Journal of Business Chemistry

# Research Paper

# Impacts of the REACH candidate list of substances subject to authorisation: The reputation mechanism and empirical results on behavioral adaptations of German supply chain actors

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The candidate list of substances subject to authorisation is an instrument provided by the EU chemicals regulation (REACH) to publicly announce and prioritize chemical substances of very high concern (SVHC) as a first step of imposing an obligation of authorisation on them, i.e. including them into the authorisation list (Annex XIV of REACH). As a consequence of inclusion into the "candidate list", a variety of obligations concerned with intensifying risk communication apply. Article producers, importers and distributors of articles have to communicate information about SVHCs contained in articles and necessary risk management measures to the recipients of the articles and provide this information to consumers on request (Art. 33 REACH). This research paper analyzes the reputational mechanism of the candidate list showing a potential to stigmatize not only the substances as such but also various actors of the supply chain associated with these substances and their brands. Drawing on behavioral psychology theories, hypotheses on the reputational impacts of the candidate list on substance manufacturers, downstream users (including formulators and manufacturers of articles) and distributors are derived. These are discussed on the basis of current empirical data surveyed by the European Commission.

## 1 Introduction

The safe use of chemicals, other than for chemicals used for medicines or pesticides and biocides, is normally ensured by other means than a formal and necessarily quite bureaucratic authorisation. Hence, the authorisation procedure under REACH – the EU chemicals regulation (Regulation (EC) No 1907/2006) – is intended for substances of very high concern (SVHC). Only these substances with specific intrinsic properties which are particularly hazardous to human health or the environment may be subject to authorisation under REACH. Examples for SVHCs are metals such as lead or cadmium being used in batteries, plastic softeners like DEHP e.g. used in consumer products and medical devices, chromium trioxide used for surface treatment (chrome plating) or certain solvents such as DMAC used in the production of textiles and dialysis membranes.

Substances identified as fulfilling the SVHC criteria are included in the so called "candidate list". Identified SVHCs represent the candidates which may be listed on Annex XIV – the "authorisation list". Including substances into the candidate list, inter alia, leads to further obligations of communicating risks within the supply chain and is thereby contributing to safe use. Producers, importers and distributors of articles have to communicate information about SVHCs contained in articles and necessary risk management measures to the recipients of the articles and to provide this information to consumers on request.

Inclusion in the candidate list can put pressure on suppliers to substitute SVHCs with lower risk alternatives but some SVHCs may be required to

achieve certain qualities of a product and it may not always be easy to replace them with alternatives. As oftentimes cited by industry representatives, the process of publicly identifying a substance as an SVHC via its inclusion in the candidate list may threaten or even damage a company's reputation (cf. Grunwald and Hennig, 2012). This potential impact has been termed the "announcement effect" of the candidate list (cf. Heitmann and Reihlen, 2007). Here, the term reputation is broadly defined as a market-average expectation of stakeholders towards a supplier's product quality and production related conduct including product performance, consumer and environmental safety issues. Thus, a certain level of positive vs. negative reputation reflects stakeholders' (e.g. consumers') high vs. low confidence or trust into the supplier's quality and conduct (cf. Schwalbach, 2000; Büschken, 1999 and 2000; Dean, 2004; Standop, 2006).

The announcement effect could hold because sensitized (private or organizational) buyers may react negatively by attributing blame on suppliers who knowingly sold products containing SVHCs. Consequently, they form negative attitudes towards suppliers and finally may terminate business relations. As organizational customers, they may even find themselves confronted with risking their own reputation and business. In a number of cases, retailers already reacted by proactively blacklisting or banning SVHC-related products. Tchibo, one of Germany's biggest multichannel-retailers, provides a practical example for this (cf. Tchibo, 2011).

Especially for small and medium-sized companies such as formulators that rely on being able to use a specific substance, negative publicity induced by the candidate list can pose a critical threat. It should be noted that these potential negative impacts need to be viewed in the context of the benefits REACH provides (cf. European Commission, 2003; Getzner, 2013). It should also be considered that there are other REACH related costs to industry such as the cost of testing chemicals. Compared with the direct costs of complying with REACH, indirect costs such as the blacklist effect are generally more difficult to estimate and less well known.

As research on reputational effects of the candidate list is scarce or limited to anecdotal descriptions, the primary research goal of this paper is to develop a comprehensive behavioral psychological model consisting of research hypotheses capable of explaining the various reputational effects of the candidate list, thereby enabling an assessment of the potential loss of reputation and a better understanding of the blacklist effect. This includes uncovering determinants to influence any potential reputational loss, like e.g. availability of substance alternatives. Due to varying roles and dependencies of actors in affected supply chains, reputational effects may vary considerably between these actors. Therefore, an actor-specific analysis of reputation is conducted considering reputational impacts of the candidate list on manufacturers, downstream users and distributors. These hypotheses are then discussed based on current empirical data surveyed by the European Commission on behavioral adaptations within REACH supply chains. Since REACH is still relatively new and its provisions are only starting to show effects, these data reflect preliminary experience of companies with the REACH provisions.

