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## **Firms dealing with regulatory change: innovation and political influence strategies**

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### **Abstract**

Firm-level strategies, particularly political strategies, are overlooked in transition studies. Therefore, we study how car manufacturers combine and change their innovation and political influence strategies in response to a technology-forcing regulation that attempts to drive transition. We use Oliver and Holzinger's (2008) conceptual framework on the case of the zero emission vehicle mandate over the period 1990-2013. We use patent and sales data to operationalize the R&D and commercialization aspects of innovation strategies, while using corporate political activities data to operationalize political influence strategies. We find that firstly, car manufacturers use specific combinations of innovation and political influence strategies, along their value maintaining or creating nature. Secondly, these manufacturers change their strategies and become more value creating over time, which supports socio-technical transition processes. Thirdly, we refine Oliver and Holzinger's (2008) strategy typology by identifying subclasses in defensive (opposition and slowdown) and proactive strategies (shaping, support and progressive).

# Corporate responses to technology-forcing regulations: innovation and political influence strategies by car manufacturers

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## 1. Introduction

Our society faces many sustainability problems and a transition towards a more sustainable society is imperative (EC, 2012; UN, 1987; Van den Bergh et al., 2011). Such a transition will involve the development of novel technologies, next to the many changes in the socio-economic and institutional contexts that are necessary to incorporate these new technologies. Many 'transition studies' papers have described possible pathways in which new technologies emerge in niches and may become part of a socio-technical regime – i.e. a stable configuration of interacting dimensions, including technology, markets, politics, culture, and science (Geels, 2002; 2010; Kemp et al., 1998; Schot, 1998). Policy interventions are an important means of facilitating transitions by supporting technological niches or by opening up the regime for novel technologies (Schot and Geels, 2008; Raven, 2005; Caniels and Romijn, 2004; Kemp et al., 2007; Loorbach, 2007; Rotmans and Kemp, 2001).

Public policy is frequently used to trigger or even force firms to engage in innovations that contribute to the transition to a more sustainable society. Examples of such policies include tax incentives, standards, R&D subsidies and technology-forcing regulations. Technology-forcing regulations – e.g. fuel or energy efficiency standards for cars, appliances and buildings, or sustainable energy obligations in the electricity mix – force firms to develop and introduce novel

sustainable technologies. Some of such sustainable technologies are radical and competence-destroying in nature (Tushman and Anderson, 1986) and may require changes in the system that surrounds the technology, e.g. infrastructure, supply chain and consumer behavior (Hekkert et al., 2005). The competence-destroying and systemic nature of a technology reduces the ability and incentive to innovate, particularly for incumbent firms (Christensen, 1997; Wesseling et al., in press). Without policy, firms would invest less in these technologies, also because the (environmental) benefits of clean technologies do not always accrue to the firms that develop them (Rennings, 2000; Van den Bergh et al., 2011).

When firms are confronted with regulatory pressure to innovate, they will not simply comply by engaging in the mandated innovation, but they may also try to actively prevent or influence the regulation through corporate political activities (CPAs). CPAs are defined as “corporate attempts to shape government policy in ways favorable to the firm” (Hillman et al., 2004, p. 838; Baysinger, 1984). The ability of firms to influence regulations has largely been overlooked in the innovation and transition studies literature, but is the focal point of the CPA literature (Hillman et al., 2004; Lawton and Rajwani, 2011). The CPA literature has developed largely independently from the literature on innovation strategies; recent CPA review studies do not even mention the words “innovation” or “technology” (e.g. Lawton et al., 2013; Lux et al., 2011; Mathur and Singh, 2011). Hence, the relation between innovation and political influence strategies is an interesting topic for transition studies to broaden the understanding of regulation in socio-technical transitions.

Recently, Oliver and Holzinger (2008) have developed a general conceptual framework in which they link compliance and active political influence strategies. They distinguish between value maintaining and value creating strategies. Value maintaining strategies involve efficiently adapting the firm’s resources and capabilities to regulatory changes (compliance), or to oppose regulations that threaten the status quo (influence). Value creating strategies on the other hand involve exploiting first mover advantages through internal adaptation to anticipated regulatory changes (compliance) and by actively shaping regulations to the firm’s advantage (influence).

Applying Oliver and Holzinger’s (2008) framework to technology-forcing regulations implies that their concept of ‘compliance strategy’ becomes similar to that of ‘innovation strategy’, as compliance requires innovation. In this paper we study if and how firms combine innovation strategies and political influence strategies with Oliver and Holzinger’s (2008) conceptual framework, applied to technology-forcing regulation, as a starting point. We thus follow up on Oliver and Holzinger’s (2008, p. 515) recommendation to research the “breadth of a firm’s strategic repertoire” and study whether firm combine innovation strategies and political influence strategies to exploit “synergies”.

The case we study is how car manufacturers responded to the Zero Emission Vehicle (ZEV) mandate over the timeframe 1990-2013. This mandate forces clean vehicle technologies onto the market, including radically new and systemic innovations, with the goal of making our currently unsustainable transportation system more sustainable (Sperling and Gordon, 2009; Lutsey and Sperling, 2009). The ZEV mandate was issued in 1990 by the California Air Resources Board (CARB) and, in response to car manufacturers’ political activities, has been continuously adapted since that date. This makes it possible to study strategic changes in the context of Oliver and Holzinger’s (2008) relatively static framework. Moreover, the mandate has been very influential, as it is adopted by

California, one of the largest car markets in world, and by nine other US states (CARB, 2012). Consequently, the ZEV mandate provides a good case to longitudinally study the interrelation and possible change of corporate innovation and political influence strategies in response to influential technology-forcing policy.

The remainder of this paper is structured as follows. Section 2 discusses Oliver and Holzinger's conceptual framework on corporate response strategies to regulatory change and links it to innovation strategy literature. The Methods are discussed next, followed by a brief description of the ZEV mandate in Section 4, and the Analysis in Section 5. We conclude by summarizing the findings of this paper and by reflecting on how the field of transition studies may benefit from studies that combine firm-level innovation strategies and political influence strategies.

## **2. Theoretical background**

### **2.1. Corporate political activity**

The Corporate Political Activities (CPA) literature argues that in strongly regulated environments, firms may strengthen their competitive advantage by engaging in political strategies (Hillman and Hitt, 1999; Oliver and Holzinger, 2008). CPAs are defined as "corporate attempts to shape government policy in ways favorable to the firm" (Hillman et al., 2004, p. 838; Baysinger, 1984). Such actions include for example lobbying, litigation, constituency building and political action committee contributions. However, not all companies engage in political influence. Consequently, the CPA literature perceives the political environment not just as a set of government-imposed constraints that impose costs on firms, but also as an opportunity set within which firms can exert influence to maintain their value or create new value (Hillman and Hitt, 1999; Lux et al., 2011; Oliver and Holzinger).

