Regulatory push-pull effects on innovation: an evaluation of the effects of the REACH regulation on patents in the chemical sector

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Find part I "Taxonomy of implemented policy instruments to foster the production of green technologies and improve environmental and economic performance" here.

Find part III "Credibility of the REACH Regulation: Lessons Drawn from an ABM" here.

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Abstract

The Europe 2020 Strategy has identified the key goal of smart, more inclusive and sustainable growth. In this direction, redirecting firms' innovation activities towards ecological targets without hampering their competitiveness is of paramount importance.

The double externality issue related to environmental innovations makes the policy intervention crucial in order to avoid sub-optimal commitment of resources to the innovation process and ensure the reduction of polluting agents emissions

However, the positive outcome of any policy inducement mechanisms is not guaranteed, as different policy frameworks may generate different innovative outcomes. An in depth analysis of environmental policy instruments is therefore all the more necessary in order to gain knowledge on the state of the art and evaluate the scenarios for further improvements.

In this perspective, the proposed research project will focus on two main research questions:

1. What are the main existing EU policy instruments explicitly designed to trigger environmental innovations? Which are their main features?

2. Which are the possible avenues leading to successful policy design?

The first research question will be tackled by performing a desk research aiming at analyzing the main environmental regulations introduced in Europe so as to produce a clear and comprehensive taxonomy to shed light on common dimensions and main differences.

The second research question will be addressed by carrying out empirical analyses based on simulation and econometric techniques. We will focus on a specific environmental policy in the chemical domain so as to draw useful insights on the effect of the policy aiming at redirecting innovation activities to environmental targets and also to highlight the main policy best practices.

Contribution to the Project

The expected output of this project consists of three papers:

1) Taxonomy of implemented policy instruments to foster the production of green technologies and improve environmental and economic performance

2) Agent-based simulation of scenarios of a regulation's impacts on environmental innovations

3) Empirical analysis of the effectiveness of a regulation on the generation of green technologies and on environmental and economic performances

In this respect the research activity is likely to provide a sound contribution to the overall objective of the WWWforEurope project, i.e. is to lay the analytical basis for a socio-ecological transition.

In particular, we will review and classify the state-of-the-art in terms of environmental policy instruments and provide analyses able to identify strengths and weaknesses of a typical regulation explicitly inspired by the Porter hypothesis (i.e. REACh). These are essential steps to identify a feasible European growth and development strategy enabling a socio-ecological transition to high levels of employment, well-being of its citizens, social inclusion, resilience of ecological systems and a significant contribution to the global common goods like climate stability.

Keywords:

Academic research, Industrial policy, Innovation, Innovation policy, Patents

Jel codes:

O33, Q53, Q55, Q56, R11

Regulatory push-pull effects on innovation: an evaluation of the effects of the REACH regulation on patents in the chemical sector

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1. Introduction

The main goal of the current contribution is to evaluate the effects of an EU-wide regulation on innovation in the chemical sector. The regulation under scrutiny is the Chemicals Regulation "Registration, Evaluation and Authorization of Chemicals" (REACh).

It configures in principles as a "Command and Control" type of regulation, as it imposes a set of requirements to be filled in order to allow firms – either producers or importers or users of chemicals- to stay in the market, according to the underlying principle "No data No Market". Such typology of regulation, has been described as weaker than market-based instruments, as it creates less incentives and lower flexibility (Requate, 2005). However, it is an interesting case study as it is not just a Command and control type of regulation, for the information requirements that are associated to its implementation. By increasing information on the risks of chemical substances it works also as an information mechanism based policies. Furthermore, it explicitly mentions the potential it creates for innovation in the chemical sector and it applies to all firms operating inside EU market: either firms producing in Europe or EU firms importing chemicals from outside EU boundaries or foreign firms exporting chemicals to Europe.

Section 2 describes the regulation in details and the main regulation and international conventions that embrace the chemical sector. Section 3 provided an overview of the peculiarities of the chemical sector in Europe and gives aggregate empirical evidences on innovative activities based on patent data. Section 4 describes the data, sources, methodology and empirical evidence on a firm level analysis we performed to test whether REACh lead to an increase in innovative activities in the chemical sector. Section 5 concludes and provides the main policy implications of our findings.

2. Case study: REACH regulation

The EU Chemicals Regulation "Registration, Evaluation and Authorization of Chemicals" (REACh), introduced on the 1st of June 2007, is an example of EU wide environmental regulation aimed at reducing the environmental threats of chemicals.

It covers any chemical substances – imported or manufactured - for all manufacturers and importers of chemicals in all EU27 Countries, Norway, Lichtenstein and Iceland. Any substance potentially hazardous, if manufactured or imported for more than one tonne per year, needs to be authorized and in some cases are banned. It excludes substances and products already regulated by legislation e.g. toys, medicines, radioactive substances (under Euratom) and substances used for R&D. The regulation is built along a 4 pillars procedure.

At first a **registration** of chemicals and their risks is required. In this step producers and importers of substances are requite to deliver safety and use data to the European Chemicals Agency. Chemical safety reports and assessments, based on the information on the substance contained in the technical dossier, should include information related to the hazards of the substance, the exposure arising from the manufacture or import, the identified uses of the substance, operational conditions and risk management measures applied or recommended to downstream users to be taken into account as well as a Human health hazard assessment and and environmental hazard assessment.

Second pillar is the **Evaluation** of the need of additional testing of the substance.

Then there is the **Authorization** step, in which chemicals are authorized, specifically substances with very high concerns, e.g. carcinogens, mutagens and substances that exhibit reproductive damaging effects, substances persistent, bioaccumulative and toxic (PBT) and identified as causing serious and irreversible effects to humans or the environment.

Lastly, there might be a **Restrictions** pillar, in which a ban of those substances that do not fulfill safety and environmental requirements is set up. This phase is a "'safety net' to deal with unacceptable risks to human health and the environment, through adopting restrictions on manufacture, use and/or placing on the market of a substance" (Warhurst, 2006: 1038).

The responsibility for fulfilling to the regulation, i.e. register and provide a risk management and assessment of used substances is no longer in the hand of single Member States, who only have to enforce the regime, rather is almost completely in the hand of private actors according to the principle of "self-responsibility".

Downstream users of chemicals share the responsibility of registering risks arising from their use of substances if those are not covered by a safety register fulfilled by their suppliers.

A central European Chemical Agency has been created by this regulation, the ECHA, in charge of receiving, validating and eventually approving the use of any chemical substance under REACH.

Each importer or manufacturer of chemicals must provide ECHA with a register of substances used (if > 1 tonne per year). ECHA evaluates the register and authorizes or not the use of each substances. The underlying principle is "no data no market". A further incorporated principle is the precautionary one, as "substances are to be screened for their possible potential effects and not only because risk has been scientifically validated" (Koch & Ashford, 2006: 40).

The timing of REACH is gradual. Introduced in 2007 it obliges registration of all already existing substances, or "non-phase in" by the 1^{st} of June 2008. The REACH Regulation creates a special transition regime for phase-in substances, i.e. new to the market substances, but they must be pre-registered. All in all, depending on substances intrinsic properties and tonnage, a pre-registered substance should be registered by 1 December 2010, 1 June 2013 or 1 June 2018.

REACH configures as a command and control type of regulation, as it imposes a requirement to be filled, by firms, to be and stay into the market.

At the same time, however, it imposes firms to provide more information on the risks associated to the use of chemicals, either on environment or health. In this respect it acts not only as a Command and Control but also as an information based instrument, as it improves consumer and users awareness on the environmental impacts of chemical substances on the market and on the alternatives available. In a way, it works similarly to Eco-labels, as it is possible to users of chemicals to be adequately informed on the risks of any registered substance and to eventually evaluate the use of an alternative – less harmful – substance.

Furthermore, it explicitly mention the potential it creates for innovation and it allows an exemption from the duty of registration to R&D activities towards product or processes. The main channel through which REACh is expected to drive innovation is the search of new substances or processes. Chemical importers or manufactures are induced to innovate in order to substitute the use of banned substances with alternative and less harmful one or to find more efficient production methods that allow a reduction in the use of certain chemicals. Furthermore, the registration of substances provides information to the users of chemicals, and can thus be seen as a softer measure of information based system.

For these reasons we have chosen to focus on this specific regulation and to evaluate its effects on innovative activities.

Although some critical contribution on its too ambitious goals and its structure have already emerged (Stokes & Vaughan, 2013), overall, evidence emerges of a substantial substances withdrawal.

The Center for Strategy and Evaluation services, elaborated a "REACh interim Report" according to which 35 percent of respondent firms have experienced a withdraw of at least 1 substance from one or more supplier.

