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MIT Center for Energy and Environmental Policy Research

Working Paper Series

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MARCH 2017

CEEPR WP 2017-006

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

When Do States Disrupt Industries?
Electric Cars in Germany and the United States

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Abstract

The literature on the developmental state suggests that state structure determines the ability of governments to drive technological change. This article argues that in mature industries systems of interest intermediation shape the state's capacity for sectoral intervention. In *corporatist developmental states*, industry and government coordinate technological transformations in consensus-driven negotiations. Such coordination prioritizes the interests of incumbent firms, resulting in weak policy intervention. In *pluralist developmental states*, competition among interest groups and state agencies allows policymakers to organize coalitions of technology challengers in support of technological change, leading to strong policy intervention. We examine our argument in the context of electric vehicle policy in Germany and the United States. While Germany failed to disrupt its auto industry, the United States adopted comprehensive policy for the manufacturing and commercialization of electric cars. Our findings suggest that, counter to conventional wisdom, pluralist states can effectively engage in sectoral intervention in mature industries.

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Introduction

The state features prominently in industrial development. Literatures on the state and industrial change highlight how variations in state structure explain the different abilities of governments to promote industrial development. Centralized bureaucracies helped industrialize East Asian countries to catch up with international competition (Wade 1990, Evans 1995), and peripheral state agencies have allowed industrialized countries to develop new high-technology sectors (Breznitz and Ornston 2013). Little research examines how states disrupt and transform mature industries. Yet sectoral government interventions since the 2009 recession have largely focused on reviving mature industries (Aggarwal and Evenett 2012). In particular, governments have begun to promote clean energy technologies through innovation and industrial policy (Rodrik 2014). This raises the question: When are states able to drive disruptive technological change in mature industries?

Bringing interest groups back into the current debates on the developmental state, this article argues that state intervention in mature industries is conditioned by patterns of interest intermediation. In *corporatist developmental states,*[1] industry and government coordinate technological transformations in consensus-driven negotiations. Such coordination inherently prioritizes the interests of incumbent firms that benefit from the existing technological regime. In *pluralist developmental states*, political competition among interest groups allows policymakers to organize coalitions of technology challengers in support of technological change against incumbent interests. Despite lacking institutional sources of state autonomy, pluralist states can utilize political competition in pursuit of disruptive technological change through strong sectoral intervention. This article complements a focus on bureaucratic institutions in current research on the developmental state by highlighting the importance of political sources of state autonomy in standing up to external opposition.

We examine this argument in the context of the German and U.S. automotive industries. Over the last decade, the electrification of transport has begun to challenge the golden age of the internal combustion engine. Both Germany and the United States have large auto sectors that produce fuel-intensive vehicles and have adopted ambitious goals to develop lead markets in electric vehicles (EVs).[2] Germany has fallen short of its ambitions, while the United States has against expectations adopted a disruptive set of industrial and regulatory policies to promote the manufacturing and commercialization of EVs (Lane, Messer-Betts et al.

2013). Providing modest R&D support for electric cars, Germany's industrial policy efforts were stalled by incumbent carmakers—Volkswagen, BMW, and Daimler. A high degree of coordination between the federal government and incumbent auto producers stalled technological change in favor of existing combustion technologies. Meanwhile, the United States implemented a comprehensive set of policies to incentivize the manufacturing and commercialization of electric cars while tightening emissions regulations to drive demand for low-carbon technologies. Such disruptive innovation policy was made possible by political competition among fluid coalitions of industry, environmental groups, and national security interests. Policymakers did not respond to incumbent demands, but actively organized coalitions to support the technological re-direction of the Big Three auto firms—GM, Ford, and Chrysler—toward cleaner technologies.

Our findings point to a trade-off between policy stability and policy disruption in innovation policy-making. Corporatist states are likely to be able to coordinate incumbent actors around long-term technology and policy visions that are compatible with incumbent interests. This tends to result in high policy stability of government support for technology development. It also suggests that corporatist states may have greater capacity to address coordination challenges that exist within technological trajectories. Policy stability, however, comes at the expense of limited policy change and the risk of regulatory capture. Although pluralist developmental states are more likely to disrupt mature industrial sectors in pursuit of technological change, the lack of coordinating institutions likely creates greater obstacles to coordinating industrial development within technological trajectories.

This article proceeds in five steps. First, we engage the debate on the role of the state in technological and industrial change to develop our argument on corporatist and pluralist developmental states. The second section outlines the puzzling contrast in electric vehicle policy between in Germany and the United States. Steps three and four explain the diverging outcomes with in-depth case studies of EV policymaking in the two countries. The conclusion identifies the implications of our argument for research and policy.

The State and Industrial Change

The promotion of technological change and economic growth through sectoral intervention often entails confrontation of powerful external constituents vested in the status quo. Hence, comparative political economists have long agreed that

developmental states seeking to encourage industrial transformation through policy intervention require considerable autonomy from outside influence. For instance, high levels of state autonomy were central to the developmental success of the East Asian late developers. These used sectoral intervention to catch up with advanced industrial economies, and benefited from powerful developmental agencies during the period of rapid economic development (Amsden 1989; Evans 1995; Johnson 1982; Wade 1990; Woo-Cumings 1999). Relationships between bureaucrats and private sector firms were important channels for information, resulting in 'embedded autonomy' for state agencies (Evans 1995). Yet the state's ability to pursue upgrading goals relied on state institutions as the key source of autonomy.

More recent scholarship emphasized the importance of state intervention in the development of new industries and technologies in advanced industrial economies (Ansell 2000; Block 2008; Hughes 2012; Mazzucato 2013). Embedded in domestic and international networks of firms and financial institutions, developmental agencies in advanced economies pursued technological innovation through the creation of linkages among state agencies and industry associations (Ansell 2000). A flexible networked organizational structure allowed the "neo-developmental" state to promote development by linking local business with global technological and financial networks (Breznitz 2007; Ó Riain 2004). Collaboration among government officials and the private sector helped to identify promising pathways for technological and industrial change (Block 2008). A third line of argument has shifted attention away from ties to networks to the relative position of developmental agencies within the government bureaucracy. Breznitz and Ornston (2013) contend that centralized bureaucracies may be effective in promoting the development of mature industries among late developers, but are unable to produce the type of radical policy innovation needed to promote high-technology sectors. Low-profile peripheral agencies are less likely to attract political interference or attention of opposing industrial interests, which provides them with sufficient autonomy to engage in continuous policy innovation in the pursuit of high-tech industrial development.

The importance of state autonomy in overcoming external opposition to industrial change has led such literatures on the developmental state to share an emphasis on state structure in explaining patterns of sectoral intervention. Indeed, sources of opposition are plenty. Businesses may not be equally capable of meeting developmental objectives, and some firms may simply prefer not to make the investments required for technological change. Resistance to change is likely

stronger in mature industries directly threatened by government intervention than in emerging industries which do not threaten existing industrial practices (Berger 1983; Uriu 1996; Moe 2010). Ultimately, the state's ability to stand up to such constituents is key to achieving state developmental objectives.