Embedded within the CPA literature, Oliver and Holzinger (2008) developed a comprehensive conceptual framework on corporate response strategies to regulatory change. We adopt this framework to study how firms combine innovation and political influence strategies, because it distinguishes in strategies between compliance and influence, and between value maintenance and value creation, see Table 1. Oliver and Holzinger (2008, p. 505) define political compliance strategies as firm-level actions undertaken in conformity with political requirements and expectations for the purpose of maintaining or creating value by adapting or anticipating to public policy. Political influence strategies can be defined as a timed sequence of consistent CPAs. Value maintenance refers to "the preservation of those firm assets and competencies that constitute the foundation of firm rents", while value creation refers to "the invention or reconfiguration of firm assets or competencies that constitute an original or unique addition to firm rents" (Oliver and Holzinger, 2008, p. 497).

Table 1: Corporate response strategies to regulatory change (Oliver and Holzinger, 2008)

		Value perspective	
		Value maintenance	Value creation
Strategic orientation	Compliance	<b>Reactive strategy</b> <i>Efficiently align internal resources and capabilities with regulatory change</i>	<b>Anticipatory strategy</b> <i>Exploit early-mover advantages of aligning with anticipated regulatory change</i>
	Political influence	<b>Defensive strategy</b> <i>Engage in political influence to oppose regulatory change and retain the status quo</i>	<b>Proactive strategy</b> <i>Engage in political influence to shape regulatory change to gain competitive advantage</i>

Compliance strategies focus on shaping the firm’s internal resources to comply with existing or anticipated regulations. Firms employing a reactive strategy aim to maintain the value of their resources and competences by aligning them efficiently and effectively with regulatory demands (Carroll, 1979; Buysse and Verbeke, 2003; Oliver and Holzinger, 2008). For example, firms installing cheap but effective emission abatement hardware to comply with emission standards, adopt a reactive strategy. Firms with an anticipatory strategy anticipate regulatory changes to create value by exploiting early-mover advantages in adopting innovative operational routines to comply with anticipated regulatory demands (*Ibid.*). To illustrate, battery manufacturers Toshiba and Hitachi anticipated more stringent battery regulations and therefore quickly acquired and implemented acid-free and renewable battery technology, which reduced their compliance cost when the more stringent regulations were issued (Shrivastava, 1995; Oliver and Holzinger, 2008).

Political influence strategies utilize CPAs to influence regulation. Firms engage in value maintaining defensive strategies to oppose regulations that threaten the value of their assets and to protect the favorable status quo (Shaffer and Hillman, 2000; Oliver and Holzinger, 2008; Stenzel and Frenzel, 2008; Hillman et al., 2004; Carroll, 1979). Tobacco companies for example, are famous for their defensive strategies, trying to thwart restrictive regulations on tobacco. Proactive strategies are intended to shape regulations in ways that support value creation for the firm (Carroll, 1979; Buysse and Verbeke, 2003; Oliver and Holzinger, 2008). Through political influence firms may increase their success in obtaining government subsidies or winning government tenders, or they may attempt to shape regulations in ways that involves low compliance cost for the firm itself, but disproportionately raises compliance costs for competitors (Oliver and Holzinger, 2008).

## 2.2. Technology-forcing regulation: compliance through innovation strategies

Applying Oliver and Holzinger’s (2008) conceptual framework on corporate political strategies specifically to technology-forcing regulations implies that to comply, firms need to adopt innovation strategies. In such instances, compliance strategies have to relate to innovation strategies. Building on previous work, we define an innovation strategy as a timed sequence of internally consistent resource allocations to the development and commercialization of technologies that are new to the firm itself and/or its markets, to achieve long-term profitability (Adams et al., 2006; Cooper et al., 2004; Dyer and Song 1998; Lieberman and Montgomery, 1998; Ramanujam and Mensch, 1985).

We conceptualize innovation strategies as having an R&D and a commercialization component. Diverse R&D activities retain the firm's flexibility, allowing it to explore and move into different technologies (March, 1991; O'Reilly and Tushman, 2008). Intense R&D investments are required to develop technology and sustain technology lead-times (Freeman and Soete, 1997). Commercialization involves mass marketing of the technology and requires significant investments in production facilities and marketing. Strategic management literature generally distinguishes three innovation strategies: a first mover strategy, a quick follower strategy or a laggard strategy (Lieberman and Montgomery, 1998; 1988; Freeman and Soete, 1997; Robinson and Chiang, 2002). In relation to the terminology of Oliver and Holzinger (2008), we postulate that 'anticipatory innovation strategies' include 'first movers' that invest heavily in R&D to maintain technology-lead time and pioneer in commercialization, and 'quick followers' that also invest heavily in R&D, enabling them to quickly follow first movers to the market (Lieberman and Montgomery, 1998). We relate 'reactive innovation strategies' to 'laggards', which lack innovative capabilities and minimize costs by investing little in R&D and entering the market last (Lieberman and Montgomery, 1998).

In some instances technology-forcing regulations fail to make firms commit strongly to new technology development and commercialization. In such cases, firms may not seek to yield long-term profit through innovation, and they may instead pursue compliance strategies that constitute a low cost alternative that they perceive as preferential to non-compliance, and which possibly involves the exploitation of regulatory loopholes (Ford, 2008; Anderson and Sallee, 2011). We also group such compliance strategies that entail the limited introduction of new technologies under "reactive innovation strategies".

Because of the high costs of innovation and firms' limited resources, firms may not be able to afford strong innovation in many different technologies. Therefore, innovation strategies are technology specific (Teece et al., 1997) and differ per type of innovation. Innovations may be typified according to the technological (incremental/radical or competence-destroying) and the socio-economic (modular – systemic) changes they bring about (Hekkert et al., 2005; Garcia and Calantone, 2002). Radical and/or competence-destroying innovations are harder to exploit by incumbents because they require new capabilities (Tushman and Anderson, 1986). Systemic innovations are more difficult to commercialize successfully because they require change by all actors affecting the technology, including consumers, policy makers, suppliers and infrastructure providers (Hekkert et al., 2007).

### **2.3 Interrelation between innovation and political influence strategies**

Table 2 displays our adaptation of Oliver and Holzinger's (2008) conceptual framework when applied to the case of technology-forcing regulations. The table distinguishes two dimensions; the upper quadrants are distinguished in the extent of innovation (reactive vs. anticipatory) and lower quadrants in the nature of political influence (defensive vs. proactive). Oliver and Holzinger (2008) suggest that firms may exploit synergies in combining different strategies, something we will explore in the Analysis section.

