

BRIEFING

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International Competitiveness and the Auto Industry: What's the Role of Motor Vehicle Emission Standards?

This paper reviews the political science, regulatory, and economics literature to illuminate the international competitiveness impacts of motor vehicle emission standards. The primary question we consider is whether motor vehicle emission standards adopted in one market will create a future competitive advantage for domestic manufacturers when policy diffusion leads other markets to adopt similar emission standards at a later date. Related questions we consider include the impact of vehicle emission standards on technology innovation, “learning by doing,” and economies of scale; the diffusion of emission standards to other markets; and the impact on the location of research and development, assembly plants, and component supplier production facilities.

WHAT IS “INTERNATIONAL COMPETITIVENESS”?

The term “international competitiveness” is frequently used, but not always well defined. Broadly, it refers to the ability to compete in international markets (Dechezleprêtre & Sato, 2014). This concept can be applied at the firm, sector, or country level, and it is important to be specific about the level when discussing competitiveness. Competitiveness at the firm level refers to an ability to produce

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products and services better and cheaper than competitors (Buckley, Pass, & Prescott, 1988). At the sector level, competitiveness refers to the attractiveness of different countries for a particular industry (Dechezleprêtre & Sato, 2014). The country level of competitiveness examines the ability for a nation to provide necessary goods and services to its people while expanding growth (Wagner, 2003). For our purposes, we are focused on competitiveness at the firm level.

Concern to promote or protect international competitiveness is frequently cited to justify government policies that affect the auto industry or the automotive market. For example, a report from the EU-ASEAN Business Council (2015) argues that because most ASEAN nations tax vehicles by vehicle price, domestic automakers are discouraged from installing emissions control technologies, making them less competitive in the global marketplace. The Council suggests their Member States institute strict emissions standards to increase the competitiveness of Southeast Asian automakers. The European Commission (2012a) created an action plan in part to ensure the global competitiveness of European automakers.

Perspectives on the competitiveness impacts of regulations vary between countries with immature auto industries (such as China and Brazil) and those with well-established auto industries (the U.S. and the EU). For example, China and Brazil view auto standards as a way to encourage domestic manufacturers to become competitive with global manufacturers. When the Chinese government instituted its latest emission standards in December 2016, the country's Atmospheric Environmental Management head Liu Bingjiang stated the tighter rules would help their automakers be more competitive in the international market (Stanway, 2016). In Brazil, a consultant report for the Ministry of Development Industry and Commerce suggested the best way to incentivize the country's automakers to compete globally was by instituting stringent auto standards (CSM Worldwide, 2010).

Mature markets such as the U.S. and Europe have traditionally focused on impacts on domestic manufacturers, although this is changing with the growth in the EV market and the increasing vehicle sales in China and other developing markets. In the future, most growth will happen outside OECD countries (Stürmer & Lau, 2017) and China's market is larger than those of the U.S. and Europe (JATO Dynamics, 2016). In addition, growth in electric vehicle sales has created a new competitive dynamic within the global auto market. The regulatory push towards electric vehicles in California has been influenced by a desire to become more economically competitive in the global auto market (Governor's Interagency Working Group on Zero-emission Vehicles, 2013). Indeed, electric vehicles are a recent example of long-standing global competition between companies and countries seeking to place the right bets on future technologies.

RACE TO THE BOTTOM OR RACE TO THE TOP?

When countries adopt environmental standards in a global economy, traditional economic theory suggests a "race to the bottom" occurs, where firms with higher costs in the regulated markets struggle to compete with those with lower costs in the less-regulated markets (Frankel, 2008). One common criticism of environmental regulations in general is that they raise costs for producers, encouraging them to relocate to places with less-strict regulations and thus lower costs—an idea referred to as the "pollution

haven” hypothesis (Ambec, Cohen, Elgie, & Lanoie, 2011; Frankel, 2008). While this may be true for regulations on manufacturing, it does not apply to regulations on a country’s vehicle market (U.S. Environmental Protection Agency, 2016a). It is possible that regulation on manufacturing may raise production and compliance costs, leading to manufacturers leaving a country, producing elsewhere, and exporting back to their home country. A regulation on the market, however, does not change the cost of manufacturing in the country, but rather of selling into the market. The regulations would increase costs equally for all producers, regardless of location. In other words, automakers would not benefit from relocating outside of a country that instituted or strengthened its standards for vehicles being sold into its market.