At the same time, producers or users close to the threshold above which registration is required, experienced a strategic reduction in production volumes to be stay below this threshold. The main explanation has been related to the relatively high costs associated to the registration.

More precisely, a scheme of fees for registration which vary according to a) the quantity used, b) the size of the firm, c) the choice of submitting the register of the substance individually or jointly has been set up and d) the substance registered. Table 1 describes the fee structure for standard substances (under Art 6,7 or 11 of Regulation EC n. 1907/2006) and big firms. Small and Medium Enterprises can have a fee reduction which varies according to the "micro", "small" or "medium" size while higher or lower fees are associated with different substances [1].

[1] For the sake of brevity we do not report all the fee tables here. These are available into Annex I to VIII of the COMMISSION REGULATION (EC) No 340/2008 of 16 April 2008 on the fees and charges payable to the European Chemicals Agency pursuant to Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

Table 1: standard fees for registration of substances (under Art 6,7 or 11 of Regulation EC n. 1907/2006)

	Individual submission	Joint submission
Fee for substances in the range of 1 to 10 tonnes	1600	1200
Fee for substances in the range 10 to 100 tonnes	4300	3225
Fee for substances in the range 100 to 1 000 tonnes	11500	8625
Fee for substances above 1 000 tonnes	31000	23250

Relevant evidence is also that downstream users can generally substitute chemicals they use if the suppliers withdrew that substance imported. They can however also choose to either change the suppliers or register the substance themselves. The transmission process of the effects of the regulation between users and producers of chemicals is thus not automatic.

An important caveat has to be highlighted. What we are evaluating are the effects of REACH on innovation in its very first phase of implementation. Future analysis will be better equipped to perform a more rigorous evaluation of the overall policy, as it is expected to display its effects in 20 years, i.e. until 2027. Our aim is thus to understand whether the expectation and the immediate introduction of this regulation has been a stimulus for innovation in the very short-term.

Although, to our knowledge, no previous contributions attempted to investigate the effects of REACh on innovation dynamics, previous works have been focused on the potential side-effects of REACh on competitiveness.

Angerer et al. (2008), for instance, focused the cost burdens associated to REACh will be, and asked whether Member States who joined the European Union in 2004 would be hampered by it. The study concludes that there is no of peculiar drawbacks for those States, as REACh would be a challenge for firms, especially small and medium-sized ones, but for the whole European chemical industry not just for new Member States.

2.1 Possible confounding factors

In this subsection we provide an overview of other policies acting on chemical sector that may exacerbate the effects of REACh or, contrarily, may limit its effects. Specifically, the exisence of other policies acting on the same sector in the same direction may indeed act as a confounding factor that creates potential biases in our analysis.

We identified 3 groups of policies:

1. Other intra-European policies;
2. Extra-European policies;
3. International conventions.

At first there might exists other **intra-EU** policies in the same sector that can possibly have an overlap with REACh. Clearily, European chemical industry already has in place chemicals regulation, and the following legislations might present some overlaps with REACh (CESS, 2012):

- The Waste Electrical and Electronic Equipment Directive - WEEE Directive, (200 2/96/EC), which imposes recycling and recovery targets for electrical goods;
- The Cosmetics Directive (76/768/EEC), which sets and bans substances in cosmetics;
- The Construction Products Directive – CPD (89/106/EEC), willing to harmonize the market for construction products;
- The Restriction of Hazardous Substances Directive "RoHS, 2002/95/EC" imposing restrictions to 6 substances.

None of these policy measures may act as a confounding factor in our empirical analysis. As we will describe, our focus is only on firms using chemical compounds for food production, to which none of the above listed policy measures applies.

Secondly, also Extra-EU policies can affect EU producers. This is the case when a regulation in a specific country affects EU producers who export to that country.

The US chemical regulation called "US' Toxic Substances Control Act" (TSCA) belongs to this group. This is very similar to REACh, but it was introduced in 1976 and reformed in 2013 and it bans the manufacture or importation of chemicals that are not registered on the Inventory.

Moreover, it might be the case that previous international initiatives with big international echo displayed some effects on firms' behavior. For instance, firms might see in this initiative a sign of a forthcoming regulations to which they are willing to preemptively respond. Among these it is needed to mention the Stockholm Convention - UNEP 1st meeting in 2001 and 2004. This was on persistent organic pollutants, mainly pesticides e.g. aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, polychlorinated biphenyls, polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and toxaphene.

Furthermore, it deserves consideration also the Rotterdam Convention 1998-2004, a multiparty agreement on trade of hazardous chemicals.

In addition, although less relevant to the current contribution, it cannot be neglected the role of REACh in stimulating innovation or even regulation pressures outside Europe as well. REACH has been instead mentioned to be an example of regulation whose effects are spread outside its boundaries in the recent EEA report (EEA, 2014). In particular, as it affects all substances that are manufactured or marketed in the EU, i.e. all chemicals that are either exported or imported to the EU, it impacts third countries as well. Countries outside EU, in order to trade within EI are indeed required to fit the standards set by the regulation and, more precisely, to register the chemical substances used. This can not only impact on other countries innovations, but also on their regulatory regimes: indeed, regulation of chemicals in countries outside EU are aligning to fit REACH (EEA, 2014).

Lastly, REACh has been quoted as an example of EU as a producer of transnational law of risk regulation, as third countries have adopted EU models for setting up their own regulatory set up in the same industry (de Morpurgo, 2013).

3. Aggregate evidence on patenting in Europe

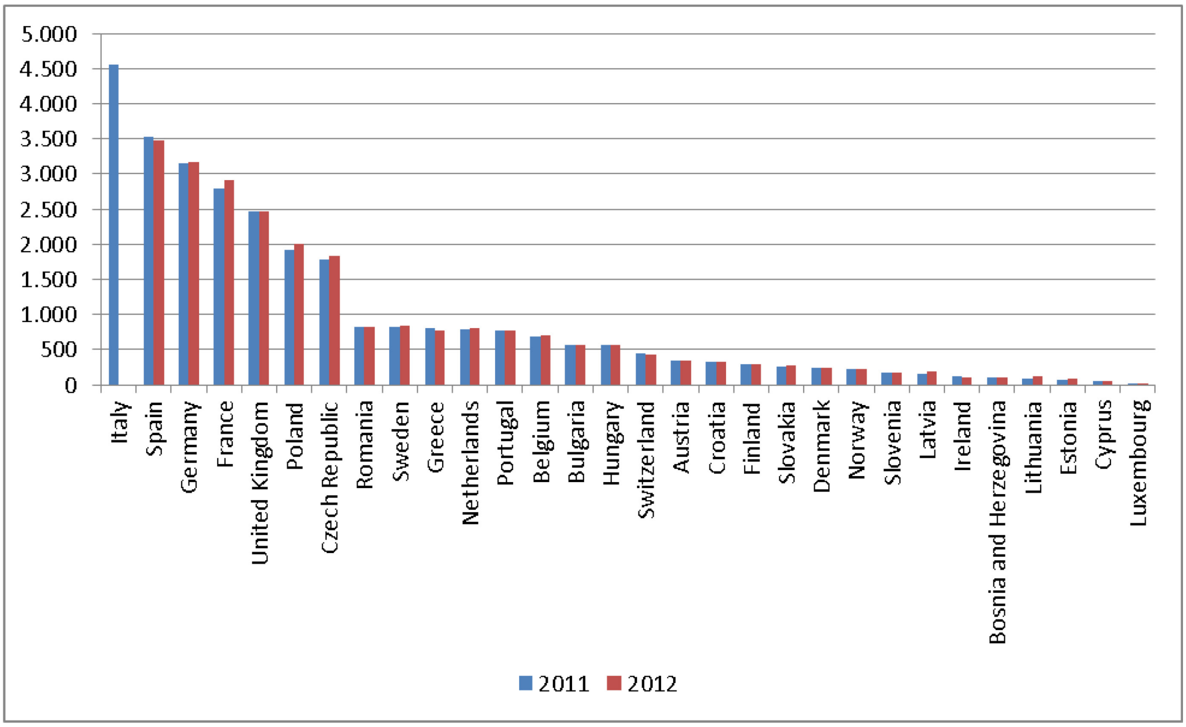
3.1 Chemical sector in Europe

Before moving to the analysis of the effects of REACH on innovative activities, it is needed an overview on the characteristics and peculiarities of the chemical sector.

The sector is characterized by a strong composition of big and multinational firms and in Europe is dominated by a relatively low number of countries.