## 2 REACH and the candidate list of substances subject to authorisation

The REACH Regulation first entered into force in 2007 and is built on four pillars: the Registration, Evaluation, Authorisation, and Restriction of CHemical substances. Authorisation is a risk management option for industrial chemicals that was newly introduced with REACH. It aims to assure that the risks from substances with certain particularly hazardous properties are properly controlled and that these substances are progressively replaced by suitable alternatives. REACH allows for subjecting the placing on the market and use of SVHCs to a requirement for authorisation, effectively reversing the burden of proof normally associated with restricting chemicals. Once subject to authorisation, a substance may only be placed on the market or used when it is demonstrated that the risks arising from the use are adequately controlled for (Art. 60 (2) REACH) or when the use can be justified for socio-economic reasons and if no economically and technically viable alternatives are available (Art. 60 (4)).

Before a substance becomes subject to authorisation, it passes through a rather complex process involving multiple steps (Figure 1). First, a member state prepares a dossier identifying the substance as falling into one of the following categories based on its intrinsic properties (Art. 57):

- Substances which are carcinogenic, mutagenic or toxic to reproduction category 1A or 1B (CMR substances),
- Substances which are persistent, bioaccumulative and toxic (PBT substances) or very persistent and very bioaccumulative (vPvB substances) or
- Substances for which there is an equivalent level of concern (e.g. endocrine disruptors).

Identified SVHCs are included in the so-called candidate list. Although the candidate list itself does not entail a requirement for authorisation, it leads to a number of important obligations. Suppliers of articles must inform recipients and, on request, consumers if the article contains an SVHC in a concentration above 0.1% weight by weight (Art. 33). Producers and importers of articles must further notify the European Chemicals Agency (ECHA) of articles produced or imported which contain an SVHC in a quantity of more than 1 ton per year above the concentration limit (Art. 7 (2)). The candidate list was comprised of 151 substances as of December 2013.

All substances included in the candidate list enter a prioritization procedure for inclusion into Annex XIV of the REACH Regulation. Substances with PBT or vPvB properties, wide dispersive use and high volumes receive priority to become subject to authorisation (Art. 58 (3)). The final decision to amend Annex XIV is taken by the European Commission in accordance with the comitology process. As of April 2013, 22 substances were listed in Annex XIV (Commission Regulation (EU) No 348/2013).

In contrast to other obligations in REACH which apply mainly to manufacturers of chemicals, the candidate list and authorisation provisions directly affect numerous other enterprises in the supply chain of a given chemical. These may include suppliers/distributors of articles (which are defined as objects which are given a special shape, surface or design during production determining their function to a greater degree than does their chemical composition, like a vehicle or an electronic device) and mixtures (which are defined as a solution composed of two or more substances) and, most notably, downstream users of substances. Downstream users are defined in REACH as any natural or legal person established within the EU other than the manufacturer or the importer, who uses a substance either on its own or in a mixture in the course of his industrial or professional activities (cf. REACH Art. 3). Typical downstream users are formulators producing mixtures (e.g. detergents, paints etc.) and companies manufacturing or finishing articles.

Although the relevant supply chains and their complexity vary from substance to substance, the general structure of the supply chain as affected by the candidate list and authorisation provisions can be illustrated with the example of a color pigment (Figure 2). The pigment itself might be manufactured by a chemical producer located in the EU. It might then be used by a formulator (downstream user) to formulate paint. The finished paint (a mixture) might be supplied to a distributor who ships the product to professional end users. One can easily see that the regulation and possible ban of the substance in question (in this case, the color pigment) may not only affect the manufacturer or importer of the chemical itself but other actors in the supply chain, including downstream users, distributors and consumers/end users, who place value on the economic and technical characteristics of the substance in the production process or the end product.

The candidate list has been the subject of much debate. For manufacturers of chemicals, there is a

**Figure 1 REACH process for Substances of Very High Concern (SVHC).**

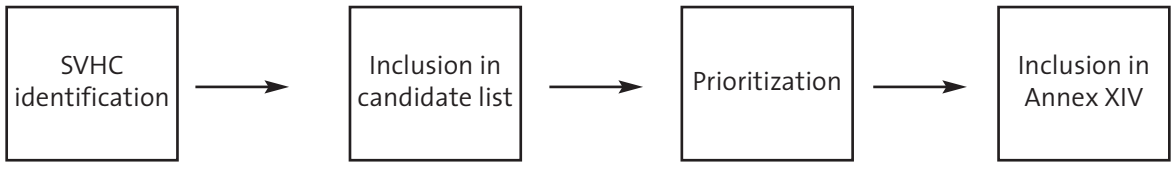
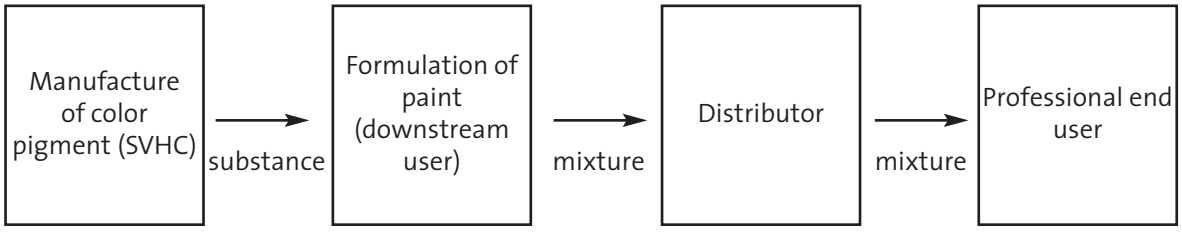