We show that structural features of the government bureaucracy are insufficient to explain variation in sectoral intervention in mature industries. Instead, we examine the role of interest intermediation in industrial policy-making, which the debate on state structure has neglected (Doner and Schneider 2016; Samuels 1987).

The Developmental State, Business-Government Relations, and Sectoral Intervention

When do states drive technological and industrial change in mature industrial sectors? We argue that the types of linkages between the state and the private sector are central to the implementation of innovation policies aimed at transforming legacy sectors. Patterns of interest intermediation determine the state's ability to deflect and reshape interest group opposition. Comparative political economists have long differentiated between two systems for interest intermediation: corporatism—operating through coordination and consensus—and pluralism—featuring competitive and adversarial relations with outside interests (Berger 1983; Dahl 1961; Schmitter 1977). In *corporatist developmental states*, industry and government coordinate technological transformations in consensus-driven negotiations. We show that such coordination inherently prioritizes the interests of incumbent firms, which benefit from the existing technological regime. In *pluralist developmental states*, however, competition among interest groups allows state agencies to organize coalitions of firms in support of technological change against incumbent interests. It is precisely the weak coordination capacity of pluralist systems, conventionally seen as a sign of weakness, that we identify as the central factor in allowing pluralist states to outmaneuver incumbent opposition in enacting policies for technological change.

Corporatist states have traditionally organized interests into a smaller number of compulsory, non-competitive groups that have the monopoly on interest representation for their particular category. By including these groups in the policy-making process in a single policy forum, corporatist states can forge coordination and agreement between various external constituents in the pursuit of common economic goals (Berger 1983; Schmitter 1974, 13). Scholars have argued that

corporatist states are thus more effective in encouraging complex industrial transformations (Jasanoff 1985), focus on national long-term goals rather than particularistic interests (Jacobs 2011), and are more capable agents of change through the compensation of losers (Lundquist 1980, Hatch 1995). In this view, policymakers in corporatist contexts are capable of developing policies that are not just reflective of external demands but reflect autonomous bureaucratic agendas (Skocpol 1999). Critics have argued that such notions of corporatism overestimate the strength and autonomy of the state vis-à-vis business (Samuels 1987). Research on the evolution of corporatism has pointed to the increasing influence of the private sector on policy design (Mildenberger 2015) and warned that consensus-driven negotiations have given way to corporatist politics as a vehicle to defend the dominance of private sector interests over labor (Streeck 2016).

Applying such insights to current debates on the developmental state, we show that corporatist developmental states are vulnerable to regulatory capture by incumbent firms, which can sharply limit policy intervention to drive technological change. Closed-door negotiations with highly coordinated industry groups are more likely to build agreement around existing technological development paths, favoring incumbent interests with privileged access to policy negotiations. We argue that the influence of incumbents in corporatist state-business relations is a function of high levels of two distinct processes: *horizontal* and *vertical coordination.* Horizontal coordination captures the level of cooperation and organizational strength of outside interests, while vertical coordination relates to the centralization and stability of business-government links.

In corporatist states, strong horizontal coordination favors incumbents, as industry associations have a monopoly on representation, are stable over time, and are characterized by highly institutionalized patterns of firm coordination. High barriers to entry for new groups protect the organizational strength of existing industry associations over time. Consequently, states facing external constituents with high degrees of horizontal coordination require more autonomy to avoid regulatory capture by incumbent interests. Corporatist developmental states with high degrees of vertical coordination restrict negotiations to a single policy forum. Fewer access points for private sector interests limit the types of groups in contact with the government. Challengers from new industries seeking to benefit from disruptive innovation policy, if they exist, are rarely included, as policymakers maintain stable relationships with incumbent firms. Although corporatist states may intervene heavily in the economy, such intervention is often tied to incumbent

interests and prone to regulatory capture even in states with high degrees of bureaucratic autonomy.

Table 1: Pluralist versus corporatist developmental states

		Corporatist Developmental State	Pluralist Developmental State
Horizontal coordination	Barriers to entry	High	Low
	Role of business associations	Central	Limited
Vertical coordination	Number of policy forums	Few	Many
	Stability of state-business relations	High	Low

In pluralist states, by contrast, interests are organized in multiple, voluntary, and non-hierarchical groups, which do not have a monopoly on interest representation and compete with other groups for political influence (Schmitter 1974, 15). Conventional wisdom holds that pluralist states have little capacity to resist external constituents, as outside groups penetrate the political stratum with relative ease. It is competition between multiple groups that prevents any particular set of interests from dominance (Dahl 1961). Yet scholars have also warned that the accessibility to outside interests makes pluralism increasingly vulnerable to capture by private sector oligopolies and a vehicle for monopolization (Gilens and Page 2014). Pluralist states thus appear poorly equipped to forge state-led industrial transformations (Atkinson and Coleman 1989:52-53; Skocpol 1980:157).

We argue instead that pluralist developmental states are able to utilize such political competition to advance industrial policy goals in pursuit of technological change in mature industries, even against external opposition. First, low degrees of horizontal coordination in pluralist systems allow new interest groups to form and a larger number of groups to compete for political influence. No individual group seeks to represent all firms in a particular sector, lowering barriers for technology challengers. The diversity of interest groups enables the emergence of technology counter alliances. Governments can utilize such political competition among outside

interests to outmaneuver opposition from incumbent firms. Interests in favor of policy intervention can be strategically included in the political process and are often supported by developmental agencies. Despite low levels of state autonomy, pluralist states can pursue policy goals in opposition to incumbent demands.

Second, low degrees of vertical coordination—a large number of different policy forums in which government agencies interact with a multitude of external interests—increase hurdles for incumbents seeking to prevent policy change. Fragmented developmental agencies can pursue parallel policy strategies targeting mature industrial sectors, opening a glut of arenas in which incumbents must compete for influence. At the same time, government-business relations frequently change, as policy-makers respond to and organize ad hoc alliances. As a result, pluralist systems rarely feature the kinds of coordination in the form of social pacts among labor and business representatives that are central to corporatist systems (Ornston and Schulze-Cleven 2015). Yet, it is precisely the exploitation of political competition among external constituents that allows pluralist states to outmaneuver incumbent interests.

Policy Intervention and Electric Cars in Germany and the United States

Germany and the United States both adopted ambitious policy goals to promote electric cars. In 2009, the German government announced to deploy 1 million electric cars by 2020 (Bundesregierung 2009*)*. The Obama administration in 2009 committed to deploying 1 million electric cars by 2015 (White House 2009a). In practice the German and U.S. governments differed in their ability to enact policy to implement these goals. While Germany failed to develop impactful policy interventions, the United States intervened strongly in the auto sector with subsidies and regulation to support disruptive technological change.

