
30 Sustainable supply chains and regulatory policy

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30.1 INTRODUCTION

Increasing concern about global sustainability has ushered in a diverse set of regulatory policies that aim to encourage sustainable practices and outcomes. This chapter sheds light on how these regulatory policies affect multiple aspects of companies' sustainable supply chain practices.

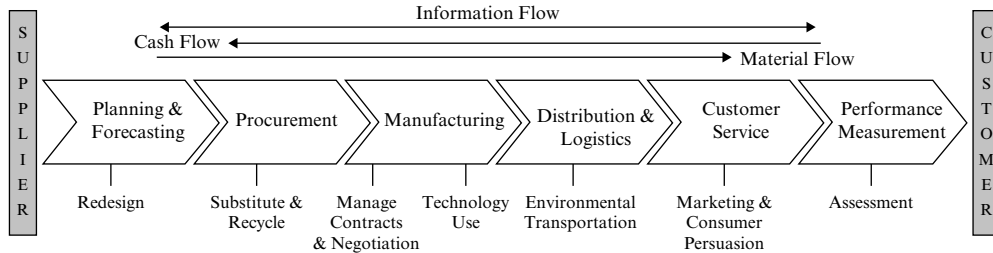
It begins by describing sustainable supply chain strategies more generally, focusing especially on firms' efforts to reduce their environmental harms. It then discusses how different types of regulation are related to firms' efforts to make their supply chains more sustainable. Three general regulatory policies are considered: (1) command-and-control regulation; (2) market-based policies; and (3) non-regulatory approaches.

All three types of regulatory policy encourage companies to re-evaluate their processes for supplier selection and contract negotiation. They encourage companies to reassess their supplier requirements and reduce environmental impacts throughout the supply chain. These activities can decrease firms' long-term risk while increasing production efficiencies. Sustainable supply chains can also enhance companies' strategic opportunities that lead to competitive advantage. However, not all companies will pursue sustainable supply chain opportunities or seek to change their production processes to produce sustainable product inputs. Indeed, firms are most likely to act only when their perceived regulatory risk and market opportunities are sufficiently high. The chapter concludes by identifying the potential impacts of future regulatory policies on sustainable supply chains and discusses areas that are worthy of future research investigation.

30.2 SUSTAINABLE SUPPLY CHAINS

While the concept of the sustainability has its roots in the 1970s (Lozano, 2008), it was the United Nations Brundtland Report that legitimized the term. That report defined sustainability as meeting the "needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987). It focused on three dimensions that firms should consider when pursuing sustainable solutions: economics, society and environment (Brundtland Commission, 1987; Mebratu, 1998; Lozano, 2008). Recognizing that supply chains depend on the natural environment in which they are embedded (Chopra and Meindl, 2013), this chapter focuses on the environmental component of sustainable supply chains. However, inevitably, economic considerations are intertwined because businesses necessarily assess the costs and benefits of the environmental strategies that they pursue.

Supply chains consist of all entities that are involved in fulfilling a customer request, including the suppliers, transporters, warehouses, retailers and customers themselves



Source: Spekman et al. (1998).

Figure 30.1 Sustainable supply chains

(Cox, 1999). Figure 30.1 characterizes a sustainable supply chain. It includes material flows as well flows related to cash resources and information (Spekman et al., 1998; Jones and Riley, 1985), and illustrates specific strategies that firms use at each stage of the supply chain to reduce their environmental impacts (Handfield et al., 2004). For instance, firms might consider alternative product designs that could change their input mix in a way that is less environmentally harmful. Alternatively, they may substitute raw materials that are less polluting, or procure products that are made from recycled materials. Related to the manufacturing process, firms manage contracts with partners in order for them to fulfill specific environmental standards and negotiate with suppliers to encourage more environmentally friendly operations and production.

At the distribution stage a business may use more fuel-efficient transportation and optimize shipping routes to minimize fuel use. Related to customer service, firms help to create a new vision for environmental sustainability that is relevant to their customers, and then evaluate their environmental performance. At each of these stages, firms assess the environmental performance of their suppliers (Handfield et al., 2002; Arimura et al., 2011) and ask or require suppliers to undertake measures that ensure the environmental quality of their products and processes (Handfield et al., 2002; Arimura et al., 2011).