There is evidence that automakers choose to locate production where the markets are located (CALSTART, 2016). For example, German automakers produce SUVs in the U.S. and exports to Europe because the U.S. has the largest market for SUVs (Valdani Vicari & Associati, Technopolis Group, & TNO, 2015). Similarly, B-segment cars (small cars) are produced in Europe, the largest market for those vehicles, and exported to other countries. Furthermore, it is no coincidence that California, which instituted a Zero-Emission Vehicle (ZEV) requirement in 1990, is the home of Tesla Motors (California Air Resources Board, 2014). California’s Zero-Emission Vehicle (ZEV) requirement requires 4.5% of an auto company’s sales to be ZEVs by 2018 and 22% by 2025 (California Air Resources Board, 2016). Companies can choose to purchase credits from those who exceed the target, which has created substantial profits for Tesla, which generates many credits from its 100% ZEV sales (Manjoo, 2017).

Some studies have challenged the idea of the “race to the bottom,” with some even suggesting there exists a “race to the top,” in which both firms and countries benefit from higher standards because of innovation and the effects of global trade (Porter & van der Linde, 1995; Saikawa, 2013). There are three main elements of the literature that examines the relationship between environmental standards and international competitiveness: the early-mover advantage, the Porter Hypothesis, and export pressures.

THE EARLY-MOVER ADVANTAGE

The first theme in the literature is the suggestion that countries that adopt strict standards early grant a competitive advantage to their industries. Porter and van der Linde (1995) suggest that if the global market is likely to head toward technological change, early adopters are likely to see greater benefit in market share. Examples they cite include the recycling industry in Germany, eco-friendly pulp and paper products in Scandinavia, and low-emissions diesel engines for trucks in the U.S. A review of the literature by Frankcx (2014) finds a consensus that early innovators in the auto sector are likely to gain a competitive advantage because of economies of scale and the additional benefits of technological learning. For example, Dechezleprêtre, Neumayer, and Perkins (2015) find that technologies transfer from innovating countries to those with similar policies. The domestic firms located within innovator countries then gain a competitive advantage when they export their technologies to the other markets because they are farther down the learning curve. Campbell and Madrid-Crost (1992) argue that Japan’s early adoption of strict hydrocarbon, carbon monoxide, and NO_x standards did in fact give its automakers an early foothold in the international market, and that those companies benefited from economies of scale and more opportunities

from learning earlier than countries (e.g., the U.S.) that gave their automakers more time to meet the standards.

In China, whose electric car market is currently larger than those of the U.S. and Europe (Pontes, 2017), the national government has established policies to promote electric vehicles. This has driven significant investments—for example, research has shown that Chinese electric vehicle automaker BYD Auto’s expansion has been driven by government policies such as subsidies for purchasing electric vehicles and development of new charging infrastructure (Masiero et al., 2016).

THE PORTER HYPOTHESIS

The second theme in the literature is the hypothesis that well-designed environmental regulations will increase firm innovation, leading to greater resource productivity and increased profits that fully offset the initial costs (Porter & van der Linde, 1995). This idea, first proposed by Harvard economist Michael Porter in 1991, has come to be known as the Porter Hypothesis, and it has generated considerable debate in the economics literature. The traditional view is that firms must have already undertaken all possible innovations. Porter Hypothesis studies have suggested that, in practice, organizations have structural imperfections, and that managers face imperfect information and have different values, such as risk aversion, that prevent them from taking all available opportunities for innovation (Ambec et al., 2011). Given that the firm level of competitiveness is determined by the ability to produce goods and services at lower cost and higher quality than competitors (Buckley, Pass, & Prescott, 1988), increased resource productivity would directly contribute to international competitiveness.

For example, it is clear that adoption of stringent fuel economy/CO₂ standards in the U.S. has led to rapid adoption of new technologies. Two sets of regulations adopted in 2010 and 2012 are expected to nearly double passenger-vehicle fuel economy in the U.S. by 2025 (U.S. Environmental Protection Agency, 2010; U.S. Environmental Protection Agency, 2012). Penetration rates for energy-efficiency technology have soared as a result. After many years of gasoline turbocharger market share stagnating between 2% and 3%, share exploded from 3% in 2010 to 18% in 2015 (U.S. Environmental Protection Agency, 2016b). Similarly, direct injection fuel systems increased from zero in 2007 to 46% in 2015, cylinder deactivation from 6% in 2010 to 13% in 2015, engine stop/start systems from zero in 2011 to 7% in 2015, and variable valve timing from 58% in 2008 to 98% in 2015.