Table 2: Response strategies to technology-forcing regulation, comprising innovation and political influence strategies, adapted from Oliver and Holzinger (2008)

		Value perspective	
		Value maintenance	Value creation
Strategic orientation	Innovation (compliance)	<b>Reactive innovation strategy</b> <i>Comply marginally with technology-forcing regulation through cost-efficient compliance and laggard innovation strategies.</i>	<b>Anticipatory innovation strategy</b> <i>Anticipate stronger technology-forcing standards and stay ahead of regulatory change through first mover and quick follower innovation strategies.</i>
	Political influence	<b>Defensive strategy</b> <i>Engage in political influence to oppose regulatory change.</i>	<b>Proactive strategy</b> <i>Engage in political influence to shape regulatory change to gain competitive advantage.</i>

### 3. Methods

#### 3.1 Case study design

To study how firms respond through innovation and political influence strategies to technology-forcing regulation, we conduct a longitudinal case study of the innovation and political influence strategies of car manufacturers regarding the ZEV mandate. For innovation strategies we focus on the R&D and commercialization activities, and for political influence strategies on the corporate political activities (CPAs); see the operationalization scheme in Table 3 on which we elaborate in the following subsections. Innovation strategies are technology-specific and the technologies under study include: clean internal combustion engine vehicles (ICEVs), Hybrid Electric Vehicles (HEVs), Plug-in Hybrid Electric Vehicles (PHEVs), Neighborhood Electric Vehicles (NEVs), Electric Vehicles (EVs) and Hydrogen Fuel Cell Vehicles (HFCVs). Ranging from competence-enhancing to competence-destroying, these technologies are listed and described in Table 4.

R&D and commercialization activities measure different aspects of the innovation process, as R&D indicates the extent to which firms are exploring and further developing new technologies, while commercialization activities refer to the stage of (mass) market introduction. To study the interaction between corporate innovation and political influence strategies, we mapped their respective indicators over the timeframe 1990-2013 and qualitatively analyzed their interaction. The timeframe of study is split up in three periods describing the trends in innovation and political influence strategies, including period 1 (1990-1999), period 2 (2000-2006), and period 3 (2007-2013). As we discuss in Section 4, each of these periods includes two amendments to the ZEV mandate on which car manufacturers could exert influence, providing a balanced selection of periods.

Table 3, Indicators of R&D, commercialization and political influence activities

Concept:	Indicator:	Database (per technology and firm):
<b>R&amp;D</b>	Patents	Global Patent Index program from European Patent Office.
<b>Commercialization</b>	Sales; CO2 emissions	US (and EU) production/sales figures for alternative vehicle technologies; CO2 emissions for ICEV technology
<b>Corporate Political Activities</b>	Arguments, litigation, compliance	ZEV mandate database: public hearing transcripts, public documents, letters to CARB and EPA, interviews, complementary sources

Our study focuses on the six ‘large volume’ car manufacturers that were consistently subject to the full requirements of the ZEV mandate, as opposed to the ‘intermediary volume’ manufacturers that were subject to less stringent requirements. These six manufacturers are General Motors, Chrysler, Ford, Toyota, Honda and Nissan. Although the analysis centered on these six firms, merger and alliance partners like DaimlerChrysler (1998-2007), Fiat-Chrysler (2014-now) and Renault-Nissan (1999-now) were also taken into account as contextual factors in the analysis.

Table 4: Acronyms and descriptions of the sustainable automotive technologies included in this study, ranging from competence-enhancing (top) to competence-destroying (bottom).

	Technology	Description
← Increasing competence-destruction	clean ICEV	Competence-enhancing, incremental innovations to reduce emissions and increase fuel economy of the Internal Combustion Engine Vehicle, e.g. start-stop systems and catalytic converts. Requires no infrastructural change.
	HEV	Relatively competence-enhancing innovation that combines ICEV technology with energy recuperation and storage to support partial (mild-HEV) or full (full-HEV) electric driving without requiring infrastructural changes.
	PHEV/EREV	Plug-in hybrids and extended range electric vehicles have a plug for external charging that enables diverging all-electric-driving-ranges before the ICEV takes over propulsion (with PHEV) or starts generating electricity (with EREV). Benefits from but is less dependent on recharging infrastructure.
	NEV	Neighbourhood Electric Vehicles are low speed, low performance EVs that are essentially glorified golf carts that require recharging infrastructure but can easily utilize home charging.
	EV	Electric Vehicles are fully battery powered vehicles that require an external recharging infrastructure for operation.
	HFCV	Hydrogen Fuel Cell Vehicles use fuel cell technology to power their full electric drivetrain which provide them with a larger action radius than EVs and require a hydrogen refuelling infrastructure.

### 3.2 Operationalization of R&D

To measure the research and development of each technology, we used patent data, since patents are a good indicator for R&D activities (Archibugi and Pianta, 1996). Patent data were obtained through the European Patent Office's Global Patent Index program which contains worldwide patent



data (EPO, 2014). We applied the HEV, EV and HFCV queries from Wesseling et al. (TFSC). For the PHEV query's basis we combined "hybrid" with "plug-in" and "range-exten\*", and the NEV query's basis comprised "neighborhood electric", "low-speed electric\*" and "low speed battery". These basic queries were combined with the keywords combination "(vehicle OR car OR automobile)" within a two word proximity. No patents were found for the low performance NEVs. To identify the patents of innovations related to emission reduction and/or fuel economy improvement of clean ICEVs, we first reviewed the literature on such innovations (e.g. Alkidas, 2007; Taylor, 2008). Keywords representing these innovations were used in the newly established search query, in addition to more general keywords related to fuel economy and emissions and engine-related concepts. We used a publication level filter to ensure relevant patent applications and ordered the data on the "date of filing" to reduce the time lag between invention and application for the patent. To prevent overlap in patents between technologies, we added mutually exclusive search strings to the basic search queries. For a more elaborate discussion on the search query formation, see Wesseling et al. (TFSC). Obtained patents were checked for relevance.

### **3.3 Operationalization of commercialization**

The commercialization of alternative sustainable automotive technologies was measured using global vehicle sales data. Global data were used since there are large differences in the sales of these different technologies amongst countries and regions (IEA, 2013). Worldwide sales were obtained from the Marklines database (Marklines, 2014) and complemented with additional sources (e.g. ICCT, 2013; AFDC, 2013; Cole, 2014; PIA, 2006) to enhance the timeframe and increase accuracy of low volume sales data (<1.000). To measure the commercialization of clean ICEVs, we did not use vehicle sales, because sales data do not account for the large fuel economy differences between cars. Instead we used Corporate Average Fuel Economy (CAFE) data of each manufacturer's car fleet, which we controlled for the weight conform EPA and Ricardo measures (EPA, 2014a; Blanco, 2009) to remove weight-induced fuel efficiency bias. These data were obtained from the EPA (EPA, 2013).

### **3.4 Operationalization of Corporate Political Activities (CPAs)**

CPA data were collected by studying the comments car manufacturers used to influence the ZEV mandate over the period 1990-2013. Car manufacturers used these comments in different types of CPAs, such as (direct) lobbying, commissioning studies, having experts testify and in law suits. The comments were obtained from a database comprising 5 public hearing transcripts; 61 letters to CARB and 22 to letters EPA; 263 policy documents that include, amongst others, data on litigation. Complementary interviews with policy makers (7), car manufacturer representatives (7), and ZEV advocates (2) were used to contextualize the CPAs. For a more comprehensive overview see Wesseling et al. (forthcoming).