Because supply chains are typically composed of multiple firms distributed geographically, they are influenced by a composite of locational practices, preferences and regulations (Manning et al., 2012; Darnall et al., 2008; Montabon et al., 2016). This means that some firms along the supply chain set the conditions of supply for upstream entities. In other instances, firms respond to requirements established by downstream actors. In both cases firms within the supply chain may be located in different political jurisdictions. As a result, regulatory policies at one point in the chain may influence firms' decisions about resource inputs, transport, supplier selection or partnership for the entire chain.

30.3 REGULATORY POLICY

Of all the rationales for why firms pursue more sustainable strategies, regulation and regulatory pressures are the most cited (Darnall et al., 2010; Henriques and Sadorsky, 1996). There are three general types of regulatory policies: (1) command-and-control regulation; (2) market-based policies; and (3) non-regulatory approaches.

30.3.1 Command-and-Control Regulation

Command-and-control (or traditional) regulations represent coercive approaches to manage pollution. They were the predominant type of regulation used prior to the 1980s. These regulations come in the form of bans over the production, purchase and use of certain substances, and tend to take a “zero-risk” approach to human health risks. One example is the European Union’s (EU) Restriction on Hazardous Substances (RoHS). Since 2006, RoHS has banned electronic and electrical equipment that is manufactured using six hazardous materials (expanded to ten hazardous materials in 2015), including lead, mercury and cadmium. Producers that continue to use these banned substances are prohibited from selling their products in EU countries. As a consequence, manufacturers both within and outside the EU that wish to sell products in the EU have had to make significant changes in their product inputs, which has affected supply chains across the globe.

Within the United States (US), in 1978 the Consumer Product Safety Commission banned the production of lead paint for application in households, toys and furniture because of its high toxicity and acute impacts upon children. This command-and-control regulation considerably changed the coatings production process. It affected suppliers, foreign manufacturers, importers and US retailers worldwide by encouraging producers and suppliers throughout the supply chain to share environmental best management practices (US Federal Register, 1977).

Technology-based approaches are another command-and-control approach. These regulations specify pollution control technologies that firms must use to comply with the law (Goulder and Parry, 2008; EPA, 2010). After installing the requisite technology, firms are allowed to emit residual pollution.

By contrast, performance standards establish legally permissible levels of pollution and rely on monitoring and enforcement to ensure conformance to the standard. One advantage of the performance standard is that it does not specify the approach firms should use to achieve the compliance threshold. Instead, companies are left to determine the most cost-effective way to meet the standard. In so doing, supply chains are inevitably affected. For instance, California, the sixth-largest economy in the world, represents a significant market for automobile sales. The state typically has fuel efficiency standards that are more stringent than US federal regulations. To be able to sell cars in California, manufacturers located in other US states or in other countries (for example, Japan and Korea) must meet California’s standards for fuel efficiency. As a result, automobile companies that wish to do business in California must make design decisions that necessarily affect the supply chain for international materials and parts.

30.3.2 Market-Based Policies

Market-based instruments are regulatory approaches that use markets and prices to create incentives for companies to reduce or eliminate negative environmental impacts. They encourage self-regulation based on the principle of economic efficiency (EPA, 2010), and reduce pollution by considering its societal cost and then imposing a tax or charge on production or product sales. Other forms of market-based policies either create property rights or facilitate the establishment of a proxy market for the use of environmental services.

Emissions trading policies (also known as cap-and-trade policies) are one example of a market-based instrument. Emissions trading policies rely on market incentives for companies to reduce their pollution. They work because firms' pollution control costs vary (EPA, 2010). At the international level, the Kyoto Protocol to the United Nations Framework Convention on Climate Change established an international climate regulation treaty that aimed at using emissions trading to reduce global greenhouse gas emissions. The US's sulfur dioxide emissions trading policy is another example. This policy has achieved significant annual reductions in sulfur dioxide emissions by imposing an emissions cap and by distributing a restricted number sulfur dioxide emission "allowances" to regulated firms. Firms have a choice of reducing their pollution below the allowable threshold (and selling their surplus allowances to other firms) or purchasing additional allowances to give them the right to pollute more (Burtraw, 1996). Related to the supply chain, firms that responded to this policy by reducing their sulfur dioxide emissions most typically did so by switching their suppliers and sourcing their coal from low-sulfur coal mines (Davies et al., 1996).