“WEAK” AND “STRONG” HYPOTHESES

Scholars have attempted to empirically test two versions of the Porter Hypothesis: a “weak” hypothesis, which states that strict environmental regulations lead to firm innovation; and a “strong” hypothesis, which states that the innovation from strict environmental regulations will create new solutions that will ultimately prove more profitable for the firms (Ambec et al., 2011).

There is considerable evidence supporting the “weak” version of the hypothesis (Ambec et al., 2011; Franckx, 2014). Studies have found a positive effect of environmental regulations on innovation in sectors such as manufacturing (Rubashkina, Galeotti, & Verdolini, 2015; Zhao & Sun, 2016) and the auto sector

(Franckx, 2014; Lee, Veloso, Hounshell, & Rubin, 2010; Stewart, 2010). In fact, the implication that regulation can spur innovation has a strong basis in literature as far back as 1936 (Ambec et al., 2011).

There is far less evidence to support the “strong” version of the hypothesis. Many studies find no significant effect of environmental regulations on productivity (Ambec et al., 2011; Franckx, 2014; Rubashkina et al., 2015; Zhao & Sun, 2016; Wagner, 2003). Furthermore, there have been very few studies examining the “strong” hypothesis specifically in the auto sector—to our knowledge, the only literature review of Porter Hypothesis studies that focuses on the auto sector is Franckx (2014). It notes that Managi, Hibiki, and Arimura (2010), in their study of the Japanese auto sector from 1990 to 2002, find that regulations increased R&D expenditures, which in turn increased productivity.

Studies on the manufacturing sector, while not directly applicable to the market regulations in the auto sector, provide some insight into the effects of environmental regulations broadly on business performance and competitiveness. A review of the literature by Ambec et al. (2011) found that while early studies on environmental regulations and productivity largely found a negative relationship, some recent studies have found more positive results. For example, Dufour et al. (1983) found that environmental regulations on Quebec manufacturers had a significant, negative impact on productivity. More recently, however, Lanoie et al. (2008) found that tightening environmental regulations in Quebec’s manufacturing sector led to an initial drop in productivity, but after four years, firms had more than offset their drop in productivity. They also found that this was stronger for firms that faced more international competition.

While many studies fail to find a positive relationship between environmental regulations and productivity or profitability, multiple studies have stated that there is little evidence that tightening environmental regulations significantly hurts productivity and international competitiveness (Dechezleprêtre & Sato, 2014; Repetto, 1995; Wagner, 2003; Valdani Vicari & Associati et al., 2015).

THE IMPORTANCE OF POLICY DESIGN

One important element of the literature on the Porter Hypothesis is the finding that policy design is an important variable in determining its validity. Porter and van der Linde (1995) suggest that the Porter Hypothesis applies to “well-designed environmental regulations” (p. 115), but do not specify what makes a regulation well-designed beyond promoting innovation and continuous improvement while minimizing uncertainty. A common conclusion in studies of the Porter Hypothesis is that more flexible regulatory mechanisms, such as taxes or tradable permits, create more opportunities for low-cost innovation than more prescriptive regulations do (Albrizio, Botta, Koźluk, & Zipperer, 2014; Wagner, 2003). However, more prescriptive regulations can lead to innovation as well—Lee et al. (2010) find that technology-forcing standards on emissions control technologies in the U.S. have had a significant, positive effect on technological innovation.

Policy stringency matters as well. A 2015 assessment of potential future CO₂ regulation on light-duty vehicles in the EU finds that the degree to which cost, innovation, and international competitiveness are affected, either positively or negatively, depends on

the stringency and design of the regulation (Valdani Vicari & Associati et al., 2015). For example, they note that the EU component manufacturing sector could gain an advantage from economies of scale if the regulation in the EU is more stringent than it is elsewhere because stricter regulations would create higher demand for emissions control components. On the other hand, the international competitiveness of automakers and suppliers is not likely to change unless the stringency of the regulation is significantly different from that in competing regions.