Using content analysis on our comments database, we identified the various CPAs and attributed them to strategy categories. We used *a priori* coding (Weber, 1990) because our theoretical framework provided categorical guidelines. This framework suggests that defensive CPAs are comments aimed at opposing the ZEV mandate, while proactive CPAs are comments aimed at actively shaping the mandate. This coding approach still leaves room to slightly revise and tighten up these categories (Weber, 1990), and thus to identify potential subcategories. We checked for inter-coder reliability by having two other researchers, not involved in the study, check our coding scheme. Our Krippendorff's alpha of 0.866 indicates the three coders have interpreted the data

similarly. The number of comments was also used as a proxy for the strength of a political influence strategy, i.e. firms providing more comments are expected to try to exert more influence.

Since limited data were available over the 1990-1999 timeframe, analysis of the 1990s relies mostly on secondary data.

#### **4. The ZEV mandate in the period 1990-2013**

The ZEV mandate was first issued in 1990 and mandated large volume car manufacturers to sell 2% of their fleet as ZEVs by 1998, 5% by 2001 and 10% by 2003. Strong political influence and infeasibility of the mandate resulted in 1996 in relaxation of the mandate, eliminating the temporary “ramp up” years of 1998 and 2001, while maintaining the 2003 standard. Car manufacturers signed a memorandum of agreement to place a total of 3.750 demonstration EVs in the marketplace by 2001 (CARB, 1998). Further opposition resulted in the 1998 amendments that allowed clean ICEVs to comply with part of the mandate (CARB, 2000).

The 2001 amendments further relaxed the mandate, as CARB agreed with car manufacturers to include provisions (i.e. additional regulatory language) in the mandate that allowed HEVs to comply with part of the mandate and that raised credits for other technologies and vehicle types in different ways (CARB, 2001). A series of lawsuits led by GM and DaimlerChrysler resulted in the 2003 amendments. These amendments delayed the ZEV requirements by 2 years, offered further credit multipliers for different technologies and attempted to stop compliance through the relatively cheap NEVs, which policy makers believed did not contribute to technological and market development of ZEVs and were therefore perceived as a loophole (NRDC et al., 2008). Additionally, the amendments included an alternative compliance path that required only a limited amount of HFCVs instead of numerous EVs to comply with the mandate – making HFCV technology a relatively cheap compliance option (CARB, 2003) or loophole according to some (NRDC et al., 2008).

The 2008 amendments enabled EVs to also comply with the less stringent alternative compliance path and allowed PHEVs to comply with part of the ZEV requirements (CARB, 2008). The ZEV requirements were raised for the first time during the 2012 amendments. These amendments provided new credit categories; allowed car manufacturers over-complying with the greenhouse gas emissions requirements in the Clean Cars program to offset part of their ZEV requirement, but eliminated the clean ICEV category; discontinued the “travel provision” for EVs by 2018, whereby car manufacturers could sell EVs in non-California states and earn credit toward the California ZEV requirements, effectively doubling the EV sales mandated. Under the political influence of car manufacturers and perceived as infeasible, the ZEV mandate has thus been continuously postponed, relaxed and shaped to fit multiple technologies.

### **5. Analysis**

#### **5.1 Introduction**

Sections 5.2-5.5 discuss the responses of individual car manufacturers to the ZEV mandate in terms of their innovation and political influence strategies, structured along the periods 1 (1990-1999), 2 (2000-2006) and 3 (2007-2013). We analyzed the strategies of all six large volume manufacturers, but to avoid repetition of similar results, we describe only the four most distinct response strategies, which are those of Nissan, Toyota, GM and Chrysler. Section 5.6 reflects on Oliver and Holzinger's (2008) conceptual framework in the context of this case study. R&D strategies as first part of the

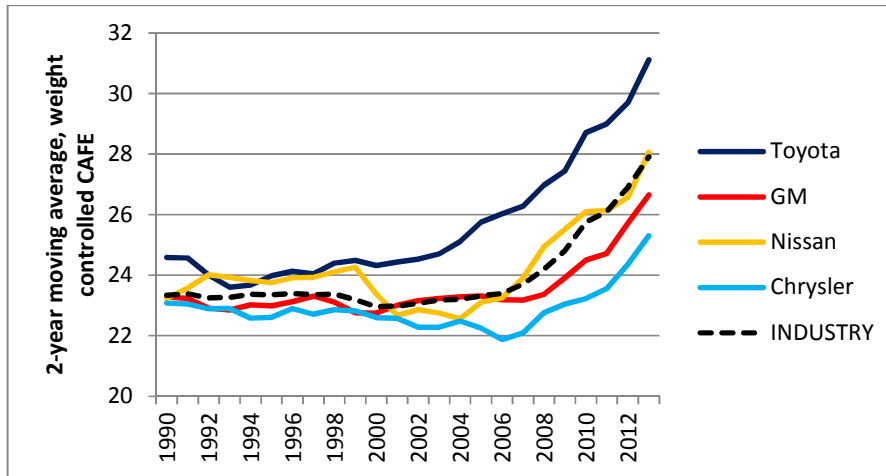
innovation strategies are depicted in Figures 2-5 that present per car manufacturer the absolute number of patent applications for each technology. Commercialization strategies as second part of the innovation strategies are depicted for the ICEV technology in Figure 1. This figure presents for the industry average, and per manufacturer, the weight controlled two-year moving average of corporate average fuel economy (CAFE) of passenger cars.

Through our iterative labelling of the data, we find that a lot of information is lost by maintaining the simple distinction in defensive/proactive influence comments by Oliver and Holzinger (2008). Instead, our qualitative analysis suggests a distinction between four types of comments in our dataset: 1) defensive comments to oppose the mandate; 2) defensive comments to slowdown and relax the mandate; 3) proactive comments to shape the mandate to benefit the firm's or disadvantage rivals' technology-specific compliance and innovation strategies; 4) proactive comments in support of the mandate. We apply this newfound typology throughout the remainder of this Analysis Section. Table 5 provides an overview of the types of comments that we collected over the period 2000-2013 for each manufacturer, indicating how politically influential companies tried to be (i.e. how many comments they submitted) and what political influence comments were most dominant for each firm (underlined). Because no company-specific comments were available for period 1, this period has been omitted from Table 5 but is incorporated in the following subsections.