The German and U.S. auto sectors share a number of structural characteristics. As such, they are excellent laboratories for the exploration of the determinants of innovation policy in mature industries (Lijphart 1971; Przeworski and Teune 1970). In both Germany and the United States, the auto sector is the largest manufacturing sector by employment.[3] In 2007, direct employment by German and U.S. carmakers amounted to 845,000 and 1,004,000 jobs, respectively. Motor vehicle manufacturing contributed about USD 83 billion to German GDP, and USD 103.4 billion to the US economy.[4] Both have historically been heavily invested in carbon-intensive vehicle technologies, as German auto firms relied on

premium cars, and U.S manufacturers depended on trucks and sports utility vehicles for revenue. The 2008 financial crisis and the high oil price environmental put severe strains on auto firms in both economies: Two of the Big Three U.S. carmakers, Chrysler and General Motors, filed for Chapter 11 protection in 2009 (Oge 2015). German carmakers remained in a more competitive position than their US counterparts during the Great Recession. However, they also relied on government support to stimulate sales, in particular the so-called *Abwrackprämie* (cash for clunkers).

Germany and the U.S. share a similar structure of their developmental state apparatuses. Neither country has a centralized agency for economic development, but rather a "networked polity" of decentralized agencies embedded in networks (Ansell 2000; Block 2008). This extends to the energy sector (Keller et al. 2017). The two countries only vary in the extent to which they coordinate across decentralized government agencies, which is at the core of our analysis of vertical coordination. Finally, both auto markets face external regulatory pressure to develop clean transport technologies. The EU started setting mandatory CO_2 standards for cars in 2009, putting pressure on German car producers. California has long set the pace on fuel economy standards for US automakers and adopted a Zero Vehicle Emission Program in 2012, which created demand for electric cars.For all their similarities, however, Germany and the U.S. have fundamentally diverged in their ability to forge disruptive innovation policies (see Table 2). Germany, despite its ambitious goals for transport electrification, failed to implement meaningful policy measures to induce innovation in the domestic auto sector beyond modest R&D subsidies of EUR 500 million in its stimulus package. Responding to incumbent interests, German policy-makers lobbied the European Union to weaken EU emissions regulations. The United States, meanwhile, adopted an industrial policy that combined subsidies for consumers and producers with regulatory requirements. The U.S. stimulus packages allocated USD 12.5 billion for purchase incentives, R&D, production, and loan guarantees for electric vehicle technologies (Fuhrmans 2011; Lane, Messer-Betts et al. 2013; Graham, Cisney et al. 2014). The U.S. government also negotiated a tightening of fuel economy standards, which created demand for the deployment of electric cars. Consequently, U.S. deployment of more than 200,000 battery electric vehicles in 2015 exceeded Germany's by a factor of ten. Combined registrations for battery electric vehicles and plug-in hybrid vehicles surpassed 500,000 cars in the United States, while Germany registered only 50,000 alternative energy vehicles by 2015.[5]

Table 2: Electric vehicle policy in Germany and the United States

	Germany	United States
Goals	1 million EVs deployed by 2020	1 million EVs deployed by 2015
Subsidies	2009 Stimulus Package II: EUR 500 million for research and development No consumer incentives until 2016	2008 EV purchase incentive 2009 American Recovery and Reinvestment Act: USD 12.5 billion for research, development, and production; loan guarantee program
Regulation	No binding regulation Opposition to regulation at EU level	2009 deal on increase of CAFÉ standards, introduction of nation-wide GHG emissions regulations for cars

Source: Compiled from Bundestag 2009; White House 2009a. See also: Fuhrmans 2011, Lane, Messer-Betts et al. 2013; Graham, Cisney et al. 2014.

Why was the United States able to affect industrial change through sectoral intervention when Germany failed? Given the similarities in government ambition, industry structure and state structure, Germany and the United States offer a most-similar case comparison. We combine this with process-tracing to examine the role of interest intermediation—conceptualized as horizontal and vertical coordination—in driving divergent patterns of state intervention. For each of the two cases, we consider two sets of policy outcomes related to subsidies and regulation to increase internal validity of our argument. Our analysis focuses on EV policy-making in Germany and the United States between 1995 and 2015 (See Table 3). We rely on industry data, government publications, legislative records, and publications on lobbying behavior. In addition, we utilize a novel dataset of 53 detailed interviews with policy-makers, representatives from auto firms and industry associations, and environmental advocacy groups collected in 2016. Interview data are triangulated across interviews or with written documentation.

Table 3: Horizontal and vertical coordination in German and U.S. auto sectors

		Germany	United States
Horizontal coordination	Barriers to entry	• Limited recognition of new industry associations and technology challengers in core negotiations • Incumbent carmakers have privileged access	• Groups of technology challengers form quickly, compete for influence with existing groups. Example: Electric Drive Transport Association
	Role of business associations	• Association of the Automotive Industry (VDA) as the only industry association representing the interests of domestic automakers • VDA as key broker between industry and government • Pro-EV supplier interests align with automaker interests	• Eight separate industry associations compete for membership, represent disparate industry groups • No one association has monopoly on interest representation and overall political influence is low • Executive insists on negotiations with individual firms, bypassing associations
Vertical coordination	Number of policy forums	• Few: Ministries of Economic Affairs, Transport, Education and Research, and Environment coordinate policy positions • National Platform for Electric Mobility as central coordination body, with domestic automakers as the dominant voice	• Multiple: executive, legislative, and key agencies (DOE, EPA, DOT) pursue different programs and policy portfolios. • Each has independent relationships and actively organizes relationship with automakers, building coalitions or negotiating with individual firms
	Stability of state-business relations	• Maintained by VDA and Chancellor's Office, relationship between state and auto industry is stable over time	• Frequent changes, as individual agencies change programs, policies, and partners in the private sector

Germany: Political Coordination and Limited State Intervention

Germany's failure to implement a comprehensive policy for electric cars is the outcome of a high degree of coordination between the government and domestic producers. Although the federal government announced ambitious goals, incumbent automakers were able to coordinate horizontally within the industry and vertically with the executive in one major policy forum around a policy strategy of limited intervention. This entailed subsidies for R&D, but not commercialization, and a push against more stringent emissions regulations.

Political coordination and the agenda for alternative transport technologies

Electric cars emerged on Germany's political agenda in the late 2000s. This followed a multi-decade exploration of the auto industry's technological future beyond the international combustion engine. In the short term, German car manufacturers focused on diesel and biofuel technologies. In the long term, auto producers and the German government coordinated around hydrogen fuel cells, building on Germany's industrial capabilities in advanced engineering. The government supported R&D for hydrogen to varying degrees since the oil crisis (Garche, Bonhoff et al. 2009). In 2006, it expanded hydrogen research, development and demonstration through the 10-year National Innovation Program on Hydrogen and Fuel Cells (Bundesregierung 2006). The program provided R&D support of EUR 1 billion over a ten-year period, ten times the annual funding available previously. In 2008, the government created the National Organisation Hydrogen and Fuel Cell Technology, which administered the program, including demonstration projects. It was largely staffed with Daimler representatives.[6] Unlike the United States, Germany avoided providing incentives to commercialize emerging technologies, including hybrid vehicles. Before 2009 the government only very marginally supported R&D for lithium-ion batteries, the core technology for electric cars (BMWi 2013, 6).

