2 costs are incurred annually, with no amortization involved.) In other words, there is an apparent exaggeration factor of at least $9 * 1.25 * 2 = 22.5$ applied to Phase 2 registration cost-related losses.

Costs of delay. The time factor assumes that there are potentially enormous losses associated with delays in bringing new products to market. This delay is compared to the assumed length of the product life cycle in each industry. Letting R = the ratio of delay to product life cycle, the model assumes that the percentage loss in production due to delay is equal to

$$(1 - [1 - R]^{2R}) * k$$

where k is the “inverse cannibalization factor.” (This is Equation 14, p.201, with simplified notation.) The only description of the cannibalization factor says that it “describes how quickly an existing product can be replaced by an innovation.” (p.54). A factor of 1 would mean that new products immediately replace old ones; a lower factor means that old ones can coexist with new ones for a while, so that losses in introduction of new products are less than expected. In ADL’s data the cannibalization factor is usually 0.5 or 0.2, although a few industries with short life cycles have factors of 0.8 (Appendix 8, pp.175-180).

In the Storm scenario, all new products are assumed delayed by 9 months. For the 35 industries covered in the study, the median length of the life cycle is 60 months (Appendix 8, pp.175-180), so $R = 9/60 = 15\%$ of the product life cycle. With $k = .5$ and $R = .15$, the expression shown above is

$$(1 - 0.85^{0.3}) * 0.5 = 0.024$$

—a relatively modest reduction of 2.4% in the median industry. However, the expression involving R is highly nonlinear; as R becomes larger (i.e., product life cycle becomes shorter), the estimated losses grow much more than proportionally. (This is true by design; ADL consciously sought a functional form with that property, according to the one vague discussion of the equation on p.54.) A quarter of the industries have product life cycles of 30 months or less; at 30 months, $R = 9/30 = .3$, and the expression for the loss (still with $k = 0.5$) becomes

$$(1 - 0.7^{0.6}) * 0.5 = 0.096$$

—nearly a 10% loss.

At the extreme, three industries have product lifecycles of 12 months ($R = 9/12 = .75$), and two of these have $k = .8$; for these, the model estimates a loss of production due to time delay of

$$(1 - 0.25^{1.5}) * 0.8 = 0.7$$

— that is, an incredible 70% loss of production due to the assumed time delay alone.

Disclosure/transparency loss. Finally, the loss due to disclosure or transparency is simply based on reporting what industry believes the losses will be. The equation for this factor (Equation 16, p.201) shows that there is no equation (at the end of a list of intricately detailed equations on other topics, Equation 16 says that the losses due to disclosure “=f(scenario)”, without further elaboration). The discussion of this part of the model merely says of the transparency parameter: “Operationalisation was carried out as follows: the production loss was estimated by industry experts as being the know-how affected.” (p.55)

According to the industry experts, the median loss due to transparency requirements was close to 5% (19 of the 35 industries had estimated production losses of 5% or less), but a handful reported much higher losses. Five industry branches, all in textiles, estimated production losses of 30% or more due to disclosure of information required under REACH (Appendix 8, pp.175-180).

There is no simple way to summarize the average exaggeration factor for Phase 2, comparable to the factor of 35 or more obtained for Phase 1. However, the Phase 1 losses, and the individual components of Phase 2 losses, are estimated separately and then multiplied, hence engaging in mutual cross-exaggeration. Since Phase 2 (new chemicals) experiences no net increase in regulation under REACH, all estimates for Phase 2 are effectively exaggerations.