**Figure 2 Example of a supply chain for a color pigment.**



risk that the inclusion of one of their substances in the candidate list will lead to a loss of reputation from being associated with a serious hazard like cancer. Also, there is a risk of lower demand for the substance as a result of potential blacklisting by customers in the supply chain. For downstream users, SVHCs may play an important role in production processes in order to achieve certain functionalities. Those downstream users which cannot substitute a candidate substance with a less hazardous alternative face a risk that their activities will be disrupted if manufacturers discontinue production of the substance concerned[1] or if actors further down the supply chain, such as distributors or consumers, insist that no SVHCs be used during production or be present in the end product. In severe cases, this could amount to an existential threat to a downstream user's business.

It should be stressed that candidate substances can be legally produced and used. However, as these substances could eventually become subject to authorisation following the prioritization procedure, a successful application for authorisation may be required to use the substance in the long term. The underlying uncertainty whether candidate substances will become subject to authorisation and, if so, whether and for how long an authorisation will be granted may adversely impact companies' willingness and ability to invest in and commit to the continued supply of candidate substances or products requiring candidate substances (cf. WVM, 2012).

Because the authorisation requirement is attached to the use of chemicals and generally not to the sale or the use of the end product, one common criticism is that downstream users located in the EU are placed at a competitive disadvantage by the authorisation requirement. This is particularly relevant where SVHCs are used during the production process of articles. In principle, these processes could take place outside the EU and the finished article could be imported whereby the authorisation requirement is circumvented (cf. BDI, 2013). For downstream users in the EU, this translates to a risk that customers, i.e. the recipients of the articles, might choose to switch to suppliers outside the EU as soon as a critical substance becomes subject to authorisation or, as a precursor to this, is included in the candidate list. It should be noted though that such an export of risk by way of moving production activities to countries with lower safety standards can also lead to reputational problems for suppliers of articles.

## 3 Hypotheses development towards a reputational model

A behavioral analysis of reputation rests on the assumption that any significant negative or positive reputational effect on a company can be observed by changes in purchase behavior eventually accompanied by adaptations of provider (supply) behavior. The latter could be changes in product portfolio including innovations, streamlining of the product range or adapting corporate communications (cf. Grunwald and Hennig, 2012). To the extent that changes to production and sales plans of supply chain actors are unforeseen and associated with adaptation costs or lost gains, a reputational loss is detectable. Behavioral reactions towards the candidate list information to reflect, prevent or reduce any reputational loss to the firm of the supply chain actor assume the role of the dependent variable to be explained in this paper.

The candidate list contains both signals of risk as indicated by the SVHC categorization and scarcity. The latter refers to the candidate substance itself, its alternatives or related products (i.e. mixtures or articles) as the substance could become subject to authorisation. Both signals and their interrelations need to be analyzed more closely since they are subject to the processes of perception and evaluation by supply chain actors potentially evoking behavioral actions. Both users and providers of the substance or substance-related products tend to be highly involved when decoding the candidate list information as a signal of scarcity. Scarcity could take the form of users losing their product use or providers losing their market for the candidate substance and related products especially when being unable to absorb resulting losses, e.g. by offering alternatives. From the negative risk-related content contained in the candidate list information potentially threatening an organization's high priority goals (cf. Ulmer, *et al.* 2006), an increasing situational involvement of supply chain actors can generally be inferred. According to the Elaboration Likelihood Model developed by Petty and Cacioppo (1986), highly involved recipients are motivated to process factual information e.g. on risks related to a product or provider. As a result, perception of risk is expected to be higher under conditions of high than low involvement. Therefore, from the negative risk-related information contained in the candidate list, perception of risk by supply chain actors can generally be expected to increase. This is also grounded on the negativity effect (cf. Mizerski, 1982; Niemeyer, 1993; Taylor, 1991) referring to crisis signal theory, which posits that the effects of a single crisis event like the candidate listing depend on its underlying signal potential. The signal poten-

1) The direct regulatory impact of authorisation is on the use and not the production of substances but there could be indirect effects on production.

tial of a crisis event is larger the more it heralds severe future problems such as long-term consumer health risks or the risk of losing business, although the current problems may be of limited nature (cf. Jungermann and Slovic, 1993; Balderjahn and Mennicken, 1994; Alvensleben and Kafka, 1999; Grunwald and Hempelmann 2010). An alternative explanation for this effect can be derived from the availability heuristic (cf. Tversky and Kahneman, 1973) describing the tendency to make judgments, e.g. on risk, based on how easy it is to recall similar instances or how topical the risk-related information is. By including a substance on the candidate list, risk-related information is made topical which according to recency effect leads recipients to better remember the information and to receive greater weight in forming judgments as compared to information presented earlier. From this the following hypothesis derives.