Two key developments in the late 2000s began to challenge the hydrogen consensus between the government and domestic producers: the need to achieve near-term cuts in transport emissions to mitigate climate change, and the emergence of electric cars in the global market as a result of the declining costs of lithium-ion batteries. In August 2007, the cabinet adopted the Integrated Energy and Climate Program, which for the first time included electric mobility in its plan to meet Germany's emissions reduction targets for 2020. Unlike fuel cells, the cost of lithium-ion batteries had decreased significantly, leading global competitors to focus

on plug-in hybrid and battery-electric cars. Tesla launched its first EV, the Roadster, in 2008. At the same time, the oil price peaked at close to USD 150 per barrel in July 2008.

Against this backdrop, policymakers and auto suppliers set out to set the political agenda for electric cars. The Federal Ministry for the Environment (BMU) and the Chancellor's Office took a keen interest in the topic—for environmental and industrial policy reasons, respectively. The BMU realized that future greenhouse gas (GHG) emissions reductions would depend on the electrification of the transport sector. Fuel cell technology was too distant in the future to play a meaningful role for climate policy. The Chancellor's Office, instead, began to worry that the German auto industry might miss a major global technological trend, with potentially severe repercussions for the German economy (Doll, Dalan et al. 2009, Altenburg, Schamp et al. 2016).[7] Since German carmakers had already missed the trend toward hybrid cars, Chancellor Merkel warned the auto industry: "we have to be at the forefront of electro-mobility" (Fuhrmans 2011). Minister for the Economy, Rainer Brüderle, considered electric vehicles "a key technology for industrial production in Germany," while Minister for Transport, Peter Ramsauer, declared the promotion of electric cars "one of the most important projects for the legislative term" (in Hawranek and Neubacher 2010). Suppliers to the auto industry, such as Bosch, Continental and Siemens, realized that EVs were an emerging technology trend that could significantly impact their business.[8] They urged the government to support R&D.[9] As a result of the renewed interest in EVs, the government organized the first National Strategy Conference on Electric Mobility in November 2008. It marked the official beginning of policy formulation for electric cars in Germany.

State-producer coordination in delaying the commercialization of electric cars

Despite its ambitious goals, Germany failed to enact a comprehensive policy package for the development and commercialization of electric cars. The government focused on moderate subsidies for R&D, while delaying commercialization and regulatory requirements. The economic stimulus program of March 2009, the "Konjunkturpaket II," provided EUR 500 million of R&D funding. In August 2009, the government cabinet approved the National Development Plan for Electric Mobility (Bundesregierung 2009). The plan declared the goal for Germany to become a lead market for EVs, aiming to deploy 1 million EVs by 2020.

The EV policy limited to R&D subsidies was the outcome of both tight vertical and horizontal coordination. From the outset, EV policy was coordinated by

four government agencies: the BMU, the Ministry for Economic Affairs (BMWi), the Ministry of Transport (BMV), and the Ministry of Education and Research (BMBF). The Ministry for the Environment was the most aggressive in pushing for the development of support policies for EVs.[10] Key officials saw the electrification of the transport sector as the only way to achieve deeper emission cuts. The Ministry had already requested a consumer incentive of EUR 5,000 to be part of the National Development Plan for Electric Mobility of 2009 (Mihm 2009). The Ministry of Transport, instead, was cautious in its support for EVs and continued to bet on hydrogen technologies. Institutionalized inter-agency coordination constrained the BMU, an early EV government champion, in spearheading EV policy and building its own support coalition.

Vertical coordination between the four agencies limited negotiations over policy proposals to interactions with the German Association of the Automotive Industry (VDA). The association is dominated by Germany's three major domestic manufacturers: BMW, Daimler, and Volkswagen (VW). In 2009, none of the German carmakers offered a commercial EV model. The main concern of automakers was to not cannibalize demand for conventional cars, while hedging against a technological trend toward EVs in the long-term.[11] The VDA was united in supporting government funding for R&D, but opposed any consumer incentives until German producers offered EVs (VDA 2008a, Frankfurter Rundschau 2010).[12] Instead, it viewed diesel as the technology to achieve greater fuel efficiency in the near term. Matthias Wissmann, president of VDA, said: "The diesel engine is not phasing out yet. On the opposite: it is continuously getting better" (in Bauchmüller 2009). The government echoed this position: Peter Ramsauer, Minister for Transport, explained why the time for EV commercialization had not yet come: "We do not yet have a mature and price-competitive serial model. [...] In the future, we want to coordinate more closely with the parties involved" (Breitinger 2011). Personal ties strengthened the high level of executive-VDA coordination. Auto lobbyist Wissmann served as the transport minister under Chancellor Kohl, when Merkel was the environment minister. Wissmann prided himself of having Chancellor Merkel's cell phone number (Mrusek 2009).

The united VDA position notwithstanding, Germany's domestic carmakers differed in their technology strategies. BMW showed the greatest interest in electric mobility. The company needed zero emission vehicles to be able to comply with future EU emissions regulation (Hawranek and Neubacher 2010). Daimler took a relatively neutral position with regard to EV technology. It continued to have a

strong interest in hydrogen technology (Seiwert 2009).[13] It also had the Smart car, which lowered pressure to develop EVs to be able to comply with EU regulations on car emissions.[14] VW, which owns the Audi and Porsche brands, was a laggard in developing electric cars (Rees, Kamp et al. 2009). The fact that these differences in strategy did not undermine the unified VDA position reflects the high degree of horizontal coordination within the industry. "It is difficult to impossible to drive a wedge into the VDA," said Viviane Raddatz from the World Wildlife Fund.[15] In 2010, the VDA established an internal coordination unit on EV policy, which was staffed with four seconded managers from the major domestic manufacturers.[16]

Compared to the United States, EV policy in Germany largely stagnated between 2010 and 2016. In May 2011, the cabinet approved the Government Program on Electric Mobility, which provided an additional EUR 1 billion of R&D funding until the end of 2013 (Bundesregierung 2011). While expanding the R&D-focused strategy, the program avoided measures on manufacturing and deployment, which were key parts of the U.S. policy focused on commercialization.

During this period of policy stagnation, the deliberation of EV policy shifted to the newly created National Platform for Electric Mobility (NPE). The coordination body, set up by the federal government in May 2010, brought together 147 representatives from industry, including carmakers, suppliers, and electric utilities, civil society groups and government ministries, while excluding foreign automakers (Mortsiefer 2010). The VDA developed the idea for such a coordination platform, and the government supported it.[17] While the government had only set the goal of making Germany a lead market by 2020, the NPE quickly embraced the dual goal of becoming a lead market and lead supplier (NPE 2010a). This reflected the interest of domestic carmakers to postpone consumer incentives until they could offer EV models. While auto suppliers initially helped to put EV policy on the agenda, they largely followed the lead of auto firms within the NPE.[18] For instance, a representative of Daimler chaired the working group on batteries, while a representative of Bosch, the world's largest auto supplier, was the deputy chair (NPE 2010b). "When it comes to public attention, suppliers let their clients, i.e., automakers, go first," an executive of a supplier said.[19] Although electric utilities initially were interested in electric mobility, they soon realized that developing a viable business model for charging infrastructure presented a challenge (Balser 2009).[20] Labor unions also followed the position of automakers (Herz and Fasse 2010).[21]