*Table 5, Political influence comments on the ZEV mandate during the periods 2000-2006 and 2007-2013, categorized per type of strategy.*

		<b>Comments period 2 (2000-2006)</b>	<b>Comments period 3 (2007-2013)</b>
<b>GM</b>	<b>Total # of comments:</b>	<b>90</b>	<b>28</b>
	% Defensive (oppose)	<u>84%</u>	18%
	% Defensive (slowdown)	4%	25%
	% Proactive (shape)	10%	<u>47%</u>
	% Proactive (support)	0%	11%
<b>Chrysler</b>	<b>Total # of comments:</b>	<b>45</b>	<b>39</b>
	% Defensive (oppose)	<u>49%</u>	17%
	% Defensive (relax)	15%	26%
	% Proactive (shape)	34%	<u>46%</u>
	% Proactive (support)	2%	11%
<b>Toyota</b>	<b>Total # of comments:</b>	<b>55</b>	<b>54</b>
	% Defensive (oppose)	<u>49%</u>	19%
	% Defensive (slowdown)	22%	11%
	% Proactive (shape)	26%	21%
	% Proactive (support)	4%	<u>50%</u>
<b>Nissan</b>	<b>Total # of comments:</b>	<b>6</b>	<b>31</b>
	% Defensive (oppose)	17%	0%
	% Defensive (slowdown)	<u>33%</u>	0%
	% Proactive (+ shape tech)	<u>33%</u>	3%
	% Proactive (support)	17%	<u>97%</u>

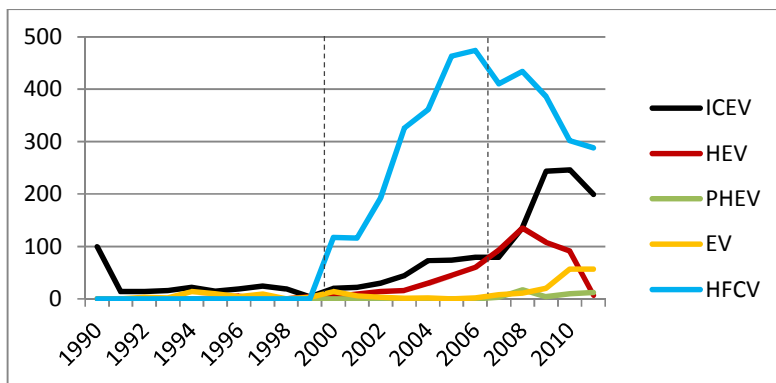
Figure 1, 2-years moving average, weight controlled CAFE of General Motors, Chrysler, Toyota and Nissan, over the period 1990-2013 (Source: EPA, 2014b).



### 5.2 Innovation and political influence by General Motors.

During period 1, GM believed that EVs might play a role in the future, and in 1990 tried to attain a first mover advantage by introducing an EV concept car and announcing production plans for the car (Hoogma, 2000; Kemp, 2005). However, when CARB issued the ZEV mandate that same year, GM’s perspective on EV strategy quickly changed. During the 1990s General Motors had abandoned its original EV strategy and would produce no more than 842 compliance EVs and used their “inability” to sell more as an argument to oppose the mandate (Boschert, 2006). Figure 2 shows that in relation to later years GM was also doing little R&D, which focused mostly on clean ICEV technology. GM’s fleet was also less fuel efficient than the industry average of the US’ 10 largest car manufacturers, see Figure 1. Instead of doing clean vehicle innovation, GM relied mostly on strong CPAs to oppose the regulation, using lobbying and, in a coordinated effort with Ford and Chrysler, litigation (Boschert, 2006; Fern, 1997). Hence, GM employed an opposition-oriented political influence strategy to compensate for its reactive innovation strategy.

Figure 2, General Motors’ patent applications over 1990-2012



During period 2, GM increased its innovative activities by intensifying and diversifying its sustainable R&D portfolio, while postponing mass commercialization. GM started focusing strongly on HFCVs and increased patenting in clean ICEVs and HEVs. Despite this R&D, GM did not improve its fleet’s

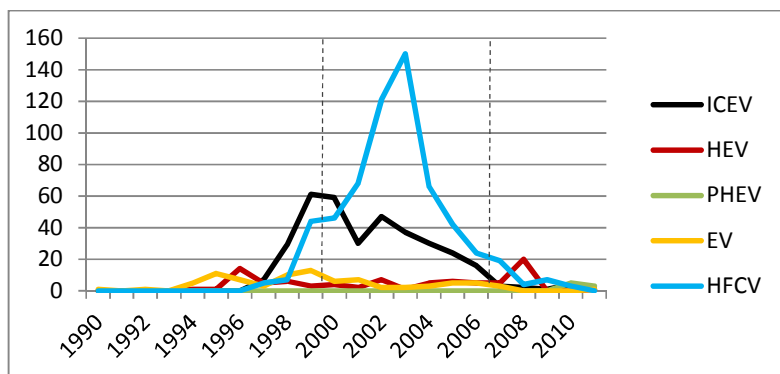
fuel economy past 1990 levels, see Figure 1, nor did they sell any LEVs (Marklines, 2013). As indicated by Table 5, GM continued its strong opposition-oriented political strategy using litigation and lobbying. GM employed two cheap short-term compliance strategies, leasing 5,000 NEVs for free and re-leasing previously built EVs, which they strongly supported through proactive lobbying. Trying to shape the mandate, GM also lobbied in favor of HFCVs, which supported their strongly HFCV-oriented R&D strategy, and lobbied against favorable HEV conditions, a technology in which they were slow to follow. In sum, during period 2 GM combined a mainly opposition-oriented political influence strategy to protect its vested interests, with a reactive innovation strategy to prevent non-compliance penalties.

GM became more innovative during period 3, increasing its sustainable R&D explosively and moving first in commercialization of PHEVs, having sold over 70,000 units worldwide between 2011 and January 2014 (Cobb, 2014). GM's HEV sales were less successful and averaged 1,300 units annually (*Ibid.*). GM's R&D in clean ICEVs peaked in 2010 and resulted in a 3-miles-per-gallon improvement of its CAFE, which is still below the industry average (Figure 1). To comply with the mandate, GM not only sold numerous PHEVs, but also launched a fleet of 119 highly credited HFCVs (Duffer, 2014) and bought numerous EV and HEV credits from Tesla, and Toyota and Honda respectively (CARB, 2013). Table 5 shows that in period 3 GM dropped its opposition-oriented influence strategy and focused more on lobbying to relax and shape the mandate to gain regulatory support for their PHEV. GM no longer lobbied for HFCV support in 2012 when HFCV patent applications dropped heavily, which may indicate that GM is abandoning its HFCV strategy. Because of its below-industry-average CAFE, GM opposed the over-compliance option in the 2012 amendments, which would benefit its more fuel efficient competitors. To conclude, as GM became more innovative and started successfully commercializing PHEVs, they finally reduced their opposition-oriented political influence and focused on shaping the mandate in favor of their now more anticipatory innovation strategies.

### **5.3 Innovation and political influence by Chrysler**

Figure 3 shows that Chrysler started their limited R&D in clean vehicles in 1995, focusing initially on EVs and HEVs; then switching to ICEV and HFCV technology by the late 1990s. Chrysler also lagged behind in fuel efficiency, see Figure 1. To comply with the ZEV mandate, they leased 207 converted EVs (PIA, 2006). Daimler's plans to sell EVs were cancelled when they merged with Chrysler in 1999 (Boschert, 2006). Chrysler adopted an opposition-oriented political strategy during period 1, using by lobbying and litigation to influence the mandate (Boschert, 2006; Collantes, 2006). Overall, like GM in period 1, Chrysler engaged in opposition-oriented political influence to protect its reactive innovation strategy that focused only on short-term compliance to prevented non-compliance penalties.