*H1: Listing a substance on the candidate list increases supply chain actors' perception of substance-related risk.*

It should be noted at this instance that the mere fact that a substance is identified as SVHC and will be subject to further regulation can also reduce supply chain actors' perception of risk since further obligations concerned with intensifying risk communication apply. So, if actors actually perceive their rights according to Art. 33 REACH, they may intensively be willing to ask providers for clarification and, if answered promptly and competently, can reduce perceived risks. Lower levels of perceived risk in turn can lead to better evaluations of product and provider quality which generally benefits provider reputation. However, as practical experience shows, information requests can be numerous and very complex due to the high complexity of supply chains so that any fast reductions in perceived risk are less probable which is therefore corroborating hypothesis H1.

When perceiving risks, the question arises who is responsible for the existence of substance-related risks and consequently for controlling or reducing them. According to attribution theory, individuals are rational processors of information whose acts are influenced by conclusions or causal events. They attempt to find reasons for the success (e.g. a satisfactory product performance) or failure (e.g. a perceived problem and risk with the product) of use-related processes and normally categorize them according to a three-dimensional scheme (cf. Folkes *et al.,* 1987; O`Malley Jr., 1996):

The first dimension refers to location, i.e. the individual locates the cause(s) of success or failure. It asks whether the reason for a problem is more likely to be attributed to external factors such as the supplier, situation and external events or internal factors (of the user himself). The second dimension of stability focuses on the (temporal) endurance of the cause(s) of success or failure. On the one hand, if causes are stable or permanent in nature, there is a greater likelihood that similar problems will arise in future due to the fact that its cause is unchangeable. Similar problems are less likely to occur if the cause is unstable in nature. The third dimension refers to control, i.e. whether it is possible for users and/or suppliers to influence the possible causes of success or failure. Controllable causes are those over which the supplier or customer exercise a degree of influence: accordingly, it may have been possible to prevent the problem by taking certain steps like applying risk management measures. On the other hand, non-controllable causes are beyond the influence of the supplier or customer.

As the candidate list provides negative use related information, it seems plausible for users to more strongly engage in attributional activity. From an increasing attributional thinking and due to a lack of positive information e.g. from providers explaining the reasons for still using the hazardous substance, users in general may hold the provider responsible for the existence of substance-related risks. Still using the substance and not substituting it or taking measures to further reduce risks may generally be perceived as a cause of risk controllable by the provider. This is expressed in the following hypothesis.

*H2: Listing a substance on the candidate list increases users' perception of provider responsibility (of substance manufacturers, downstream users or distributors) for the existence of substance-related risks.*

Fueled by higher levels of involvement, both perceived degree of exposure to the candidate substance and perceived availability of alternatives, are assumed to directly impact perceived substance-related risks and provider responsibility, respectively. The impact of perceived exposure on perceived substance-related risk seems self-explanatory in that the level of exposure beyond other variables forms a key factor in risk assessment determining the level of risk. The influence is described by the following hypothesis:

*H3: The higher users' perception of substance exposure, the higher is their perception of substance-related risks.*

The impact of perceived availability of alterna-

tives on perceived provider responsibility is less obvious and needs further explanation. According to attribution theory, the less (more) a provider is able to control or reduce substance-related risks, the less (more) he is held a plausible cause for the existence of the risks. For instance, a large company provider with a considerable R&D budget who could have invested much more in the past into early substitution and measures to control or reduce risks is attributed more responsibility than a smaller company provider being unable to take such measures. For the smaller provider, the cause for lacking alternatives seems to be less controllable than for the large company provider. In case alternatives are widely available on the market to both small and large company providers, recipients of this information are prone to attribute more blame on providers in general irrespective of company size as under conditions of low availability. Any defensive approach like further waiting to substitute SVHCs through alternatives is likely to be further challenged by users. From this hypothesis 4 derives.

*H4: The higher supply chain actors' perception of availability of alternatives, the more providers are perceived responsible* for the existence of substance-related risks.

Given that high involvement motivates recipients of the candidate list to more intensely evaluate its information content, the process of evaluation of perceived signals of risk and scarcity in forming users' attitudes towards providers of substances and related products needs to be further scrutinized. Users' attitude is assumed to be an enduring variable to reflect users' evaluations of the provider's quality and conduct (cf. Grunwald and Hennig, 2012) being influenced by situational variables like perception of substance-related risks and provider responsibility capable of evoking behavioral reactions. Consistently, according to research on negative publicity, perceptions of risk as well as perceived provider responsibility reflecting users' attributions of blame for any existence of product-related problems or risks are directly linked to the reputation construct (cf. Grunwald and Hempelmann, 2010; Standop, 2006; Tucker and Melewar, 2005; Matos and Veiga, 2004; Dean, 2004; Lyon and Cameron, 2004 and 1998; Gutteling, 2001; Dawar and Pillutla, 2000; Tadelis, 1999; Coombs, 1998; Dawar, 1998; Al-Najjar, 1995; Siomkos and Kurzbard, 1994; Siomkos and Shrivastava, 1993; Mowen, 1980).