The NPE broadened the participation of interest groups, yet its deliberations were largely influenced by continued backroom coordination among the VDA, the three domestic car manufacturers, and the Chancellor's Office. NPE participants suggested that much of what the NPE discussed was already decided by the government and the automakers. A senior executive of an electric utility concluded: "The NPE was essentially a process run by the auto industry and the federal government. They co-opted the representatives of other sectors."[22] During the 2009-2013 legislative term, the CEOs of German carmakers visited the Chancellor's Office 65 times, more than the representatives of any other industry sector (Dellhaes, Ludwig et al. 2012). Germany's adoption of an R&D policy on EVs—without support for manufacturing and commercialization—resulted from this high degree of coordination among domestic auto manufacturers and between the auto industry and the executive. Reflecting on the outcome of the NPE, Henry Kuhle, Senior Manager at VDA, said: "For us [VDA] everything went as we wished for."[23]

State-producer coordination in resisting more stringent EU emissions regulation

Parallel to Germany's limited R&D push into batteries and EVs, the European Union adopted mandatory CO_2 standards for new passenger cars for the first time in 2009. The European Automobile Manufacturers Association (ACEA) had failed to implement a voluntary agreement, which precipitated the Commission to propose mandatory standards in 2007 (ten Brink 2010). The European Council supported the Commission's proposal with overwhelming majority. Germany, however, fiercely opposed the design and stringency of the standards, considering them a direct threat to its premium carmakers: "We believe that this path is not economically favorable. Therefore we think that industry policy is being made here which burdens Germany and German carmakers," said Chancellor Angela Merkel (Milner 2007). The regulation was seen to benefit French and Italian car manufacturers that produced smaller cars, while hurting German producers of luxury vehicles.

In 2008, heads of state took over the negotiation of CO_2 regulation from environment ministers. France and Germany struck a deal, which responded to many of Germany's requests: the emission reduction target was based on vehicle weight, was gradually phased in, and provided flexibility options (Gulbrandsen and Christensen 2014). The target was 120 g/km by 2015. In 2012, the Commission moved to propose a tightening of the CO_2 standards to 95 g/km by 2020. Again, the German government and carmakers opposed such regulations and the Chancellor intervened personally to prevent their implementation.[24] Germany's opposition

resulted in the delay of a vote at a European Council meeting in early 2013 (Carrington 2013). The EU eventually agreed on emission standards at the end of 2013, granting manufacturers a one-year phase-in period and resulting in an effective compliance date of 2021 (Council of the European Union 2013).

Executive-carmaker coordination was central to Germany's pushback against EU regulation (Hey 2010, Nowack and Sternkopf 2015) and reflected broader patterns of corporatist coordination in Germany's auto sector (Mikler 2007). The VDA coordinated with the BMWi, BMV and the Chancellor's Office (Ott 2016). The VDA challenged key elements of the proposed CO_2 standard (VDA 2008b). Prior to the 2013 decision to postpone future EU car regulation, Wissmann had written to Chancellor Merkel expressing the auto industry's concerns (Ruhkamp 2013). Auto suppliers, by contrast, stood to benefit from tighter emissions regulations, as these would create demand for advanced technology components. Yet in German domestic context, auto suppliers did not come out in support of regulation and only did so at the European level (European Commission 2009). The EU's introduction of mandatory emissions standards fueled some interest among German carmakers to pursue R&D in EVs. Ultimately, however, Germany's successful push to accommodate luxury carmakers in EU regulation postponed the need for disruptive transport technologies.[25]

Taken together, Germany's response to the global emergence of electric cars reflects a high degree of both vertical and horizontal coordination around the interests of domestic producers. Vertical coordination included tight coordination among agencies, with the Chancellor's Office as the lead, and stable government-VDA relations. Horizontal coordination among domestic auto producers created significant barriers to entry for even large corporations from outside the auto industry, including electric utilities in support of transport electrification. Corporatist coordination allowed the most powerful incumbents to set the pace of innovation policy and prevented disruptive state intervention.

United States: Political Competition and Strong State Intervention

In contrast to the tepid German support for new vehicle technologies, the U.S. government intervened strongly in the auto sector by subsidizing the development, production and commercialization of electric cars. It also tightened fuel economy standards and introduced the first federal greenhouse gas emissions standards for

cars and light trucks. Government actors interested in redirecting the technological path of the auto industry were able to implement this disruptive set of policies by strategically organizing fluid coalitions of industrial, environmental and security interests. Although two automakers—GM and Chrysler—were bailed out in the 2009 financial crisis, such government support did not lead to the imposition of technology choices on incumbents. Several of the policy initiatives to push electric vehicles predated the crisis and bailed-out firms continued to oppose policy initiatives of the government, as we demonstrate. It is also not clear that incumbents under economic stress are politically weak. Instead, their weakness can be a case against disruptive government intervention. Only the strategic crafting of support alliances allowed policymakers to adopt a set of disruptive innovation policies.

Political competition and the agenda for alternative transport technologies

In the early 2000s, U.S. policy makers became increasingly interested in promoting alternative transport technologies, largely to reduce oil imports. President George W. Bush promoted the vision of a hydrogen economy (Hultman and Nordlund 2013, Andreasen and Sovacool 2015), increasing R&D support through the Department of Energy (Canis 2011). This included the FreedomCAR and Fuel Partnership, in which the government collaborated with Daimler, Ford and GM on fuel cell research and development (Department of Energy 2006). Unlike Germany, however, the U.S. did not abandon battery R&D, but continued a multi-faceted technology R&D strategy. Government funding for battery R&D stayed relatively stable until 2006, before it began to increase substantially (Canis 2011). The Department of Energy's Vehicle Technologies Office eventually determined that hybrid battery technologies were sufficiently advanced to support full battery-electric vehicles.[26]

Beyond President Bush's interest in hydrogen, a bipartisan alliance of security and environmental interests supported advanced transport technologies. In the aftermath of 9/11, the notion of oil independence gained traction in national security circles. A number of alliances, including Set America Free Coalition and the Energy Future Coalition, emerged as prominent voices in support of advanced transport technologies to reduce oil imports. In the words of Anne Korin, co-chair of Set America Free: "The idea is to jumpstart a shift in the transportation sector away from petroleum to domestic energy sources . . . so we can reduce our oil dependence and send less money to countries that, in the words of President George Bush, don't particularly like us" (Ghazi 2005). These interests aligned with

environmental goals to reduce the CO_2 emissions from transport through advanced technologies. The Natural Resources Defense Council, for instance, joined the security interests in the call for a push of advanced transport technologies (Fialka and Ball 2005). In contrast to Germany, such alliances were competing with one another for political influence and there was no designated coordination body between the federal government and the private sector.