Figure 3, Chrysler's patent applications over 1990-2012



During period 2, Chrysler's R&D peaked, focusing mainly on HFCVs and clean ICEVs, see Figure 3. Chrysler's weight-controlled CAFE started lagging further behind on the industry average (Figure 1) and as various interviewees indicated, commercialization was limited to Chrysler's NEV-oriented short-term compliance strategy of selling thousands of NEVs produced in collaboration with NEV manufacturer GEM. For compliance Chrysler also relied on its partner Daimler's HFCV credits (Sperling, 2001). While complying, Chrysler was opposing and trying to relax the ZEV mandate through lobbying, see Table 5, and litigation (CARB, 2003). In addition to this mandate-wide defensive strategy, Chrysler was also trying to shape the mandate at the technology-specific level by lobbying to support their NEV-oriented short-term compliance strategy and their clean ICEV and HFCV-oriented R&D strategies<sup>1</sup> (CARB, 2001; 2003). Chrysler also lobbied against regulatory provisions that disproportionately benefitted their competitors, like the early phase-in multipliers for re-leased EVs and the HEV category (CARB, 2001; 2003). Chrysler thus continued their mainly opposition-oriented political influence strategy in period 2 to protect their interests, and enhanced its shaping-oriented influence strategy to support their cheap reactive innovation strategy to prevent non-compliance penalties.

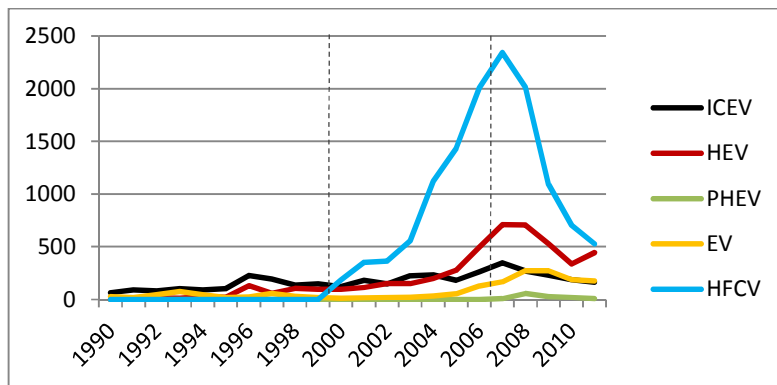
Chrysler's clean vehicle R&D dropped drastically during period 3, see Figure 3, and Chrysler's CAFE continued to fall farther behind on its competitors' (Figure 1). In 2007 Chrysler split from Daimler and after filing for bankruptcy in 2009 was slowly bought up by Fiat until wholly owned in 2014 (Flak, 2014). Having introduced no clean vehicles under the Chrysler brand other than ICEVs and NEVs (Marklines, 2013), Chrysler relied on the EV credits it bought from Tesla and got from Fiat (Voelcker, 2014; CARB, 2013). Despite its lack of innovation, Chrysler lessened its political opposition, lobbying instead to slowdown and relax the mandate (CARB, 2012). Chrysler tried to shape the mandate by lobbying to protect its NEV credits and lobbying in favor of HFCVs and plug-in technologies, although Chrysler never introduced more than 109 PHEVs (Chrysler, 2012). Chrysler also lobbied against the over-compliance option that would disproportionately benefit its competitors with a better CAFE (CARB, 2012). Hence, throughout the timeframe 1990-2013, Chrysler's political influence strategy has focused increasingly on shaping the mandate to support their still reactive innovation strategy.

<sup>1</sup> Both the compliance through NEVs and low-volume HFCVs were perceived as loopholes by some organizations (NRDC et al., 2008).

#### 5.4 Innovation and political influence by Toyota

During period 1, Toyota steadily increased its clean vehicle R&D, focusing on ICEVs, a little on EVs and later also HEVs. As a result of Toyota's mainly clean-ICEV-oriented R&D strategy, Toyota had a fairly fuel efficient vehicle fleet, see Figure 1. As a compliance strategy, Toyota marketed 320 RAV4 EVs and would not meet the reportedly higher demand (Hoogma, 2000, p. 267). Toyota also moved first in HEV commercialization, launching its Prius HEV in Japan and in the US in 1997 and 2000 respectively (DOE, 2014). Toyota did try to shape the mandate by lobbying for HEV credits until the 2001 ZEV amendments (CARB, 2001). Instead, Toyota lobbied defensively against the ZEV mandate during period 1 (Hoogma, 2000, p. 266; Collantes, 2006). Toyota thus combined a reactive EV innovation strategy and anticipatory clean ICEV and HEV innovation strategies with a defensive political influence strategy against a mandate that required ZEVs, because Toyota did not perceive ZEVs as profitable.

Figure 4, Toyota's patent applications over 1990-2012



Toyota increased its R&D in clean ICEV, HEV and particularly HFCV technology in period 2, see Figure 4. Toyota's annual HEV sales averaged over 80.000 during this time (Marklines, 2013), while their CAFE continued to improve more strongly than the industry average (Figure 1). As of 2001, Toyota accumulated ZEV credits using various generations of HFCV test fleets (Toyota, 2007). Politically, Toyota maintained a defensive, particularly opposition-oriented, political influence strategy in period 2, see Table 5. Toyota also tried to shape the mandate by lobbying in favor of 1) HEVs to support its first mover HEV strategy; 2) HFCVs to support its R&D and compliance strategy; 3) clean ICEVs to support their lead in clean ICEVs (CARB, 2001; 2003). During period 2, Toyota thus became more innovative in the fields of clean ICEVs, HEVs and HFCVs which is reflected in the shaping CPAs oriented at supporting these innovation strategies, but otherwise Toyota's political influence strategy remains predominantly defensive.

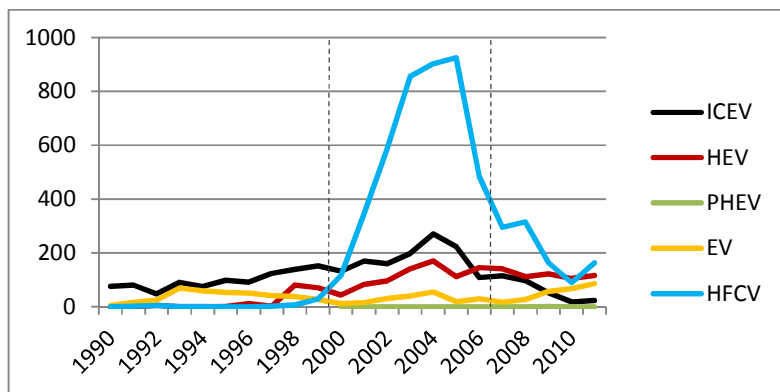
Toyota's R&D efforts peaked in 2007-2008, see Figure 4, while its commercialization efforts continued to increase and became more diverse. Toyota continued to lead in HEVs, with global annual sales exceeding 1.100.000 in 2012 (Marklines, 2013). Additionally, Toyota adopted a quick follower PHEV strategy, launching its PHEV Prius in 2012 (two years after GM) and selling over 20.000 units that year (Marklines, 2013). Also in terms of CAFE, Toyota continued to outperform its rivals (Figure 1). They also started selling their compliance RAV4 EV in 2012, built in collaboration with EV startup Tesla, although sales have been far below the 2.800 unit target (hybridcars.com). During period 3, Toyota became more supportive of the ZEV mandate, see Table 5. Toyota tried to

shape the mandate by lobbying in support of its quick follower PHEV strategy and its HFCV R&D and compliance strategy. In sum, Toyota’s trend of increasing innovativeness coincides with a trend away from a defensive and towards a proactive, mainly supportive, political influence strategy.