Drawing on this stream of research, it is assumed for increases in risk perception and provider responsibility for the existence of such risks to negatively impact users' attitudes towards providers of SVHC related products in absence of any provider reaction regarding crisis management to reduce such negative perceptions. This rests on the assumption for the candidate list information to be perceived as credible and correct by users. However, it is not far from being realistic for recipients to also question the validity of the information received within their evaluative process of attitude formation. For instance, potential long-term negative effects of the chemical may be devaluated by users due to perceived forecast uncertainty of long-term impact assessments (cf. Grunwald, 2010). Besides, high individual time preference rates characteristic for myopic buying behavior may lead users to discount the negative risk-related information in light of (positive) scarcity information benefitting an altogether more positive risk and consequently better cost-benefit evaluation (cf. Hummel, 1999; Loewenstein, 1992). Since the candidate list information has an official status as being part of a legal procedure, it is assumed here that the negative influence of perceived risk and provider responsibility on attitude formation is likely to prevail as is reflected in the following two hypotheses.

*H5: In absence of any provider response, the higher users' perception of risk, the more negative are their attitudes towards providers of SVHCs or related products.*

*H6: In absence of any provider response, the higher users' perception of provider responsibility for the existence of substance-related risks, the more negative are their attitudes towards providers of SVHCs or related products.*

Drawing on attitude-behavior-hypothesis and with generally increased levels of involvement of supply chain actors as typically found on business-to-business markets and further enhanced by the candidate list, it is assumed here for users' attitudes towards the provider to influence supply chain actors' demand and supply, respectively, as long as changes in attitudes are perceivable to them. This holds true because changes in attitudes of customers can be seen as predictors of future demand to be placed on the respective supplier the attitude refers to. Thus, the subsequent attitude-behavior-hypotheses for each individual supply chain actor emerge.

*H7: The more negatively end-consumers' attitudes towards the provider of the SVHC containing article are impacted by the candidate list, the lower is their demand for the article.*

*H8: The more negatively distributors' atti-*

*tudes towards the provider of the SVHC containing product (article or mixture) are impacted by the candidate list, the lower is their demand for the product.*

*H9: The more negatively downstream users' attitudes towards the provider of the SVHC or SVHC containing mixture are impacted by the candidate list, the lower is their demand for the substance or related mixture.*

*H10: The more negatively users' attitudes towards the SVHC manufacturer are impacted by the candidate list, the lower is substance manufacturer's supply of the candidate substance.*

The latter may even hold under conditions of stable demand when the substance manufacturer takes precautionary measures to shielding his own reputation and avoiding negative spill-over-effects to further products from his range. As already explained, listing a substance on the candidate list shows a potential to signal both negative substance-related risks and (future) scarcity of a specific substance or the substance-related products, drawing attention to a potential substance ban concomitant with considerable lack of information on alternatives and the way the substance will finally be regulated. Therefore, besides analyzing perception and evaluation of risk drawing on negative publicity and product-harm crises research (cf. Standop and Grunwald, 2009 for a literature review), also analyzing forms and distribution of scarcity along the supply chain provides useful insights into behavioral reactions of supply chain actors (cf. Lynn and Bogert, 1996; Brock, 1968; Ditto and Jemmott, 1989; Brannon and Brock, 2001; Inman *et al.,* 1997). Since scarcity in turn is likely to depend on supply chain actors' power relative to other actors, an actor-specific analysis of reputational effects incorporating the construct of supply chain power promises in-depth insights.

Power in the supply chain represents the extent to which a company has influence on other members of the supply chain, in turn reflecting an actor's degree of dependency on other actor(s) which can take various forms such as coercive or reward (cf. French and Raven, 1959; Maloni and Benton, 1999). It is based on access to scarce resources like information (non-material) or commodities (material) or the interrelation between the two. Scarce commodities can be thought of as chemical substances technically or economically indispensable for competitively attaining product characteristics crucial to customers. Scarcity of information in the context of REACH supply chains can take the form of limited knowledge or access to information on how a substance can be used in processing a mixture or an article. Such information may be asymmetrically distributed between actors along the supply chain (cf. Grunwald and Ostendorf, 2013). Similarly, private end-consumers could perceive risk-related compared to promotional information as scarce. Both scarcity of information and commodity can limit an actor's response options and information settings relevant for decision making both varying with their relative supply chain power.

Reactions towards perceived asymmetry in supply chain power can be psychological, like cognitive reactance e.g. to be perceived by consumers when feeling inadequately informed about product risks potentially leading to consumer distrust, as well as behavioral (cf. Grunwald and Hennig, 2012; Jones and Brehm, 1970; Kroeber-Riel and Weinberg, 1996). According to balance theories such as contribution inducement theory (cf. March and Simon, 1993), equity theory (cf. Homans, 1968; Adams, 1965) or theory of cognitive dissonance (cf. Festinger, 1957), imbalances in the cognitive system like in the form of (anticipated) decreases in the balance of inducement utilities over contribution utilities (cf. Tosi, 2009), psychological reactance or deteriorating output-input-ratios will motivate deciders to reduce them in order to (re-)gain cognitive equilibrium or harmony. With regard to power imbalances in the supply chain, this can be achieved by compensating shortfalls in informational power sources through material ones and vice versa. Supply chain power is assumed to influence both psychological and behavioral reactions. While the latter seems to be self-explanatory in that material or financial disposition limits strategic choice, the former grounds on information processing to be largely dependent on the amount and quality of information available.