If we look at the number of enterprises operating in the chemical sector, we find that Italy, Spain, Germany and France are the countries with the highest values (own elaboration on Eurostat data).

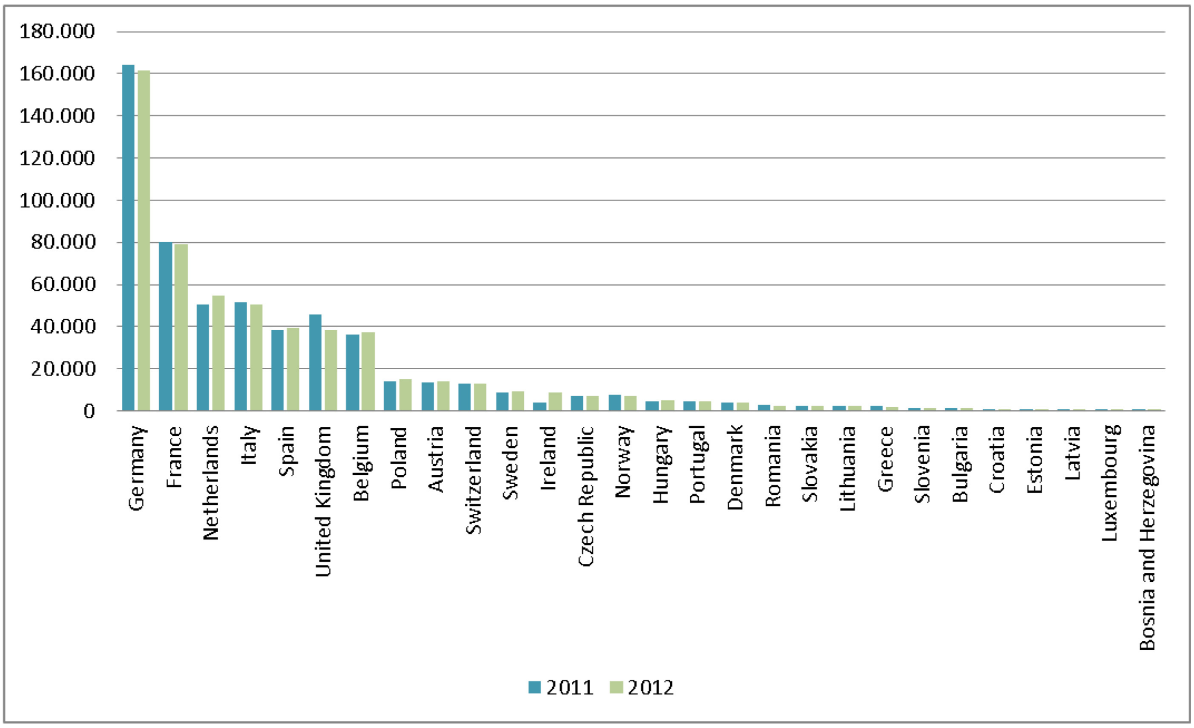
Figure 1: Number of enterprises in the chemical sector 2011, 2012



Source: Eurostat, only countries with available data

This domination of the European market by a few countries is reflected also in terms of economic returns. Turnover generated by chemicals and chemical products is distributed as in Figure 2, with Germany, France, Netherlands and Italy that are leading the ranking.

Figure 2: Turnover od chemicals and chemical products 2011, 2012

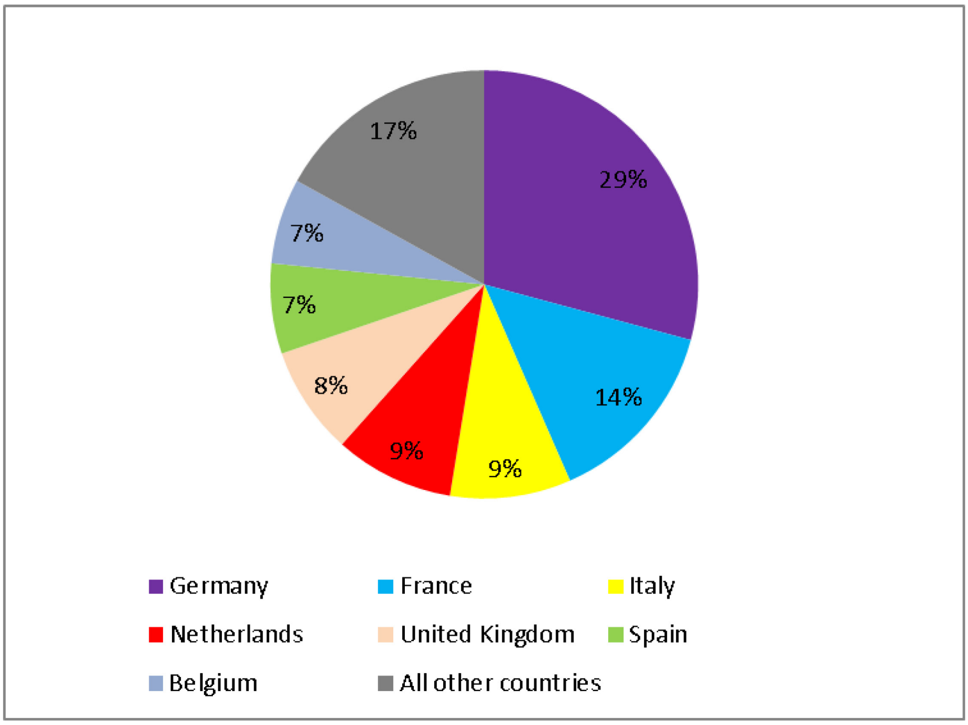


Source: Eurostat, only available countries

More interestingly, more than half of the turnover of the chemical sector in 2011 has been in the hand of only 3 countries and only 7 countries account for the 83% of it, as in Figure 3.

These evidences lead us to circuscribe the empirical analysis to only a subset of European countries, i.e. those with the highest values of enterprises in the chemical sector and with the highest share of turnover.

Figure 3: Share of turnover in chemicals and chemical product by EU countries, 2011



Source: Own elaboration on Eurostat data

3.2 Innovation in the chemical sector

Drawing on patent data we provide in this section aggregate evidence of the patenting activities in EU selected countries in the Chemical Sector.

We extracted data on patent both at the European Patent Office (EPO) and under the Patent Cooperation Treaty (PCT) from the OECD-REGPAT Database – July 2014 release. We then considered for our analysis patent applications that have been assigned to the country according to the address of the inventors.

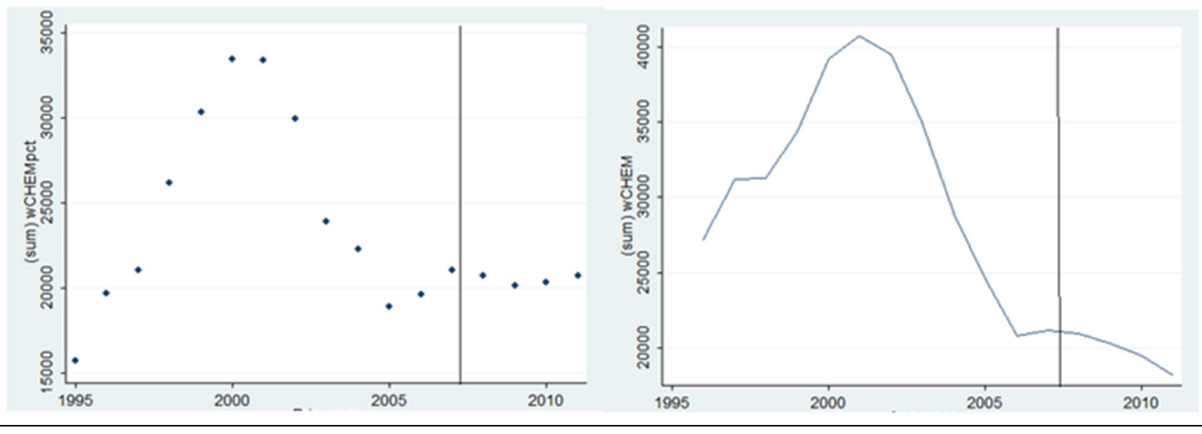
To analyze patents in the chemical sector we exploited the International Patent Classification (IPC) by WIPO and defined as chemical those patents whose IPC codes range from C01 to C14 included, as outlined into Table 2.