The first major energy bill in a decade, the Energy Policy Act of 2005 offered the opportunity to scale up R&D spending for transport technologies. As part of the bill, the CLEAR Act introduced consumer tax credits for hybrid cars and plug-in hybrids to shift consumer demand away from the combustion engine and to support commercialization of disruptive vehicle technologies. Senators Orrin Hatch (R-UT) and Susan Collins (R-ME), who sponsored the bill, carefully crafted a support coalition among environmental and industry interests (Collins 2005). Senator Hatch worked closely with the Electric Drive Transport Association (EDTA), the lobby group promoting the commercialization of electric cars (Taylor 2009). Unlike in Germany, representation of the auto industry was incomplete. Only Ford, Toyota and Honda were part of the alliance (Clear Act Coalition 2003). Toyota in particular was in favor of the legislation given its market leadership in hybrid technology. GM, the largest domestic auto producer, was focused on hydrogen fuel cells. It did not support the bill proposal and hired top Republican lobbyist Tom Korologos to challenge the Clear Act Coalition. The fact that the coalition represented a consensus proposal between parts of industry and environmentalists, however, kept the legislative sponsors on board.[27] Ultimately, political competition allowed a minimal winning coalition to shape innovation policy in the auto industry, creating market competition for the internal combustion engine.

Industry-environment-security coalitions and the commercialization of electric cars

In the midst of the economic crisis of 2008/09, the U.S. government's multi-pronged strategy for advanced transport technologies turned into a major initiative for electric cars through the combination of massive subsidies and emissions regulation. The Emergency Economic Stabilization Act (EESA) of October 2008 adopted consumer tax credits for battery-electric vehicles. The American Recovery and Reinvestment Act (ARRA) of 2009 expanded the consumer tax credit and scaled up support for R&D and manufacturing. In contrast to Germany, neither the U.S. government nor the Auto Alliance, a trade association of carmakers, engaged in

stable vertical coordination. Rather, U.S. EV policy emerged from multiple policy streams with shifting support coalitions.

In 2008, the U.S. car industry was in crisis: in addition to the recession, U.S. carmakers had been losing market share to Japanese competitors in particular (Klier and Rubenstein 2013). Congress and the administration perceived the U.S. auto industry as lacking international competitiveness and lagging in the development of fuel-efficient cars. At the brink of bankruptcy, the CEOs of the Big Three initial plea for government support on November 18, 2008 was not well-received by Congress. In a letter to the automakers a few days later, House Speaker Nancy Pelosi (D-CA) and Senate Majority Leader Harry Reid (D-NV) asked the companies to explain how they intend to remain solvent while retooling to become global leaders in the production of energy-efficient vehicles (Marr 2008).[28]

The EESA of October 2008 was the first and smaller fiscal stimulus policy package. It included a tax credit for electric cars of up to USD 7,500 with an industry cap of 250,000 cars that could receive the credit. The EV tax credit had already been proposed in the Freedom Act of 2007, which was co-sponsored by Senators Hatch (R-UT), Cantwell (D-WA) and Obama (D-IL). The effort was a continuation of Senator Hatch's leadership on the CLEAR Act of 2005. As in 2005, Senators Hatch and Cantwell strategically built a coalition in support of their proposal, rather than responding to demand from industry.[29] This time, GM was supportive of new legislation, as it was developing its first electric model, the Chevrolet Volt, which it had initially presented at the Detroit Auto Show in 2007.[30] Jared Brown, Senior Energy Advisor to Senator Hatch, stated that the goal was to implement tax credit by the time the Volt came to market. The Volt itself was "calculated to position GM as the chief partner in Washington's emerging green industrial policy" (Dalmia and Payne 2009). Toyota was also engaged as it was exploring the launch of a plug-in hybrid vehicle. Other key supporters were Auto Alliance, EDTA, the electric car and battery start-ups Tesla and A123, and key environmental groups such as the Environmental Defense Fund and the Union of Concerned Scientists.[31]

The ARRA of February 2009 expanded state support for the production and commercialization of electric cars in an unprecedented manner. The politics, however, reflected the earlier dynamics: policymakers with a technological preference for electrification organized an eclectic support coalition among industry and environmental groups. Newly inaugurated President Obama had pledged support for electric cars during his campaign, including USD 2 billion for battery research

(Vaughan 2008). Key political appointments reflected his technological preferences. For instance, David Sandalow, previously working on EV policy at the Brookings Institution, was appointed Assistant Secretary for Policy and International Affairs at the Department of Energy, eventually becoming Under Secretary of Energy. Charles Kutz, another Brookings official who was on Obama's transition team, said about the politics of ARRA: "The narrative coming from the top was: 'Let's make sure we take advantage of this disruptive moment'" (in Grunwald 2012, 161). President Obama's interest in electric cars aligned with the approach of Jennifer Granholm, Governor of Michigan, the epicenter of the U.S. auto industry. Already during the presidential campaign, then Senator Obama and Governor Granholm "brainstormed about re-tooling Michigan's empty factories to build fuel-efficient cars" (Langley 2008). After the CEOs of the Big Three failed to secure government support from Congress in 2008, Governor Granholm "urged the auto officials to embrace electric vehicles and to apologize for pushing gas guzzlers." She called William Ford Jr., Chairman of Ford, with a plea: "Go on offense and be the voice of this industry." Mr. Ford said, "she's very passionate" about redirecting Detroit's carmakers (Langley 2008).

The Administration worked closely with Congress in allocating funds in the stimulus package to battery manufacturing and electric vehicles (Grunwald 2012).[32] In particular representatives from Michigan supported the government push for battery R&D and manufacturing.[33] Two weeks before Barack Obama's inauguration in January 2009, Senator Carl Levin of Michigan sent a letter to Obama highlighting the promise of lithium-ion technology. "The country or region that controls and dominates the production of batteries will also ultimately control green-vehicle production," the Senator said in a speech he later gave to the Senate. Levin's efforts effectively prepared that battery grants became part of the ARRA (Gertner 2011).[34]

On the industry side, incumbent automakers, unable to agree on a unified position, ultimately went along with the push into advanced transport technologies by the Obama administration and the Democratic majority of Congress.[35] EDTA and GM were key supporters, as were major electric utilities (PRNewswire 2009).[36] Silicon Valley also backed the push into battery manufacturing, electric cars, and clean energy more broadly (Waters 2009). Mainstream environmental groups such as NRDC expressed strong support for the clean energy components of the stimulus package (NRDC 2009). The opposition to the clean energy and EV appropriations was directed more generally at the idea of fiscal stimulus. The bill received no

Republican votes in the House, but was supported by three Republicans in the Senate. Again, political entrepreneurs in government, propelled by a Democratic majority, combined with an eclectic alliance of large auto companies, start-ups, firms from outside the auto industry, and environmental groups in devising a major government investment in electric cars. In August 2009, Obama announced the stimulus funding for batteries and electric drive components: "If we want to reduce our dependence on oil, put Americans back to work and reassert our manufacturing sector as one of the greatest in the world, we must produce the advanced, efficient vehicles of the future" (White House 2009b).

Political competition and vehicle emissions regulation

In May 2009, after decades of regulatory impasse, the Obama administration negotiated the first comprehensive regulatory reform of fuel economy standards since their introduction in the 1970s. Corporate Average Fuel Economy (CAFE) standards would reach 54.5 miles per gallon by 2025, nearly doubling the regulatory requirements in place since the 1980s and creating regulatory pressure for automakers to commercialize electric vehicle models (Freeman 2013). A Rose Garden announcement by President Obama, arranged to convey consensus among government officials, automakers, and labor representatives, masked months of fierce negotiations. Ultimately, however, government negotiators had prevented automakers from mounting a unified opposition to new regulatory requirements, leading several of them to break rank and accede to government demands.