Market success of substance manufacturers is dependent on derived demand for the substance produced. It describes the demand placed on the substance to be dependent on the demand and changes in the price for mixtures or articles related to that substance. Assuming the candidate substance to be crucial for end product quality, in absence of suitable alternatives any credible market signal of scarcity like the candidate list information could entail (temporary) increases in prices for that substance. This is explained by users (i.e. formulators, article manufacturers and distributors) increasing their demand to build up stocks of the substance or the mixture or articles containing that substance in expectancy of scarcity given constant substance supply for the time being.

A similar effect can be observed with regard to end-consumers and distributors building up their stocks of traditional light bulbs to be phased out

in the EU in favor of a new generation of energy-efficient lighting. The example may insofar be well paralleled to the case of SVHCs as alternatives such as new energy-saving light bulbs may as well possess negative properties like developing electrical smog or containing cancer causing chemicals (cf. Ward, 2011). Side-effects of alternatives may be explored less than those of the candidate substance so that the majority of the manufacturers' direct or indirect clients will be decoding the candidate list information more likely as a (positive) signal of scarcity than a (negative) signal of risk.

Resulting stable or even rising demand for the substance will nourish positive profit expectations at least temporarily causing the substance manufacturer to maintain or even increase production and supply. This general dependency of the substance manufacturer's supply from downstream users' demand and in turn downstream users' demand from the demand of distributors (e.g. retailers) as reflecting end-consumer demand for product quality relying on the candidate substance is expressed by the following hypotheses. These hypotheses also reflect demand effects which are not necessarily dependent on prior attitude formation as is likely to be the case with lowly involved actors.

*H11: The higher (lower) end-consumers' demand for product quality relying on the candidate substance, the higher (lower) is distributors' demand for substance-related products.*

*H12: The higher (lower) distributors' demand for products related to the candidate substance, the higher (lower) is downstream users' demand for the candidate substance.*

*H13: The higher (lower) downstream users' demand for the candidate substance, the higher (lower) is manufacturers' supply of the candidate substance.*

The analysis reveals potential determinants of the reputational loss of the respective supply chain actors resulting in the behavioral model displayed in Figure 3. As can be seen from Figure 3, direct changes in demand to the market are primarily end-consumer driven. However, behavioral reactions of actors further up in the supply chain may as well be indirectly induced by attitudinal changes as is reflected by hypotheses 8, 9 and 10 which are therefore shown dashed in Figure 3.

## 4 Empirical results on German supply chain actor adaptions: Methodology and discussion

While there has been much debate about the candidate list and the authorisation procedure under REACH, any evidence on the actual impact of these instruments on enterprises in the supply chain of chemicals has so far been largely anecdotal. Some empirical evidence can be derived from a study commissioned by the European Commission in preparation for the Commission's review of REACH in 2012. The study was based on a survey conducted by CSES (Centre for Strategy & Evaluation Services LLP) between June and August 2011 in which affected companies across the EU were asked to report their experiences with the operation of the REACH Regulation via an online questionnaire. The general results of the survey can be found in CSES (2012) and NKR (2012). In this section, the answers of German manufacturers of chemicals, downstream users and distributors to the survey questions focusing on the impact of the candidate list are analyzed. The sample consists of 181 manufacturers, 161 downstream users (formulators and manufacturers of articles) and 9 distributors. Here, it should be noted that some survey participants did not answer some questions so the number of respondents may not be the same for all questions. The results are discussed in the same order below.

18% of manufacturers stated that one or more of the substances they produce is included in the candidate list. The survey participants were asked what the result of the entry of a substance they produce in the candidate list for authorisation has been. The most wide-spread impact was an increase in costs for the business as a result of the information requirements triggered by the candidate list (as shown in Table 1, 61% of respondents said this occurred "sometimes", "frequently" or "always"). 55% of respondents stated that the inclusion of a substance in the candidate list led to a reduction in the demand for the substance. Hence, an impact of the candidate status on the demand of a substance is registered by manufacturers in just over half of the reported cases but apparently not in the others. The developed behavioral model may aid in explaining this ambivalent picture through the recognition that case-specific factors such as the availability of alternatives and the perception of risks may influence behavioral reactions from actors in the supply chain that determine the total demand for a substance.

When asked whether they have decided to withdraw any substance from the market as a result of REACH, 23% of manufacturers answered in the affir-