Table 2: Patents in the chemical sector, IPC codes - WIPO

IPC	Sector
C01	Inorganic chemistry
C02	Treatment of Water, Waste wter, Sewage or Sludge
C03	Glass, Mineral of slag wool
C04	Cements; Concrete; Artificial stone; Ceramics; Refractories
C05	Fertilisers
C06	Explosives; Matches
C07	Organic chemistry
C08	Organic macromolecular compounds; their preparation or chemical working-up; compositions based thereon
C09	Dyes; Paints; Polishes; Natural resins; Adhesives; compositions not otherwse provided for; Applications of materials not otherwise provided for
C10	Petroleum, gas or coke industries; technica gases containing carbon monoxide; fuels; lubricants; peat
C11	Animal of vegetable oils, fats, fatty substances or waxes; fatty acids therefrom; detergents; candles
C12	Biochemistry; Beer; Spirits; Wine; Vinegar; microbiology; enzymology; mutation or genetic engineering
C13	Sugar industry
C14	Skins; Hides; Pelts; Leather

In Figure 4 we plot the trend of patent applications in chemical IPC codes by European applicants. We considered both patent applications under Patent Cooperation Treaty (PCT), that simultaneously allow protection for an invention in multiple countries[2] and patent applications submitted at the European Patent Office (EPO) to provide a clearer picture. The main evidence is that of a descreasing trend in chemical inventions protected by patents from 2001, which follows a peak in 2000. The second evidence is that, after REACh was introduced in 2007, the descreasing trend seems to persist. Overall, we do not find aggregate evidence of an uptake of patents after REACh adoption.

Figure 4: Trend in innovative activity in chemicals of European applicants, respectively under PCT and at EPO

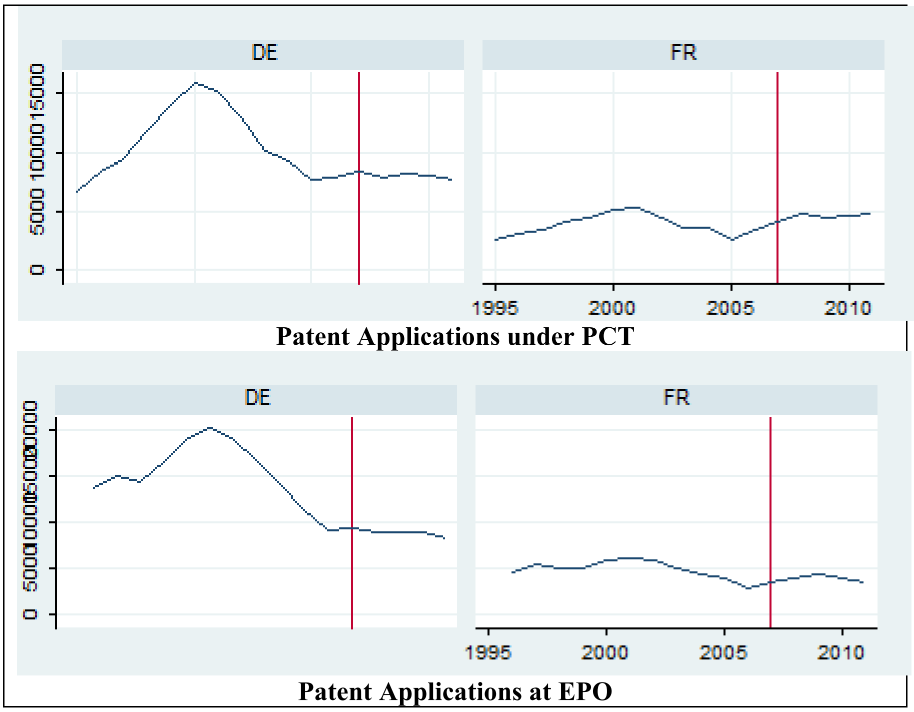


We then disentagle this evidence by plotting the trend in patenting activities for those European countries that emerged as the leading countries for the chemical sector in Europe into Section 3.1. For a matter of scale in patenting activity we report into Figure 5 the number of patent applications

[2] So far States that signed the treaty are 148, and are listed by the World Intellectual Property Organization here http://www.wipo.int/pct/en/pct_contracting_states.html.

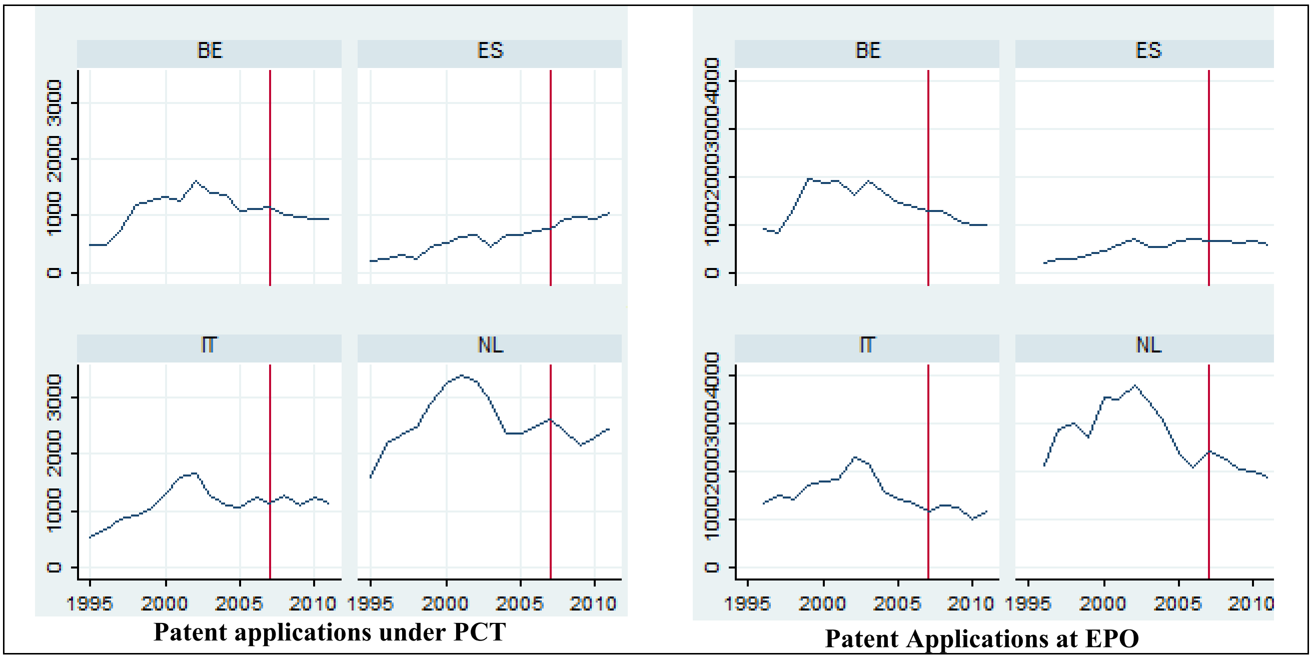
by German and French applicants, who show bigger absolute values and into Figure 6 those of Belgium, Italy, Netherlands and Spain.

Figure 5: Trend in innovative activity in chemicals of German and French applicants, respectively under PCT and at EPO



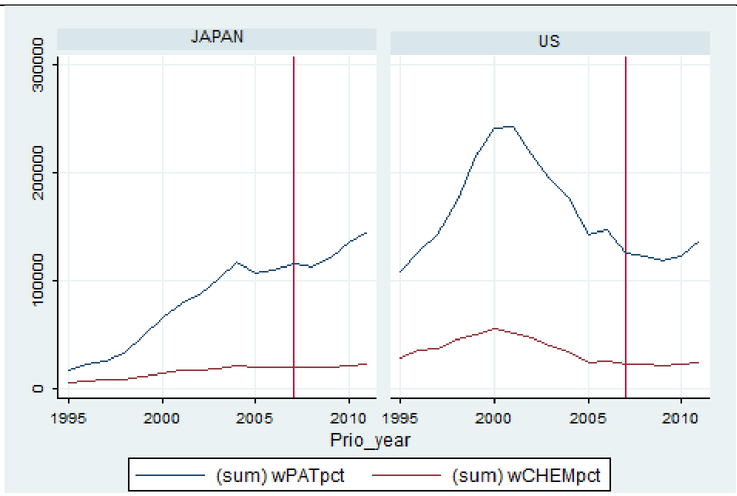
Also when presenting separate trends for each country we do find a confirmation of a decreasing trend in patenting by the chemical sector after a peak in 2000, with the only exception of Spain, where no peak is outlined in 2000. Furthermore, none of the Member States shows a peak in correspondence of 2007. Interestingly, patent applications under PCT are systematically showing increasing trends after 2007 while applications at EPO are decreasing. This evidence might suggest that chemical firms tend to increasingly protect their inventions outside EU boundaries. Contrarily, our expectations would be of an increase in patent application at EPO, as this is the Patent Office where to protect inventions for the European market, i.e. the market in which REACh is expected to display much of its effects.