Designed in the wake of the 1970s oil shocks, CAFE standards had not been tightened for more than two decades (Klier and Linn 2011). In the mid-2000s, however, two major shifts occurred. California, in 2001, passed Assembly Bill 1493, which required the California Air Resources Board to develop greenhouse gas emissions standards for passenger vehicles.[37] Even without new federal standards, car manufacturers would have to introduce new technologies to meet the California requirements. At the federal level, Massachusetts and eleven other states won a 2007 Supreme Court case against the Environmental Protection Agency, which ordered the agency to regulate greenhouse gas emissions as pollutants.

The incoming Obama administration in 2009 built on these broader shifts to push for disruptive changes to the existing regulatory framework for vehicle emissions and to harmonize federal requirements with California's standards. In contrast to the corporatist developmental state in Germany, low levels of vertical coordination brought multiple actors in the U.S. federal government into policy

negotiations and complicated industry attempts to mount an effective opposition. Five government actors in the federal government pursued parallel negotiation strategies with automakers. In the White House, President Obama in January 2009 directed Carol Browner, the newly appointed Director of the White House Office of Energy and Climate Change Policy, to lead negotiations between the administration and the automakers in passing stricter emissions requirements. Browner was joined on the Presidential Task Force on the Auto Industry by Ron Bloom, a Senior Advisor to the Secretary of the Treasury, in developing both a competitive strategy for the domestic auto sector and extracting environmental concessions (Oge 2015). A bipartisan group of legislators put pressure on carmakers: In the Senate, Bob Corker (R-TN), who led the effort to torpedo an auto industry bailout during the final months of the Bush administration, stated that a regime to lower carbon emissions would be imposed over the course of the following year. In the House, Henry Waxman (D-CA) and Ed Markey (D-MA) sought to curb emissions by pushing the development of plug-in electric vehicles, charging infrastructure, and by setting a "low-carbon fuel standard" for the transportation sector. John Dingell (D-MI), a longtime champion of his home state's auto industry, echoed support of a federal emissions policy that would harmonize federal standards with those in California (Voorhees 2009). The third and fourth players in forging policy change were the National Highway Traffic Safety Administration (NHTSA) and the EPA. Each were independently tasked with developing stricter standards. NTHSA, under the Energy Policy and Conservation Act, was required to develop CAFE standards at the "maximum feasible level" to ensure energy conservation, though considerable flexibility existed in interpreting what that entailed. EPA, following the 2007 Supreme Court Decision, needed to regulate vehicle greenhouse gas emissions under the Clean Air Act (CAA). Under pressure from the White House to avoid conflicting regulatory standards, the two agencies agreed to align their requirements (Oge 2015). Each agency maintained independent relationships with automakers in the process of determining the feasibility of new technical requirements (Oge 2015). Finally, the Department of Energy's Vehicle Technology Office funded private sector research and development activities in alternative vehicle technologies, including hybrid, hydrogen, and battery electric cars. The research programs revealed that a shift to low-carbon vehicle technologies was technologically feasible and, increasingly, economically viable, making possible a new push for tighter regulatory requirements.

In addition to low levels of vertical coordination, automakers in the United States did not maintain a unified lobbying position, allowing federal agencies to exploit their internal divisions. Automakers were strongly opposed to increased regulatory requirements for fuel efficiency and greenhouse gas emissions, even if they had different technological capabilities and competitive strategies for the U.S. market (Oge 2015). Yet their political strategies were not tightly coordinated as those of German producers. In addition to lobbying efforts of individual automakers in DC, no less than eight separate auto associations competed for political influence. [38] To fight California's emissions reduction requirements and their adoption as federal statutes, carmakers had launched individual court battles rather than concerted action.[39]

Federal agencies, and the White House in particular, refused to negotiate with groups of automakers, further dividing the domestic car industry and playing individual carmakers out against one another. This strategy led automakers to break rank with their peers and to begin to support CAFE reform. Hoping for a competitive advantage over the rest of the industry, Ford, the only one of the three automakers not to receive a federal bailout, was the first firm to declare that it could meet the proposed requirements. Under increased scrutiny from the public and environmental groups after Ford's accession, GM eventually also offered support and conceded that its internal R&D had made emissions reductions goals attainable. Federal officials continued negotiating with individual automakers, with Toyota and Daimler as the last two companies to submit to new requirements (Oge 2015). Ultimately, all automakers but Volkswagen signed letters of commitment to refrain from challenging federal standards in court and agreed to dismiss all pending lawsuits challenging California's legal authority to regulate GHG emissions for cars. [40] In addition, the federal government convinced the United Auto Workers (UAW) to support its proposal. After decades of opposing federal standards out of concerns for jobs in the rust belt, the UAW conceded that such opposition had neither saved jobs nor helped bring the U.S. automakers into a competitive position internationally. [41] The Rose Garden Announcement of May 2009 concealed these contentious negotiations, in which government officials exploited political competition in the auto sector to diffuse opposition to sectoral intervention.

Conclusion

State intervention is central to technological and industrial change. Conventional explanations of sectoral state intervention focus on the creation of new industries—either in emerging economies that are catching up with global competition, or in industrialized economies developing high-technology sectors. In these cases state structure has been shown to be a source of state autonomy in shaping the economy. Since the Great Recession, however, state intervention in mature industries has been on the rise, as industrialized and emerging economies promote technological change in mature sectors. In this process, states have to stand up to powerful vested interests in support of the status quo.

This article argued that state intervention in mature industries is conditioned by patterns of state-business relations. In *corporatist developmental states*, industry and government coordinate technological transformations in consensus-driven negotiations. Such coordination inherently prioritizes the interests of incumbent firms that benefit from the existing technological regime. Germany limited intervention to a modest R&D push for electric cars, despite a history of state intervention and strong public demand for green industrial policy. Legacy automakers were able to prevent sectoral intervention aimed at encouraging a shift to disruptive low-carbon vehicle technology. Evidence suggests that this pattern extends to other corporatist developmental states such as the Netherlands (Kern and Smith 2008). In *pluralist developmental states*, political competition among interest groups allows policymakers to organize coalitions of technology challengers in support of technological change. Policy-makers can outmaneuver incumbent interests and diffuse external opposition through decentralized negotiation strategies. The United States intervened strongly in its auto sector to promote electric cars. Low levels of vertical coordination in state-business relations allowed policy-makers to create technology counter alliances; a lack of horizontal coordination among incumbent interests prevented a unified opposition to federal government policies. Political competition can thus result in strong sectoral state intervention. This runs counter to the conventional wisdom that pluralist states are limited in their ability to intervene in the economy.