**Figure 3 Behavioral model of supply chain effects of the candidate list.**

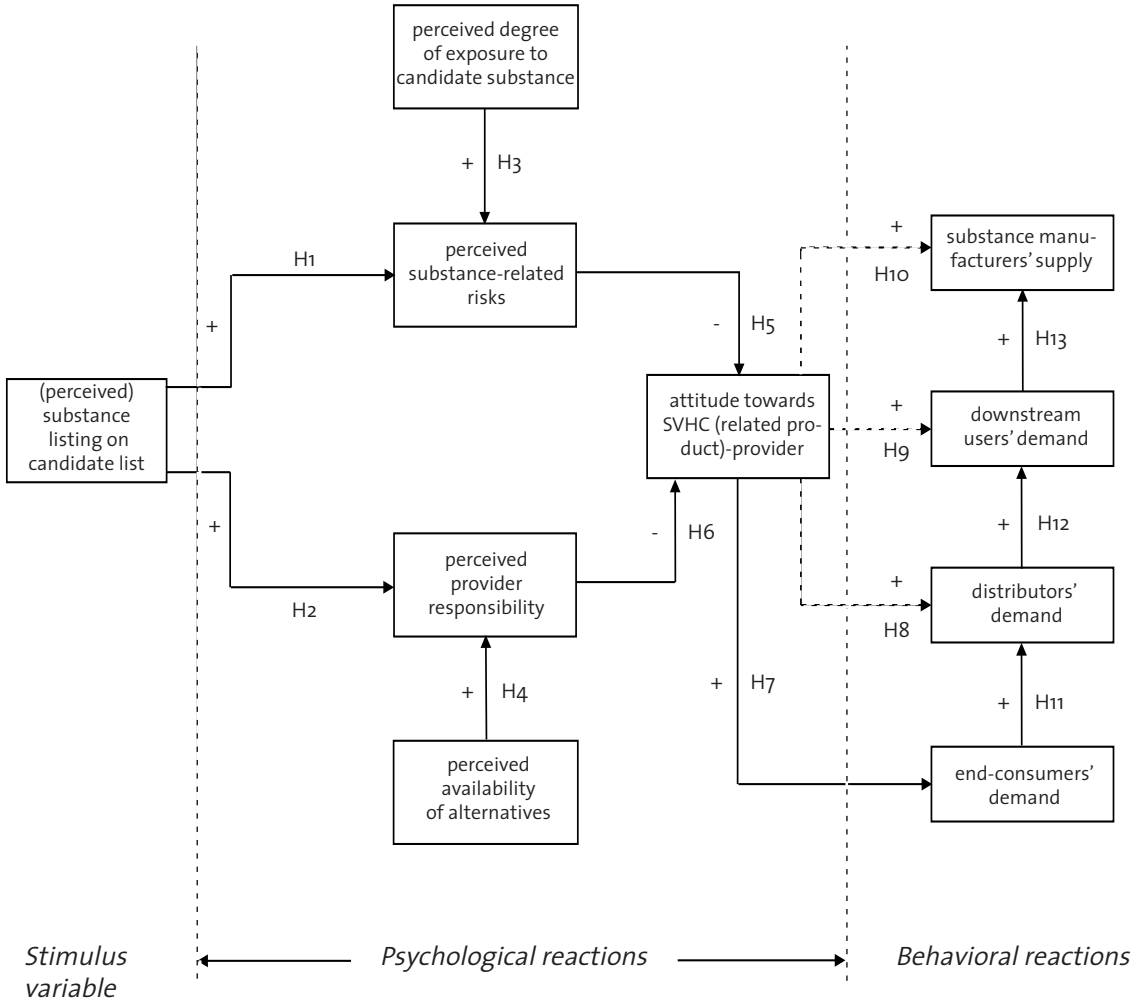



**Table 1 Impact of entry of substance in candidate list from manufacturer's perspective (representative sample of 181 manufacturers of chemicals in Germany, survey conducted by CSES between June and August 2011).**

| *Potential impact of candidate list* | *Likelihood of occurrence according to respondents* | | | | | |
|---|---|---|---|---|---|---|
| | Don't know | Never | Seldom | Sometimes | Frequently | Always |
| No impact | 10% | 40% | 15% | 15% | 0% | 20% |
| Led to an increase in the costs for the business as a result of the requirement to provide informati-on to customers | 19% | 14% | 5% | 14% | 14% | 33% |
| Led to a reduction in the demand for the specific substance | 10% | 15% | 20% | 20% | 5% | 30% |

mative and 25% declined but said that they are considering doing so in the future. However, only 22% stated the reason for the withdrawal was the inclusion of the substance in the candidate list (other possible reasons were that the substance was subject to a restriction or to a registration requirement under REACH). This calls into question whether reputational risk associated with the candidate status is the primary concern of manufacturers when deciding whether to continue marketing a substance. It should also be noted that the withdrawal of a certain substance from the market by one manufacturer does not necessarily lead to the non-availability of that substance to downstream users since there is usually more than one manufacturer or importer placing a particular substance on the market.

54% of downstream users stated that one or more of the substances used in their formulations/mixtures or in the articles they produce is included in the candidate list. Like for manufacturers, the most wide-spread result of the candidate listing was an increase in costs due to the information requirements which 80% of downstream users said happened sometimes, frequently or always, as shown in Table 2. 61% of respondents indicated that the inclusion in the candidate list led to the decision to replace the substance with a less hazardous one. This shows that the candidate list may indeed increase awareness and involvement regarding substance-related risks and prompt substitution efforts on the part of downstream users, provided that suitable alternatives exist. Suppliers removing the substance from the market (which could disrupt downstream users' activities if critical substances are no longer available) and increases in the price of the substance do not appear to be dominant impacts of the candidate list from the perspective of downstream users. The latter point is somewhat surprising since it could be expected that suppliers would adjust prices for candidate substances upwards to account for increased costs due to information requirements and possible reputational risks.