Figure 6 Trend in innovative activity in chemicals of selected European applicants (BE, ES, FR, NL), respectively under PCT and at EPO

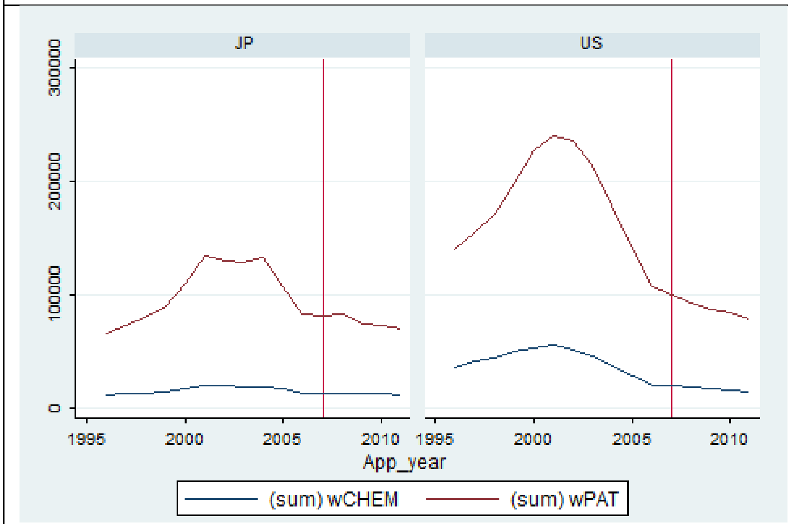


To provide a descriptive evidence of the effects of REACh on innovation of firms operating outside EU but with strong commercial exchanges with EU market, we then analyze the evolution of innovative activities in the chemical sector in Japan and US. As it emerges into Figure 7, there is evidence of an increasing patenting activity of Japan, which is counterbalanced by a decreasing number of applications to protect inventions in the European market (at EPO). Coherently, neither US shows evidences of an increasing innovative activity to respond to the EU regulation. It has however to be stressed that US already set up an internal chemical legislation, the US' Toxic Substances Control Act (TSCA), long before the European REACh.

Figure 7: Trend in patent applications of Japan and US in chemicals and total innovations



Patent applications Japan and US under PCT



Patent applications Japan and US at EPO

4. Micro Evidence on REACH's effects on innovation

This section describes the empirical analysis we performed to evaluate the effects REACh had on innovation by adopting a micro level perspective.

Whereas in Section 3 we outlined aggregated evidences based on trends in innovative activies across time for the main countries, we now move to a more rigorous analysis which is focused on firms rather than countries.

Recalling that our main goal is to understand whether REACh has lead, in its initial phase, to an increase in innovative activities in Europe, we built our empirical design as follows.

Once we understood the mechanisms behind the function of REACh, as described into Section 2, we came to the conclusion that all European firms should be considered as treated by the regulation. In other terms, all European firms that either use imported chemical substances or export substances produced in EU are obliged to register substances. Furthermore, the treatment of the regulation is not depending on any observable characteristics of the firm. More precisely, the fee of the registrations might depend on the size of the firm, but no matter of the size every European firm have to register any substance used for more than 1 t per year.

This lead us to exclude any empirical design aimed at evaluating the impact of policies which is built on the construction of a control group of non-treated firms to be used as a benchmark to evaluate differential outputs registered in the presence of a regulation. Consequently we could not perform any difference-in-difference designed, such as those exploited by (Calel & Dechezleprêtre, 2014; Wagner, Muûls, Martin, & Colmer, 2014) to evaluate the effects of the European Trading Scheme (EU ETS). In our case all chemical firms are treated and the only variable that differentiates between treatment and non-treatment is “time”.

4.1 Dataset construction

To evaluate the effects of REACh on innovation under a micro level perspective we performed a long and multi-step procedure to construct a database of firms and their patent applications.

Starting point has been to construct a database of firms that registered one or more substances at the European Chemical Agency in the “Food” sector of use to have a homogeneous sample of firms. We focus on food for several reasons. First of all, food production represents one of the excellence areas of some European countries, which export their products all over the world. Secondly, the impact of chemical compounds used for food production on human health is direct and immediate. Moreover, food consumption concerns potentially all the population, and hence the impacts of dangerous chemical compounds can spread over a larger part of persons.

In order to do that we accessed the register of substances registered at the EChA and, substance by substance, we created a database of applying firms and their addresses. In Table A1 of the Annex a list of substances registered under the sector of use “Food” is reported. Extraction of data has been performed until the 10th of October 2014 and it inevitably changes as every day firms can register chemical substances.

We then extracted from the Bureau Van Dijk ORBIS database ids, names and addresses of all the firms available in balance sheet database for the main countries of interest, i.e. Germany (DE), Italy (IT), France (FR), Spain (ES) and Belgium (BE).

A merge between the register of firms submitting a substance and the database containing all existing balance sheets data has been done in order to link each firm registering a substance to its Bureau Van Dijk id (bvd_id). This procedure is a bit complex as names of firms may vary according to the dataset used but, in this case, the register of substances had no information on firms other than their name and address. In other words, no unique id is available to match register data with external sources of information on those firms.

To minimize mistakes in the matching procedure, which has been built on the name of the firm, we first cleaned all the names according to the procedures used in (Marin, 2014) and described in Marin & Lotti (2013), that follow a matching method built on the harmonization routines proposed by NBER Patent Data Project. This allowed us to standardize and clean the names both in ORBIS and in our constructed register of firms that submitted a substance at EChA.

Secondly, we matched the two datasets by using, in Stata, the matching algorithm "matchit" as described in Raffo & Lhuillery (2009), which allowed us to assign as much as possible a bvd_id to firms in the register of substances. A visual screening of each match has been performed to check that no wrong matching were performed.

We then filled this dataset with the OECD Han Database information in order to be able to match each id to the patent applications submitted by each firm available in PATSTAT and REGPAT.

We ended up with a database containing all patent applications submitted by firms who registered a substance at the EChA of the selected European countries at the EPO. Overall, for the 5 countries under scrutiny (BE, DE, ES, FR and IT) a dataset of 895'123 patent applications by only firms who registered a substance in response to REACh over a time span from 1990 to 2011 has been constructed.

Consequently, we looked at the IPC codes of each patent in our dataset in order to evaluate to which domain it belonged.

More precisely, every patent application was defined as "CHEM" is the domain was one of those outlined into Table 2. Furthermore, given the potential environmental content of innovation performed in response to REACh, we have also assigned patents to the green realm. Patents have been labeled as in "green technologies" (GT) by exploiting three international classifications: the World Intellectual Property Organization (WIPO) IPC Green Inventory, the OECD EnvTech and the European Classification System (ECLA). As discussed in Ghisetti & Quatraro (2014), the three classifications for selecting environmental technologies greatly differ, and we thus adopted separately each of the three in order not engender any bias in our empirical setting.

Lastly, the dataset was reorganized in order to have, for each registered firm, the total number of patent applications (PAT), the total number of chemical patents (CHEM) and the total number of green patents (GTWIPO, GTOECD and GTECLA depending on the international classification adopted). This lead us to a sample of 288 firms, that applied , between 1990 and 2011, for 895'123 patents.

4.2 Empirical setting

To evaluate the effects of REACh on innovative activity in the chemical sector – sector of use "Food" we focus on a sample of firms which are necessarily treated by the policy, as they have registered one or more substances at the EChA. For this subset of firms, our goal is to study whether an increase in innovative activities has followed the introduction of the policy or not.

As we anticipated, the design of such exercise cannot follow a more standard approach of policy evaluation, as in our specific case there is no way to construct a proper control group of firms which are not treated by REACh and that face similar observable characteristics than treated ones. As we said, all European firms in the chemical sector are treated and the only variable beside the treatment is “time”.

Consequently, no “counterfactual” situation can be built nor a control group. Our choice has thus been to focus not on all firms operating in the chemical sector, as it would have led to a too complex picture, but only to a subset of firms that, at a first stage of the implementation of the policy, have already registered a substance. In other words, these firms might have already invented new substances or new production processes in order to meet the requirements of REACh so that they potentially have already tried to protect their inventions in the EU market by applying for a patent at the EPO.

As the only variable available to capture REACH’s effects is time, we ground our empirical analysis on PRE-POST differences. The intuition is that the same group of treated firms could have responded to the policy stimulus by increasing its innovative efforts after a certain threshold. This threshold should reflect at best the time of adoption of REACh.