In the case of vehicle efficiency policy, economists tend to favor a fuel tax over standards because, in their view, taxes induce the same benefits as standards while also incentivizing less driving. However, fuel taxes are politically unpopular because they impose tangible costs on consumers and can be regressive (Anderson, Parry, Sallee, & Fischer, 2011). There are clear benefits to CAFE standards that can be articulated, such as the finding that tightening vehicle standards will save consumers up to \$5,000 in fuel costs (Bianco et al., 2014). Convincing the public to raise taxes, on the other hand, is a difficult task, even if it would potentially benefit society in the long run. In addition, some research has suggested that consumers do not fully value the savings earned from greater fuel economy (Helfand & Wolverton, 2010; Turrentine & Kurani, 2007). It is, therefore, unclear that taxes truly do induce the same benefits as standards.

LIMITATIONS OF THE PORTER HYPOTHESIS LITERATURE

As stated above, there is very little Porter Hypothesis research focusing on the auto sector. Because of this, we need to rely largely upon studies of other sectors. This may miss potential variables that are unique to the auto sector. Regarding Porter Hypothesis research generally, Ambec et al. (2011) detail a number of issues that can affect positive or negative findings. First, the kind of change that the Porter Hypothesis implies is long-term in nature. Most studies of the hypothesis, however, use cross-sectional data from when the policy is instituted, and so they do not necessarily capture the true long-term effects of the regulations. Indeed, Ambec et al. (2011) show that longitudinal studies that account for the lagged effects of regulation find a positive relationship between strict environmental regulations and productivity. For example, Lanoie et al. (2008) demonstrate that tightening manufacturing regulations in Quebec led to an initial decrease in productivity after one year, but the effect was positive starting in year two and continued to increase. Second, Ambec et al. (2011) note that researchers have not been able to explain why results seem to vary across time periods and industries. A study on the petroleum industry from 1987 to 1995 (Berman & Bui, 2001) found that regulations led to an increase in productivity, while a study on the paper industry in the same time period (Gray & Shadbegian, 2003) found the opposite result. This suggests that perhaps there are industry-specific factors the studies are not accounting for. Finally, more global datasets would allow for greater comparisons across countries and give a clearer picture of the relationship between environmental regulations and international competitiveness.

CRITIQUES OF THE PORTER HYPOTHESIS, AND RESPONSES

The main critique of the Porter Hypothesis comes from Palmer, Oates, and Portney (1995), who argue that Porter and van der Linde (1995) are naïve and incorrect in arguing that environmental regulations can increase firm profitability. Palmer et al. (1995) present the traditional economic rationale that environmental regulations

will raise pollution abatement costs and provide a net cost to the firm. They criticize the implication by the Porter Hypothesis that firms will often miss opportunities to innovate, insisting that the profit-maximizing firm is likely to find most opportunities to innovate. However, other scholars have suggested that firm decisions are driven by their managers, and managers may have reasons to miss opportunities. These reasons include short-term planning horizons (Chowdhury, 2010), a desire to minimize effort (Aghion, Dewatripont, & Rey, 1997), or focusing on present costs instead of future benefits (Ambec & Barla, 2006). In addition, Bauman (2004) responds to Palmer et al. (1995), arguing that it demonstrates exactly what Porter and van der Linde (1995) criticized: the model is static and only addresses end-of-pipe abatement solutions, while the Porter Hypothesis argues for dynamic models and the potential for more efficient production.

EXPORT PRESSURE AND POLICY DIFFUSION

The final theme in the literature on motor vehicle emissions standards and international competitiveness is export pressure. Vogel (1997) presents a theory of trading-up—the “California effect”—based on the observation that as California has tightened its motor vehicle emission standards, other states and the federal government have tightened theirs as well to keep up with California’s market. Although Vogel developed the theory from examining policy diffusion in the U.S., he argues that the same effect occurs internationally when firms in unregulated countries export to markets that have standards. The theory posits that the firms, now obligated to produce vehicles that meet the higher standards of the importing markets, must choose to either stop exports to that market or upgrade their production of those particular vehicles. Then, the manufacturers lobby their own governments to institute the higher standards at home because it will give them a competitive advantage over their domestic competitors who do not yet have to comply with the other markets’ standards. Saikawa (2013) also refers to this effect as direct export pressure.