### 5.5 Innovation and political influence of Nissan

Figure 5 shows that during period 1, Nissan was already doing quite some R&D in clean ICEV, EV and, as of 1997, also HEV technology. Nissan also had an above average CAFE, see Figure 1. To comply with the memorandum of agreement, they marketed approximately 210 compliance EVs in 1998 (Nissan, 2009; PIA, 2006). Already investing in clean vehicle technologies, Nissan lobbied only moderately defensively against the ZEV mandate in 1996, leaving the stronger opposition to its competitors (Hoogma, 2000, p. 266). Hence, Nissan combined reactive innovation strategies with a mildly defensive political influence strategy during the first period.

Figure 5, Nissan’s patent applications over 1990-2012 (excluding Renault’s patents)



During period 2, Nissan further increased its R&D in clean ICEV, HEV and particularly HFCV technology, at the costs of EV technology – see Figure 5. Nissan’s CAFE actually dropped significantly during this time to below the industry average (Figure 1). Not having moved into mass commercialization yet, Nissan complied with the mandate through re-lease of EVs and testing of HFCVs (Nissan, 2002). Table 5 shows that Nissan provided only 6 comments to influence the ZEV mandate, indicating they adopted no weak political influence strategy in period 2. Nissan did try to shape the mandate by lobbying in favor of HEV credits (although their HEV sales never really took off) and in favor of their EV compliance strategy (CARB, 2001; 2003). Overall, although particularly R&D oriented, Nissan did become more innovative and adopted a less influential political strategy.

Nissan’s R&D activities were reducing in period 3, although EV patenting continued to increase. Nissan adopted a first mover EV strategy, mass commercializing the first purpose build EV, the Leaf, by late 2010 and becoming EV market leader by selling 100.000 units by January 2014 (Cobb, 2014). Nissan’s CAFE has been slightly above average during this period and their annual HEV sales increased to 35.000 in 2012. During this period, Nissan’s anticipatory EV innovation strategy, enabling long-term compliance, is reflected in their political strategy, which was very supportive of the ZEV mandate and included lobbying in favor of EVs, see Table 5. Throughout the timeframe 1990-2013 Nissan became increasingly innovative and its initially defensive political influence strategy became strongly oriented towards support for the mandate.

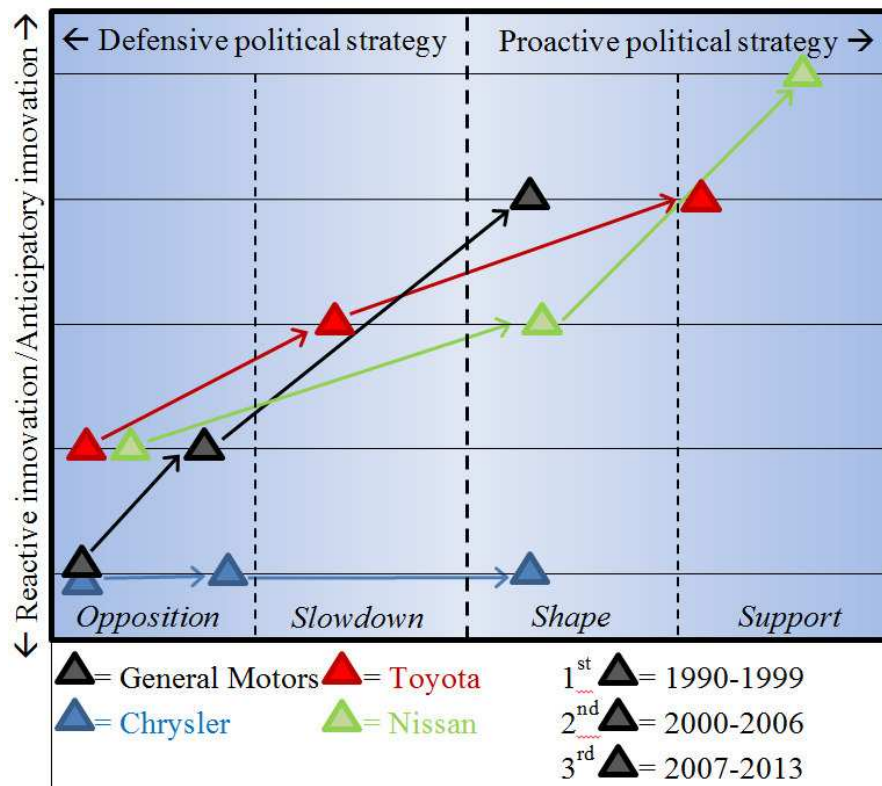


### 5.6. Reflecting on Oliver and Holzinger’s conceptual framework

Sections 5.2-5.5 show that car manufacturers indeed use different strategies at the same time. Figure 6 inventories the different strategies used by each car manufacturer over the three periods, placing the innovation strategy on the y-axis and political influence strategy on the x-axis. The Figure shows that car manufacturers initially combined reactive innovation and defensive political influence strategies and adopted steadily more anticipatory innovation and proactive political influence strategies over time (hence the diagonal). In other words, in response to the technology-forcing regulation under study car manufacturers combine compliance and political influence strategies of either value maintenance (reactive and defensive) nature or value creation (anticipatory and proactive) nature. Over time, their strategies changed from value maintenance to value creation.

Only Chrysler deviates from this trend as their political influence strategy became less defensive over time, without becoming more innovative. Chrysler’s lack in innovation may be explained by their financial struggles and their dependency on take-over partners Daimler and Fiat (Flak, 2014), which may have prevented the company from making the necessary large investments in ZEV technologies. The fact that Chrysler became politically less defensive over time may be explained by their increased government-dependence, created through their bail-out in this period.

Figure 6, Changes in the innovation and political influence strategies of the car manufacturers over the periods 1990s, 2000-2006 and 2007-2013.