We have chosen to focus on two threshold separately to be confident on our findings: 2007, i.e. the year of adoption of REACh and 2008, i.e. the year in which the first obligations of REACh were in place.

The empirical setting is thus built to evaluate differences pre-post, respectively to 2007 and 2008, in the mean of the patent applications in the group of treated firms. Empirically a Student T-Test is performed to compare, for each firm, pre and post means in patenting activity.

This difference is evaluated on:

1) General innovations, measured by total patent applications (PAT);
2) Chemical innovations (CHEM);
3) Green innovations, with patents assigned according to the WIPO Green Inventory (GTWIPO);
4) Green innovations, with patents assigned according to the OECD EnvTech (GTOECD);
5) Green innovations, with patents assigned according to ECLA Y02 (GTECLA).

4.3 Main results

Pre-post differences have been estimated through T-Test comparisons of the means in patent applications pre-post policy intervention. For each typology of patent considered (mainly PAT, CHEM, GTWIPO, GTOECD and GECLA) a first comparison has been done on the basis of the mean patent applications in a) years 2004 to 2007 and from 2008 and 2011 and b) years 2005 to 2008 and 2009-2011.

As it emerges from Table 3, we find statistical evidence that the mean of PAT before REACh introduction is significantly different from the mean of PAT after REACh introduction, independently on the threshold chosen. The test on the difference of the two, reported into the first columns, rejects the hypothesis that the two means are equal. Furthermore, the overall number of patent applications is in mean significantly higher before REACh introduction than in the subsequent period.

Table 3: T test on mean comparisons PAT before and after REACh

Structure T-Test	Mean(diff)!=0	Mean(diff)<0	Mean(diff)>0	Number of obs
PAT_04-07=PAT08_11	0.0501 *	0.9749	0.0251 *	289
PAT_05-08=PAT09_11	0.0325 *	0.9837	0.0163 *	289
CHEM_04-07=CHEM08_11	0.0783	0.9608	0.0392 *	289
CHEM_05-08=CHEM09_11	0.0587 *	0.9706	0.0294 *	289
GTWIPO_04-07=GTWIPO08_11	0.2792	0.8604	0.1396	289
GTWIPO_05-08=GTWIPO09_11	0.1165	0.9418	0.0582	289
GTOECD_04-07=GTOECD08_11	0.1499	0.9250	0.0750	289
GTOECD_05-08=GTOECD09_11	0.0107 *	0.9946	0.0054 *	289
GTECLA_04-07=GTECLA08_11	0.4094	0.7953	0.2047	289
GTECLA_05-08=GTECLA09_11	0.1558	0.9221	0.0779	289

This evidence is supported also when looking at patent applications in chemicals (CHEM). Also in this case, the mean of CHEM before REACh is higher than after REACh introduction.

As far as Green Technologies are concerned, we find a weak evidence in the same direction. Only for Green Technologies assigned through the OECD EnvTech Classifications, and only when the year 2008 is used as a threshold, the mean in GT before REACh is significantly higher than after REACh.

All in all, not only we do not find a support in the initial hypothesis that REACh have spurred innovation but, contrarily, we find that before REACH introduction there was an higher patenting activity at stake for the subset of firms that are treated by REACh.

Given the decreasing trend in patents observed and outlined into Section 3, we have cleaned our means in PAT, CHEM, GTWIPO, GTOECD and GTECLA by their trend. On these data we repated the empirical analysis and compared the pre-post REACh means.

Results, reported into Table 4, strongly change. As we can see differences pre-post in the means of all the typologies of patents do not differ. In other words, the number of patent applications after REACh introduction has not significantly changed, neither in terms of chemical patents, nor in terms of green technologies nor in terms of all patents considered.

Table 4: T test on mean comparisons PAT before and after REACh, cleaned by trend

Structure T-Test	Mean(diff)!=0	Mean(diff)<0	Mean(diff)>0	Number of obs
PAT_04-07det=PAT08_11det	0.3943	0.8029	0.1971	289
PAT_05-08det=PAT09_11det	0.4112	0.7944	0.2056	289
CHEM_04-07det=CHEM08_11det	0.4412	0.7794	0.2206	289
CHEM_05-08det=CHEM09_11det	0.4986	0.7507	0.2493	289
GTWIPO_04-07det=GTWIPO08_11det	0.9279	0.5361	0.4639	289
GTWIPO_05-08det=GTWIPO09_11det	0.5271	0.7364	0.2636	289
GTOECD_04-07det=GTOECD08_11det	0.4728	0.2364	0.7636	289
GTOECD_05-08det=GTOECD09_11det	0.1440	0.0720	0.9280	289
GTECLA_04-07det=GTECLA08_11det	0.5020	0.7490	0.2510	289
GTECLA_05-08det=GTECLA09_11det	0.3951	0.8024	0.1976	289

All in all, for the subset of firms we considered, i.e. firms that registered one or more chemical substances in the sector of use "food", and for the time being, REACh does not show to have lead firms to innovate more in response to its introduction, contrarily to our initial expectations.

The current study cannot however exclude that REACh would display some effects on innovations in subsequent periods. It is needed to recall that we have evaluated the effects of REACh at the very beginning of its implementation, as we considered patent applications in the first 4 years after its introduction. As REACh has obligations of registrations that are extended until 2018, according to the substance and usage, we cannot exclude different outcomes might emerge in later periods. Currently, the latest possible year on which we could exploit patent data is 2011, as some time is needed before patent applications are available and reliable in the PATSTAT database. Similarly, although REACh has been introduced in 2007, its discussion started long before. It is reasonable to assume that some pre-emptive response to a forthcoming regulation was adopted by early-mover firms. As this is not fully controllable, as the only variable to capture REACh was –as explained – time, we have to recognize that this is a limitation of the current study that potentially threatens its results.

Furthermore, we have focused on the use of chemicals for food applications. We can neither exclude the possibility of registering (significant) innovative responses in different sectors of use.

Further limitation of the current work lies in the choice of using patent data to proxy innovation. The limits of using patent data to measure innovative activities are known. In this empirical context we do focus on the effect of REACh on the initial stage of the Schumpeterian innovation process, i.e. on the invention phase, to see whether REACh affected the creation of new knowledge. Coherently, the choice of patent data rather than innovation counts, seems to be appropriate. However, we cannot exclude that not all patented inventions get commercialized and thus become innovations. Consequently, the current contribution cannot be extended to analyze the effective impacts REACh might have on health and environment, as nothing can be said on the effective adoption of the patented inventions. This could be an interesting future extension of the paper.

Future research might thus focus on REACh effects on innovation in a more extended time laps or on different sectors of use of chemical products. Interesting complementary research would be on the evaluation of the competitiveness gains or losses associated to REACh introduction in the European chemical market and on its composition and balancing between big firms and SMEs. Are European firms – under REACh – threatened by chemical firms without such regulatory constraints when exporting to external markets? Lastly, interesting would be to analyze the effects of REACh existence on potential incomers in that market, to evaluate whether it prevents or not new incomers to join the market.

5. Conclusions and Policy implications

The increasing attention to environmental challenges has fostered a surge in the analyses of the effectiveness of policy measures aiming at reducing polluting emissions or the use of polluting compounds. More recently, specific attention has been devoted to the impact that environmental regulation may have on the generation and the adoption of eco-innovations, which may have the double effect of contributing the improvement of environmental performances and the increase of firms' productivity through innovation-driven production costs reduction.

This paper intended to provide a preliminary assessment of the effects of the REACh regulation in terms of incentives to innovate. The assessment is preliminary for at least two reasons. First of all firms have time until 2018 to register the substances they use in their production processes. This means that the whole effect of the regulation still has to manifest itself, as firms may choose a waiting strategy. Secondly, gaining access is everything but easy. The European Chemical Agency actually denies any data request. Information can only be copied record-by-record from the REACh register website. This makes research times dramatically longer.

As we have showed, innovation dynamics in the chemical fields are interested by a generic decreasing trend. This is evident both at the aggregate level and across different countries. Such trend surely affects the potential effects that the REACh may have on the generation of innovations in the chemical sector. Actually, the comparison between pre and post regulation dynamics based on detrended clearly shows that there are no significant changes in firms' innovative behavior.

The implications for policymakers that can be drawn at this stage are not encouraging, and are consistent with the literature cited in the introduction, which describes such kind of regulation as substantially weak, in that it creates less incentives and lower flexibility than market-based instruments (Requate, 2005). First of all, providing economic agents with such large time windows to comply with the regulation can promote a 'wait and see' strategy that delays the potential benefits stemming from the reduced use of dangerous substances. Secondly, the register as a tool is likely to scarcely be effective, as information asymmetries and monitoring difficulties makes opportunistic behavior very likely to occur.