Perkins and Neumayer (2012) provide evidence for the existence of trading-up or the “California effect” in the global auto market. They find that from 1993 to 2008, developing countries that exported to more stringent markets were more likely to have stringent emissions standards. They also suggest that the amount of foreign direct investment (FDI) a country receives in the auto sector may lead to “investing-up,” where transnational corporations export higher vehicle standards to the countries in which they invest to gain a competitive advantage. While they find this to be significant for cross-sectional data in 2008, they do not find evidence for this in their longitudinal analysis from 1993-2008. Saikawa (2013) finds evidence for the “California effect” as well, showing that the more a country exports to regulated markets, the more likely it is to adopt stringent standards.

Saikawa (2013) also introduces the idea of indirect export pressure, which refers to when firms export to markets in which their competitors face standards in their home countries. Firms face pressure from the variety and balance of their export markets. In the context of exports, variety refers to the number of markets to which a firm exports and balance refers to the firm’s market share. If a firm has low variety, which is to say few countries to which it exports, it will face more pressure to adapt to meet the importing country’s standards and to expand to additional markets. If a firm is not particularly dominant in a country’s imports, which is to say it does not have significant

market share in that country, it will face more pressure to differentiate to set itself apart. If a firm has low diversity and/or low balance, Saikawa suggests, then it will innovate with new emissions control technologies to differentiate itself, then lobby its home country to tighten standards so it is not undercut at home. She finds evidence for this effect, but hers is currently the only paper to test for this.

CONCLUSIONS AND OPPORTUNITIES FOR FURTHER RESEARCH

CONCLUSIONS

In summary, scholars have found that countries that adopt strict environmental standards secure an early-mover advantage for their firms by creating conditions in which economies of scale can develop, network effects can grow, and technological “learning by doing” can take place. Specifically, the literature tends to support the following observations:

- (1) Strict, well-designed environmental regulations spur innovation
- (2) Domestic firms achieve a first-mover advantage through “learning by doing” and economies of scale
- (3) Policy diffusion of emission standards leads other markets to adopt similar standards after a brief lag time, and the technological innovations they induce diffuse throughout industry in a related but independent process
- (4) Domestic manufacturers (automakers and suppliers) are able to comply with standards adopted in other markets at lower cost than their competitors
- (5) Global automakers exporting to markets with stringent emission standards will lobby their home governments to raise their standards to gain a competitive advantage over other, non-global domestic manufacturers
- (6) Research and development, assembly plants, and component supplier production facilities tend to be located in those markets with advanced auto emission standards

OPPORTUNITIES FOR FURTHER RESEARCH

The literature on motor vehicle regulations and international competitiveness would benefit from more research that focuses on the auto sector, instead of relying on implications from environmental regulations as a whole, especially because producers behave differently when facing regulations on production as opposed to regulations on markets—that is to say, the “pollution haven” hypothesis that predicts manufacturers will flock to low-regulating countries does not apply to regulations on the vehicle market. In addition, studies incorporating segments of the auto sector other than automakers (e.g. suppliers) would capture the effects that go beyond impacts on original equipment manufacturers.

One potential opportunity for further clarifying this topic is to conduct a survey of automakers, suppliers, and policymakers on the current understanding of the competitiveness of U.S. automakers. What are the perspectives of each stakeholder group on the competitiveness impacts of vehicle emission standards? A survey

that seeks diverse perspectives would be useful to move forward, especially if it illuminated points of agreement and possible opportunities for collaboration among all stakeholders. Similarly, case studies of the impacts of environmental regulations on the competitiveness of individual producers in the auto market supply chain would provide a deeper, albeit anecdotal, understanding of the benefits and costs of environmental regulations throughout the auto sector. Two studies from CALSTART provide illustrative examples of the potential value these methods can bring: a survey of automotive suppliers (Ricardo Energy & Environment, 2016) finds a consensus view that suppliers support stringent fuel efficiency and greenhouse gas standards in the U.S., and case studies of the clean transportation technology industry in California (CALSTART, 2016) show how clean transportation technology companies have integrated with and boosted the local economy.

Also, as Ambec et al. (2011) outline, there are a few issues with the Porter Hypothesis literature that need to be addressed in future research. First, future studies need to focus more on longitudinal data to capture the potential long-term effects of environmental regulations. Second, future studies should attempt to determine why results of statistical tests might vary across sectors, with particular consideration to the auto sector. Finally, studies of global economics and trade would benefit from increasingly global datasets to provide greater precision and greater understanding of the truly global effects of environmental regulations and international competition.

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