These findings raise at least two questions for future research. One avenue of inquiry concerns the possibility that patterns of state-business relations vary across sectors. Industries differ in their organizational capacity, industry structure, and ties to government agencies. This may lead to variation in both horizontal and vertical

coordination. For instance, Germany succeeded at implementing disruptive innovation policy in the energy sector through aggressive support for renewable energy. The pattern of interest intermediation in the electricity sector is more pluralist than in the automotive sector (Hey 2010). Faced with strategic state actors, the German utility industry invested in fossil fuels failed to mount an effective opposition to consecutive waves of renewable energy policy that shattered existing business models and shifted market power to technology challengers. Meanwhile, an emerging renewable energy coalition could shape policy outcomes.

A second line of research relates to cross-national variation in state-business relations beyond the corporatist and pluralist models. Corporatist systems display strong horizontal and vertical coordination, while pluralist systems feature weak horizontal and vertical coordination. Such processes of coordination can, however, occur in any combination (Baccaro 2003). For instance, East Asian developmental states had highly coordinated vertical ties between centralized state agencies and the private sector, but weak horizontal coordination among business groups seeking to resist sectoral intervention. Seen through this lens, state-led economic development in East Asia was also the result of weak horizontal coordination of external constituents. The opposite may be true in situations where low degrees of vertical coordination leave fragmented government agencies unable to compete with horizontally coordinated private sector interests. Such cases make state-led disruptive innovation policy unlikely, suggesting instead policy-making processes in which state developmental agencies respond to the initiative of private sector interests.

Finally, our findings suggest implications for policy, in particular for the transition to clean energy. States around the globe are aiming to transform energy sectors in the attempt to mitigate climate change and to revive economic growth. Our research shows that state intervention is likely to face a trade-off between policy stability and the level of policy intervention depending on the type of state-business relations. Corporatist states tend to provide stable long-term support for new technologies, once incumbents are on board. They also have greater capacity to address coordination challenges that exist within technological trajectories. These are particularly prevalent in network industries such as electricity and transport. The ideal-type is Japan, where firms and government coordinate around the long-term vision of hydrogen fuel cells as the technological future of the transport sector. Pluralist states, instead, tend to develop more disruptive policy, likely at the expense of long-term stable support. For instance, U.S. tax incentives for solar

photovoltaics and wind have fluctuated significantly over time, depending on political support coalitions. Due to low barriers of entry for new groups and multiple policy fora, pluralist states may also face greater obstacles in coordinating multiple actors within technological trajectories. As states increasingly intervene in mature industries to promote clean energy transformations, their comparative political advantages in implementing industrial policy may feature ever more centrally.

Acknowledgments

We are grateful for valuable comments from Chris Ansell, Tobias Schulze-Cleven, and Eric Thun on an earlier version of this article. Dan Willis provided helpful research assistance. We gratefully acknowledge funding from the Climate Works Foundation.

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[1] Whether the developmental state concept applies to industrialized economies is a question of debate. We follow Block (2008), who advances a broad notion of the developmental state as one that uses innovation and industrial policy to promote technological and industrial change. The developmental state in industrialized economies is more decentralized and networked than the centralized bureaucracies of the classic developmental state in Japan and Korea.

[2] The term electric car, here, refers to battery-electric vehicles, which only have a battery-powered electric engine. Hybrid vehicles, instead, combine an internal combustion engine with a battery-powered electric engine. Plug-in hybrids also combine an internal combustion engine with a battery-powered electric engine, but the battery can be charged from an external electricity source.

[3] See https://www.selectusa.gov/automotive-industry-united-states, http://money.cnn.com/2015/09/22/news/economy/volkswagen-germany-cars-economy/

[4] Compiled from OECD STAN Database (2017).

[5] http://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

[6] Interview with official, Federal Ministry for Environment (March 14, 2016).

[7] Interviews with official, federal ministry (February 24, 2016), representative of NPE (April 15, 2016).

[8] Interviews with official, federal ministry (January 22, 2016), anonymous source (April 21, 2016), and former Deputy Director, Ministry of Transport (June 13, 2016).

[9] Interviews with official, federal ministry (January 22, 2016), Henry Kuhle, Senior Manager, VDA (March 23, 2016), representative of NPE (April 15, 2016), and former Deputy Director, Ministry of Transport (April 21, 2016).

[10] Interviews with Henry Kuhle, Senior Manager, VDA (March 23, 2016) and representative of trade association (April 11, 2016).

[11] Interviews with Viviane von Raddatz, World Wildlife Fund (January 19, 2016), and senior manager of German carmaker (June 14, 2016).

[12] Interviews with official, federal ministry (January 22, 2016), Marcus Weller, German Federation for Motor Trades and Repairs (February 2, 2016), and official, federal ministry (February 24, 2016).
[13] Interviews with representative, Federal Ministry for the Environment (March 14, 2016), anonymous source (April 21, 2016), former Deputy Director, Federal Ministry for Transport (June 13, 2016), and senior executive of auto supplier (July 4, 2016).
[14] Interview with former Deputy Director, Federal Ministry for Transport (June 13, 2016).
[15] Interview with Viviane von Raddatz, World Wildlife Fund (January 19, 2016).
[16] Interviews with Henry Kuhle, Senior Manager, VDA (March 23, 2016).
[17] Interview with representative, major trade association (April 11, 2016).
[18] Interview with representative, NPE (April 15, 2016).
[19] Interview with senior executive, auto supplier (July 4, 2016).
[20] Interview with former Deputy Director, Federal Ministry for Transport (June 13, 2016).
[21] Interview with Viviane von Raddatz, World Wildlife Fund (January 19, 2016).
[22] Interview with anonymous industry source (June 27, 2016).
[23] Interview with Henry Kuhle, Senior Manager, VDA (March 23, 2016).
[24] Interviews with expert at major environmental group (January 6, 2016) and Henry Kuhle, Senior Manager, VDA (March 23, 2016).
[25] Interviews with official, federal ministry (February 24, 2016), senior manager at German carmaker (June 14, 2016), anonymous industry source (July 7, 2016), and senior executive of auto supplier (July 4, 2016).
[26] Interviews with senior officials, Department of Energy (September 29 and November 15, 2016).
[27] Interview with Jared Brown, Policy Advisor for Senator Orrin Hatch (September 8, 2016).
[28] http://blogs.wsj.com/autoshow/2008/11/21/letter-form-pelosi-reid-to-auto-makers-on-terms/
[29] Interview with senior legislative staffer (September 6, 2016).
[30] Why did GM develop an electric car? See Tillemann
[31] Interview with Jared Brown, Policy Advisor for Senator Orrin Hatch (September 8, 2016).
[32] Interview with anonymous industry source (August 29, 2016).
[33] In January 2009, Michigan passed legislation that provided financial incentives related to battery manufacturing.
[34] Sander Levin (Michigan) was conferee of stimulus package and very in tune with auto industry.
[35] Interview with Jared Brown, Policy Advisor for Senator Orrin Hatch (September 9, 2016).
[36] Interview with Robbie Diamond, CEO, Securing America's Future Energy and Electrification Coalition (September 9, 2016).
[37] Footnote on California's special status under the Clean Air Act and the waiver requirement
[38] https://www.selectusa.gov/automotive-industry-united-states
[39] Freeman 2011, 358.
[40] Interview with senior EPA official (October 21, 2016).
[41] Interview with Jim Marston, Environmental Defense Fund (October 11, 2016)

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