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Appendix

Table A1: List of registered substances – Sector of use "Food", downloaded October 2014

Substances
(+)-L-arginine hydrochloride
(+)-tartaric acid
(+/-) trans-3,3-dimethyl-5-(2,2,3-trimethyl-cyclopent-3-en-1-yl)pent-4-en-2-ol
(1-hydroxyethylidene)bisphosphonic acid, potassium salt
[1α(E),2β]-1-(2,6,6-trimethylcyclohex-3-en-1-yl)but-2-en-1-one
[3-(2,3-epoxypropoxy)propyl]triethoxysilane
[3-(2,3-epoxypropoxy)propyl]trimethoxysilane
[carbonato(2-)]hexadecahydroxybis(aluminium)hexamagnesium
1,2-benzisothiazol-3(2H)-one 1,1-dioxide, sodium salt
1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethylindeno[5,6-c]pyran
1,4-dioxacyclohexadecane-5,16-dione
1,6,7,8,9,14,15,16,17,17,18,18-dodecachloropentacyclo[12.2.1.16,9.02,13.05,10]octadeca-7,15-diene
1-[(2E)-3,7-dimethylocta-2,6-dien-1-yl]pyrrolidine-2,5-dione
12-hydroxystearic acid
2-(2-butoxyethoxy)ethyl 6-propylpiperonyl ether
2-(2-ethoxyethoxy)ethanol
2,2',2''-(hexahydro-1,3,5-triazine-1,3,5-triyl)triethanol
2-ethylhexane-1,3-diol
2-ethylhexyl oleate
3-(2,2-dimethyl-3-hydroxypropyl)toluene
3-(trimethoxysilyl)propylamine
3-aminopropyltriethoxysilane
3-trimethoxysilylpropyl methacrylate
6-phenyl-1,3,5-triazine-2,4-diyldiamine
A mixture of: tetrasodium-phosphonoethane-1,2-dicarboxylate; hexasodium-phosphonobutane-1,2,3,4-tetracarboxylate
Activated Carbon - High Density Skeleton
activated carbon - low density skeleton
aluminium
aluminium dihydrogen triphosphate
aluminium hydroxide
aluminium metaphosphate
aluminium oxide
aluminium potassium bis(sulphate)
aluminium tris(dihydrogen phosphate)
aluminium, 4,5-dihydro-5-oxo-1-(4-sulfophenyl)-4-[(4-sulfophenyl)azo]-1H-pyrazole-3-carboxylic acid complex
aluminium, 6-hydroxy-5-[(4-sulfophenyl)azo]-2-naphthalenesulfonic acid complex
Amides, C16-C18 (even) , N,N'-ethylenebis
Amides, C8-18 (even numbered) and C18-unsatd., N, N-bis(hydroxyethyl)
Amines, N-C12–C14(even numbered)-alkyltrimethylenedi-, reaction products with chloroacetic acid
ammonia, anhydrous
ammonium acetate
ammonium carbamate
ammonium carbonate

ammonium chloride
ammonium dihydrogenorthophosphate
ammonium hydrogencarbonate
ammonium hydrogensulphite
ammonium nitrate
ammonium sulphate
ammonium sulphite
Ammonium zinc chloride
antimony
aspartic acid
Aspartic acid, N-(3-carboxy-1-oxo-sulfopropyl)-N-(C16-C18 (even numbered), C18 unsaturated alkyl) tetrasodium salts
Bentonite, acid-leached
Benzene, C10-13-alkyl derivs.
Benzene, mono-C10-13-alkyl derivs., distn. residues
bis(2-ethylhexyl) adipate
bis(2-ethylhexyl) carbonate
boron orthophosphate
butane
Butanedioic acid, 2(or 3)-sulfo-, 4-[2-[(1-oxododecyl)amino]ethyl] ester, sodium salt
Butanedioic acid, 2(or3)-sulfo-, 4-[2-[(1-oxo(C12-C18(even numbered) and C18 unsaturated)alkyl)amino]ethyl]esters, disodium salts
Butanedioic acid, sulfo-, 4-C12-14 (even numbered)-alkyl esters, disodium salts
calcium bis(dihydrogenorthophosphate)
calcium carbonate
calcium chloride
calcium dihydroxide
Calcium dihydroxide precipitated with carbon dioxide during sugar juice purification
calcium hydrogenorthophosphate
calcium iodate
calcium magnesium dihydroxide oxide
Calcium magnesium oxide
calcium nitrate
calcium oxide
calcium oxide
calcium sulfate
carbon monoxide
Carbonic acid, zinc salt, basic
Castor oil, hydrogenated
Charcoal
Charcoal, coconut shell
chloroacetic acid
citric acid
Cocoa, ext.
Cocoa, powd., alkalized
Corn, steep liquor
cysteine hydrochloride
cystine
decamethylcyclopentasiloxane

D-gluconic acid
D-gluconic acid, compound with N,N''-bis(4-chlorophenyl)-3,12-diimino-2,4,11,13-tetraazatetradecanediamidine (2:1)
D-glucono-1,5-lactone
D-Glucopyranose, oligomeric, butyl glycoside
diammonium [[N,N'-ethylenebis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']hydroxyferrate(2-)
diammonium dihydrogen ethylenediaminetetraacetate
diammonium hydrogenorthophosphate
dibismuth trioxide
diethyl phthalate
diiron trioxide
dipotassium disulphite
dipotassium hydrogenorthophosphate
disodium [[N,N'-ethylenediylbis[N-(carboxylatomethyl)glycinato]](4-)-N,N',O,O',ON,ON']zincate(2-)
disodium dihydrogen ethylenediaminetetraacetate
disodium disulphite
disodium metasilicate
DL-malic acid
docosanoic acid
docusate sodium
dodecan-5-olide
Dolomite (CaMg(CO3)2), calcined
edetic acid
ethyl (S)-2-hydroxypropionate
ethyl 2-cyanoacrylate
Ethylendiaminetetraacetic acid ferrous sodium
exo-1,7,7-trimethylbicyclo[2.2.1]hept-2-yl acetate
Fatty acids, C12-14
Fatty acids, C12-18
Fatty acids, C14-18 and C16-18 unsatd., triesters with trimethylolpropane
Fatty acids, C14-18 and C16-18-unsatd.
Fatty acids, C14-18 and C16-18-unsatd., mixed esters with neopentyl glycol and trimethylolpropane
Fatty acids, C16-18
Fatty acids, C16-18 and C18-unsatd., 2-ethylhexyl esters
Fatty acids, C16-18, 2-ethylhexyl esters
Fatty acids, C16-22
Fatty acids, C18-22
Fatty acids, C18-unsatd.
Fatty acids, C5-10, esters with pentaerythritol
Fatty acids, C6-24 and C6-24-unsatd., Me esters, distn. residues
Fatty acids, C8-10
Fatty acids, C8-18 and C18-unsatd., esters with pentaerythritol
Fatty acids, coco, triesters with trimethylolpropane
Fatty acids, dehydrated castor-oil
Fatty acids, essential, Et esters
Fatty acids, palm-oil, hydrogenated
Fatty acids, soybean oil, conjugated
Fatty acids, sunflower-oil, conjugated

Glycerides, C12-18
Glycerides, C14-18
Glycerides, C16-18
Glycerides, C16-18 and C18-unsatd. mono-
Glycerides, C16-18 and C18-unsatd. mono-, di and tri-
Glycerides, C16-18 mono-
Glycerides, C16-18 mono- and di-
Glycerides, C16-22
Glycerides, C8-18 and C18-unsatd.
Glycerides, mixed decanoyl and octanoyl
Glycerides, tall-oil mono-, di-, and tri-
glycine
Graphite
hexafluorosilicic acid
hexamethyldisiloxane
hexanoic acid
hexyl salicylate
hydrogen chloride
hydrogen peroxide
hydrogen sulphide
Ilmenite (FeTiO3), conc.
iron
iron hydroxide oxide yellow
iron manganese trioxide
iron orthophosphate
isobutane
isopentyl acetate
isophthalic acid
Kieselguhr, soda ash flux-calcined
l-(+)-lactic acid
Lactic Acid
L-alanine
Lime (chemical), hydraulic
L-leucine
L-menthol
L-proline
L-serine
L-valine
magnesium carbonate
magnesium chloride
magnesium dihydrogen disulphite
magnesium hydrogenorthophosphate
magnesium hydroxide
magnesium sulphate
manganese
manganese dichloride
manganese ferrite black spinel