55% of downstream users stated that they have experienced the withdrawal of one or more critical substances used in the production of formulations or articles as a result of REACH and a further 22% are expecting this to happen in the future. The relatively high percentage of respondents experiencing or expecting the withdrawal of substances underlines the potentially challenging position of downstream users which are typically located at an intermediate stage of the supply chain. Consequently, they may be directly affected by behavioral reactions of both supply-side and demand-side actors to changes in attitudes towards SVHCs or SVHC-related products. When asked what has been their response to the withdrawal of critical substances, 77% of responding downstream users

**Table 2 Impact of entry of substance in candidate list from downstream user's perspective (representative sample of 161 downstream users in Germany, survey conducted by CSES between June and August 2011).**

| *Potential impact of candidate list* | *Likelihood of occurrence according to respondents* | | | | | |
|---|---|---|---|---|---|---|
| | Don't know | Never | Seldom | Sometimes | Frequently | Always |
| No impact | 3% | 24% | 17% | 21% | 21% | 14% |
| Led to an increase in the costs for the business as a result of the requirement to provide information to customers | 3% | 7% | 10% | 27% | 30% | 23% |
| Led to an increase in the price of the substance(s) | 21% | 29% | 21% | 18% | 0% | 11% |
| Led to the decision of your suppliers to remove the substance from the market | 6% | 29% | 26% | 29% | 6% | 6% |
| Led to the decision to replace the substance with a less hazardous substance | 3% | 25% | 11% | 25% | 25% | 11% |

answered that they sometimes, frequently or always switched to other substances with less hazardous properties. In contrast, only 39% switched to another supplier in the EU and 25% to another supplier outside the EU. This leads to the conclusion that if the supply of an SVHC is disrupted as a result of the supplier stopping production e.g. due to a fear of negative publicity, a downstream user would be more likely to attempt to substitute the substance with an alternative rather than to try to find another supplier for the same problematic substance.

100% of distributors participating in the survey said that the products they distribute or sell contain one or more chemical substances included in the candidate list. When asked what has been their response to the inclusion of a substance in the candidate list, 57% of distributors stated that they asked their suppliers to stop supplying products that include the substance or to ensure that none of the products supplied contain the substance. The remaining 43% had no specific response. Although the survey's sample size for distributors is too small to draw any final conclusions, it is apparent that a very high percentage of distributors have experienced that substances they sell as such or that are contained in products they sell were placed on the candidate list. The reaction of more than half of the responding distributors was to in effect blacklist those substances. As end products are usually sold to the end user or consumer through distributors, such companies often have the legal responsibility for communicating to the final customer that an article contains an SVHC. The result that a significant share of distributors (but not all) blacklisted candidate substances is consistent with the developed behavioral model in so far as there is on one hand a strong tendency for distributors to avoid the reputational risk of being associated with products containing SVHCs. On the other hand, an outright blacklisting of candidate substances may not be feasible or desirable from the distributor's point of view in all circumstances, for instance, when the end customer's involvement and degree of exposure are low and there are no suitable alternatives.

## 5 Conclusion

The goal of this research paper is to develop a behavioral reputational model to describe and explain potential effects of the REACH candidate list of substances subject to authorisation on supply chain actors' reputation. The candidate list is an instrument provided by the EU chemicals regulation to publicly announce and prioritize SVHCs as a first step of imposing an obligation of authorisation on them. As the candidate list comprises signals of risk and scarcity of information and commodity (i.e. a potential lack of the substance, substance-related products or alternatives), the reputational model is based on negative publicity and risk perception research considering the distribution of information and power across actors along the supply chain.

The crucial factors in determining a potential reputational loss induced by listing a substance on the candidate list appear to be the supply chain actors' involvement raising perceptions of substance-related risks and provider responsibility for the existence of such risks being influenced by perceived exposure to the candidate substance and availability of alternatives. Perceptions of risk and provider responsibility in turn are supposed to directly impact actors' attitudes towards the SVHC (or related product) provider. Attitudes towards the SVHC provider form a mediating variable hypothesized to elicit behavioral reactions (such as reducing demand, blacklisting the substance or withdrawing it from the market) with unforeseen changes in buying or supplying behavior indicating a reputational loss to the respective supply chain actor. Whereas direct changes in demand to the market according to the model appear to be primarily end-consumer driven, behavioral reactions of actors further up in the supply chain may as well be indirectly induced by attitudinal changes.

Preliminary experience of companies with the candidate list derived from a study commissioned by the European Commission is used in this paper to shed light on the empirical relevance of the reputational model developed. The results show that a significant percentage of the surveyed actors have already been directly affected by the inclusion of substances in the candidate list and this will intensify as further SVHCs are identified. The candidate status often leads to non-negligible costs for fulfilling information requirements and potentially to a decrease in demand but the severity of this perceived effect cannot be quantified with the available data. In addition to the perception of reputational risks by manufacturers and a heightened level of awareness in the supply chain, demonstrated impacts of the candidate list include substitution efforts by downstream users and blacklisting by retailers. However, in practice the occurrence of these potential impacts varies widely from case to case and differences in substances' properties, uses and supply chains likely play a key role in this, as suggested by the developed behavioral model.

Further empirical evidence is needed to empirically test the reputational model derived. These data could be gathered by stakeholder consultations using questionnaire designs incorporating the constructs used in the model to enable micro-analyses. Companies may use the model to derive

suitable strategies of corporate social responsibility (CSR), e.g. communicative responses, to manage negative publicity induced by the candidate list and to shield or rebuild reputation by considering e.g. perceptions of substance exposure and availability of alternatives as strategic target variables in shaping attitudes.

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