Through our detailed analysis of car manufacturers’ political influence comments we also refined Oliver and Holzinger’s (2008) typology of political influence strategies. Ranging from value maintenance to value creation, we identified subclasses of defensive (opposition and slow down)

and proactive influence strategies (shape and support) which are still very different and provide more thorough insights in corporate strategies. Our analysis of the individual car manufacturers showed this is a useful refinement of the strategy typology and that specific combinations with innovation strategies can be identified. The following is a reflection on these subclasses of political influence strategies and their relation to corporate innovation strategies.

We find that the least innovative firms use ‘opposition influence strategies’ on technology-forcing policy intervention to maintain the value of their core technology investments, prevent themselves from being forced to innovate and reduce the competitive disadvantage resulting from a lack of innovation. GM and Chrysler for example challenged the ZEV mandate in court to protect their interests. The other way around, reactive innovation strategies also support credible defensive political influence strategies, as car manufacturers used the inability to innovate as an argument to oppose the regulation, i.e. ‘fact based lobbying’.

When firms are unable to prevent regulatory change, they may employ ‘slowdown influence strategies’ to slowdown and/or relax regulatory change, allowing the firm to maintain value for as long as possible while buying time for their innovation strategies to create new value. To illustrate, various car manufacturers advocated less stringent and slower ramp-up of ZEV standards, and compliance through less radical technologies.

More innovative firms already betting on certain technologies to comply with the regulation tend to employ ‘shaping influence strategies’ to shape the regulation in ways that benefit their technology-specific innovation strategies. General Motors for example lobbied for higher PHEV credits to support its anticipatory PHEV innovation strategy. A shaping strategy can however also be used to try and maintain or create loopholes in the mandate, to support cheap compliance through reactive innovation strategies. Chrysler for example lobbied to maintain the NEV credit category.

Still more innovative firms that have no trouble complying with the regulatory change and therefore require no further shaping of the regulation, may employ a ‘support political influence strategy’ to support the successful implementation of the regulation. An incentive for supporting the regulation is to increase the cost of compliance for their rivals, generating an indirect competitive advantage<sup>2</sup>. During the 2012 ZEV amendments, Nissan for example supported the mandate as a whole.

## 6. Conclusion

To conclude, we have successfully applied the conceptual framework of Oliver and Holzinger (2008) on corporate response strategies to regulatory change, onto a case of technology-forcing regulation where compliance strategies become innovation strategies. This case study complements Oliver and Holzinger’s (2008) research in various ways. First, we find that firms combine innovation and political influence strategies. Firms combine value maintaining or value creating innovation and political influence strategies. In other words, where Oliver and Holzinger (2008) positioned the four strategy quadrants of their framework to be independent, we find that particularly the upper and lower quadrants are frequently combined. These combinations constitute the strategic synergies that Oliver and Holzinger (2008) suggested may exist. Second, we find that firms changed their strategies, generally from value maintenance strategies to value creation strategies over time. Third, we refine

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<sup>2</sup> We perceive statements of support as an influence strategy, because it provides policy makers the legitimacy to push regulation despite opposition by other firms; it thereby indirectly influences policy making.

Oliver and Holzinger’s (2008) typology of political influence strategies by introducing subcategories of the defensive political influence strategies – namely opposition and slowdown strategies – and of the proactive political influence strategies – namely shaping and support strategies. These subclasses of political influence strategies show clear synergies in combination with specific innovation strategies.

In reflection, ranging from value maintenance to value creation it would be possible to identify an even more extreme value creating subclass of proactive political influence strategies, namely not just supporting but progressing the stringency of the regulation. Looking outside the scope of our firm selection, we found that Tesla Motors, a startup that builds only EVs, adopted this progressive strategy. Tesla sells its EV credits to rival car manufacturers so that they may comply with the regulation; a more stringent standard implies higher demand for EV credits and thus more profit for Tesla. Based on this case study Table 6 summarizes the framework of potential corporate response strategies to technology-forcing regulations.

Table 6: Response strategies to technology-forcing regulation identified in this case study

		Value perspective								
		Value maintenance		Value creation						
<b>Strategic orientation</b>	Innovation (compliance)	<b>Reactive innovation strategy</b> <i>Comply marginally with technology-forcing regulation through cost-efficient compliance and laggard innovation strategies.</i>		<b>Anticipatory innovation strategy</b> <i>Anticipate stronger technology-forcing standards and stay ahead of regulatory change through first mover and quick follower innovation strategies.</i>						
	Political influence	<b>Defensive strategies:</b> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Opposition</b>  <i>Oppose regulation to protect incumbent technology</i> </td> <td style="width: 50%; vertical-align: top;"> <b>Slowdown</b>  <i>Slowdown and/or relax regulation for innovation strategy to “catch up”</i> </td> </tr> </table>		<b>Opposition</b> <i>Oppose regulation to protect incumbent technology</i>	<b>Slowdown</b> <i>Slowdown and/or relax regulation for innovation strategy to “catch up”</i>	<b>Proactive strategies:</b> <table border="0" style="width: 100%;"> <tr> <td style="width: 33%; vertical-align: top;"> <b>Shaping</b>  <i>Shape regulation in favor of innovation strategy</i> </td> <td style="width: 33%; vertical-align: top;"> <b>Support</b>  <i>Support the regulation because rivals have higher compliance costs</i> </td> <td style="width: 33%; vertical-align: top;"> <b>Progressive</b>  <i>Increase stringency of regulation to increase rivals’ compliance costs</i> </td> </tr> </table>			<b>Shaping</b> <i>Shape regulation in favor of innovation strategy</i>	<b>Support</b> <i>Support the regulation because rivals have higher compliance costs</i>
<b>Opposition</b> <i>Oppose regulation to protect incumbent technology</i>	<b>Slowdown</b> <i>Slowdown and/or relax regulation for innovation strategy to “catch up”</i>									
<b>Shaping</b> <i>Shape regulation in favor of innovation strategy</i>	<b>Support</b> <i>Support the regulation because rivals have higher compliance costs</i>	<b>Progressive</b> <i>Increase stringency of regulation to increase rivals’ compliance costs</i>								

By studying the interplay between and changes in innovation strategies and political influence strategies this study provides useful insights on the role of technology-forcing policy interventions that aim to support socio-technical transition processes. We found that car manufactures could significantly slow down the transition to a sustainable mobility system by opposing technology-forcing regulation and limiting innovation to cheap compliance options. However, as (battery) technologies matured and car manufacturers got time to develop their innovation strategies, their political influence strategies became more proactive and oriented at supporting and shaping the mandate to benefit their individual (technology-specific) innovation strategies. This supported the transition to a more sustainable mobility system, as more clean automotive technologies were brought to the market and, without the industry’s opposition, policy makers could develop more stringent regulations. Policy makers may thus expect initial opposition to technology-forcing regulations. However, as innovation processes get time to develop, opposition becomes less,

creating room for policy makers to ramp up their regulations. Since these findings are based on only one case, a fruitful area of further research would be to test whether this relation between innovation and political influence strategies we found is generalizable to other technology-forcing regulations aiming to drive socio-technical transitions.

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