manganese sulphate
Mentha arvensis, ext.
methanol
methylsilanetriyl triacetate
N,N'-ethane-1,2-diylbisoleamide
N-carboxymethyliminobis(ethylenenitrilo)tetra(acetic acid)
nicotinamide
nitric acid
No IUPAC name allocated
Not applicable-UVCB
octamethylcyclotetrasiloxane
octanoic acid
orthophosphoric acid
oxybispropanediol
pentacalcium hydroxide tris(orthophosphate)
pentane-2,4-dione
Pentapotassium 2-[2-[2-(bis(carboxylatomethyl)amino)ethyl-(carboxylatomethyl)amino]ethyl-(carboxylatomethyl)amino]acetate
pentasodium (carboxylatomethyl)iminobis(ethylenenitrilo)tetraacetate
Peptones, casein
peracetic acid
Perboric acid, sodium salt
Poly(oxy-1,2-ethanediyl),α-hydro-ω-hydroxy- Ethane-1,2-diol, ethoxylated
potassium acetate
potassium carbonate
potassium dimethyldithiocarbamate
potassium hydrogen tartrate
potassium hydrogencarbonate
potassium hydroxide
potassium methanolate
potassium permanganate
potassium sodium tartrate
potassium sulfate
propane
Protein hydrolyzates, animal
Protein hydrolyzates, vegetable
Reaction mass of : Sodium or ammonium [1-{(E)-[2-(hydroxy-kO)-5-(2-methylbutan-2-yl)-3-nitrophenyl]diazenyl}naphthalen-2-olato(2-)-kO][3-{(Z)-[2-(hydroxy-kO)-5-(2-methylbutan-2-yl)-3-nitrophenyl]diazenyl}naphthalen-2-olato(2-)-kO]chromate(1-) Sodium or ammonium [3-{(E)-[2-(hydroxy-kO)-5-(2-methylbutan-2-yl)-3-nitrophenyl]diazenyl}naphthalen-2-olato(2-)-kO][1-{(E)-[2-(hydroxy-kO)-4-nitrophenyl]diazenyl}naphthalen-2-olato(2-)-kO]chromate(1-) Sodium or ammonium [3-{(E)-[2-(hydroxy-kO)-5-(2-methylbutan-2-yl)-3-nitrophenyl]diazenyl}naphthalen-2-olato(2-)-kO][1-{(E)-[2-(hydroxy-kO)-5-nitrophenyl]diazenyl}naphthalen-2-olato(2-)-kO]chromate(1-) Sodium or ammonium [1-{(E)-[2-(hydroxy-kO)-4-nitrophenyl]diazenyl}naphthalen-2-olato(2-)-kO][3-{(E)-[2-(hydroxy-kO)-4-nitrophenyl]diazenyl}naphthalen-2-olato(2-)-kO]chromate(1-) Sodium or ammonium [1-{(E)-[2-(hydroxy-kO)-4-nitrophenyl]diazenyl}naphthalen-2-olato(2-)-kO][3-{(E)-[2-(hydroxy-kO)-5-nitrophenyl]diazenyl}naphthalen-2-olato(2-)-kO]chromate(1-) Sodium or ammonium [1-{(E)-[2-(hydroxy-kO)-5-nitrophenyl]diazenyl}naphthalen-2-olato(2-)-kO][3-{(E)-[2-(hydroxy-kO)-5-nitrophenyl]diazenyl}naphthalen-2-olato(2-)-kO]chromate(1-)
Reaction Mass of 1-(1,2,3,4,5,6,7,8-octahydro-2,3,8,8-tetramethyl-2-naphthyl)ethan-1-one and 1-(1,2,3,4,6,7,8,8a-octahydro-2,3,8,8-tetramethyl-2-naphthyl)ethan-1-one and 1-(1,2,3,5,6,7,8,8a-octahydro-2,3,8,8-tetramethyl-2-naphthyl)ethan-1-one
reaction mass of 3-[3-(2,3-dihydroxypropoxy)-2-hydroxypropoxy]propane-1,2-diol, 3-(2,3-dihydroxypropoxy)propane-1,2-diol,3-[3-[3-(2,3-dihydroxypropoxy)-2-hydroxypropoxy]-2-hydroxypropoxy]propane-1,2-diol,
Reaction mass of 3a,4,5,6,7,7a-hexahydro-4,7-methanoinden-5-yl acetate and 3a,4,5,6,7,7a-hexahydro-4,7-methanoinden-6-yl
Reaction mass of ammonium dihydrogenorthophosphate and diammonium hydrogenorthophosphate

Reaction products resulting from the esterification of Sorbitol with C8 – 18 (even) and C18 unsaturated fatty acids in the ratio of 1:1
Rutile (TiO_2)
Rutile, tin zinc
Saccharomyces cerevisiae, ext.
Silicic acid, aluminum sodium salt
Silicic acid, calcium salt
Silicic acid, magnesium salt
Silicic acid, potassium salt
Silicic acid, sodium salt
silicon dioxide
sodium 3-(allyloxy)-2-hydroxypropanesulphonate
sodium acetate
sodium carbonate
sodium chloroacetate
sodium D-glycero-D-gulo-heptonate
sodium dimethyldithiocarbamate
sodium dithionite
sodium feredetate
sodium glucoheptonate
sodium hydrogencarbonate
sodium hydrogensulfite
sodium hydrogensulphate
sodium hydroxide
sodium hypochlorite
sodium metaphosphate
sodium methanolate
sodium nitrate
sodium permanganate
sodium sulphate
sodium sulphite
sodium tetrahydroborate
stearic acid
stearic acid, monoester with glycerol
strontium chloride
succinic acid
sulfur
sulphamidic acid
sulphur dioxide
sulphuric acid
Syrups, corn, hydrogenated
Syrups, wheat, hydrolyzed starch
tetraammonium hexamolybdate
tetraethyl orthosilicate
tetrairon tris(pyrophosphate)
tetrasodium ethylenediaminetetraacetate
tetrasodium N,N-bis(carboxylatomethyl)-L-glutamate
tin dichloride

titanium dioxide
triacetin
tributyl citrate
tricalcium bis(orthophosphate)
triethoxy(methyl)silane
triethoxy(vinyl)silane
triethyl citrate
triethylamine
triiron tetraoxide
trimagnesium bis(orthophosphate)
trimethoxy(methyl)silane
trimethoxyphenylsilane
trimethoxyvinylsilane
tripotassium orthophosphate
trisodium 2-(carboxylatomethyl(2-hydroxyethyl)amino)ethyliminodi(acetate)
trisodium hydrogendicarbonate
trisodium nitrilotriacetate
trizinc bis(orthophosphate)
urea
Vinasses, residue of fermentation
Vinasses, residue of fermentation containing biomass of bakers yeast (Saccharomyces cerevisiae)
Vinasses, residue of fermentation containing biomass of bakers yeast, salt-enriched
Vinasses, residue of fermentation containing biomass of Corynebacterium glutamicum
Vinasses, residue of fermentation, depotassified
xylose
Y-4036
Zeolite, cuboidal, crystalline, synthetic, non fibrous, thermally produced
Zeolite, cuboidal, crystalline, synthetic, non-fibrous
Zeolite, phosphor containing, crystalline, synthetic, non fibrous
Zeolite, silica and titanium based, crystalline, synthetic, non fibrous
Zeolite, silica rich, crystalline, synthetic, non-fibrous
Zeolite, silica rich, without aluminium, crystalline, synthetic, non fibrous
zinc
zinc chloride
zinc ferrite brown spinel
zinc hydroxide
zinc oxide
zinc sulphate
zinc sulphide
β-methyl-3-(1-methylethyl)benzenepropanal

Project Information

Welfare, Wealth and Work for Europe

A European research consortium is working on the analytical foundations for a socio-ecological transition

Abstract

Europe needs change. The financial crisis has exposed long-neglected deficiencies in the present growth path, most visibly in the areas of unemployment and public debt. At the same time, Europe has to cope with new challenges, ranging from globalisation and demographic shifts to new technologies and ecological challenges. Under the title of Welfare, Wealth and Work for Europe – WWWforEurope – a European research consortium is laying the analytical foundation for a new development strategy that will enable a socio-ecological transition to high levels of employment, social inclusion, gender equity and environmental sustainability. The four-year research project within the 7th Framework Programme funded by the European Commission was launched in April 2012. The consortium brings together researchers from 34 scientific institutions in 12 European countries and is coordinated by the Austrian Institute of Economic Research (WIFO). The project coordinator is Karl Aiginger, director of WIFO.

For details on WWWforEurope see: www.foreurope.eu

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Partners

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