Taxes and subsidies are two other market-based instruments. Pollution taxes are designed to increase the cost of pollution such that firms with lower marginal pollution control costs will seek to reduce their environmental impacts, whereas firms with higher marginal pollution control costs will choose to pay the tax. Pollution taxes include effluent charges, deposit-refund systems, gasoline taxes and user charges. Governments try to set the tax rate at a level equal to the social costs of pollution, and so firms pay the social costs of their pollution. Higher taxes increase the likelihood that firms will pressure their supply chains to reduce their environmental impacts, thus avoiding the tax. For example, firms facing pollution taxes may switch from suppliers who produce non-recyclable or non-reusable inputs to others who produce similar inputs, but contain recyclable content or reusable parts. Similarly, taxes on fossil fuels may encourage switching to renewable energy sources.¹

Information policies are other market-based tools that regulators use to curb pollution. Increased information about the environmental content of products or the environmental concerns associated with production processes create incentives for companies to better manage their environmental risks. For instance, when manufacturing companies in North America, Europe and Japan were first required to publicly report information about their toxic chemical releases, the outcome was systematic and sustained reductions in firms' volumes of toxic chemicals (Gamper-Rabindran, 2006). In order to achieve these reductions, firms made significant changes in their environmental strategies and across their supply chains.

30.3.3 Non-Regulatory Approaches

In addition to command-and-control regulation and market-based policies, policy-makers have created a host of non-regulatory approaches which encourage companies to reduce their environmental impact and green their supply chains. These approaches include: (1) voluntary environmental programs (VEPs); and (2) non-regulatory information-based environmental programs such as eco-labels and sustainable public procurement.

A VEP is a program, code, agreement or commitment that encourages firms to voluntarily reduce their environmental impacts beyond the requirements established by the

environmental regulatory system (Carmin et al., 2003). VEPs characteristically employ market forces to provide economic benefits to participants. They also use recognition and other incentives to encourage firms to exceed legal environmental requirements. These approaches help firms to develop collaborative relationships with government by promoting shared learning and capacity development (Darnall and Sides, 2008; Darnall and Carmin, 2005), while creating a foundation for long-term environmental stewardship (Darnall and Carmin, 2005; Morgenstern and Pizer, 2007). Exceeding regulatory expectations also has the potential to enhance participants' environmental image and confer external legitimacy (Darnall, 2006). While often difficult to quantify, enhanced image and legitimacy could lead to such things as increased sales, improved ability to recruit talented employees, and enhanced relations with external stakeholders (Kollman and Prakash, 2001).

Related to supply chain management, regulators are encouraging businesses to voluntarily adopt sustainable supply chain practices to further reduce their impact on the natural environment (Darnall et al., 2008). For example, the US Environmental Protection Agency (EPA) established a pilot program with General Motors Corporation (GM) to develop a multi-media technical assistance program aimed at voluntary pollution prevention in GM's supply chain (EPA, 2003). More comprehensive collaborations within the automobile industry include a partnership between the EPA and automobile suppliers to create the Suppliers Partnership for the Environment, a trade association comprised of automotive and vehicle suppliers seeking to create new and innovative business-centered approaches to environmental protection (Darnall et al., 2008). The Partnership provides a forum for automobile producers and suppliers to share environmental best management practices and to promote sustainable supply chain practices (Jusko, 2003).

In some instances, VEPs may not be directly related to sustainable supply chains, but still affect them. For instance, in Japan, local governments encourage firms to adopt environmental management systems. These systems tend to focus on the environmental impacts within a company's operational boundaries. However, evidence shows that firms which participate in these VEPs are associated with a 7 percent greater likelihood that they will assess their first-tier suppliers' environmental performance (Arimura et al., 2011). Additionally, they are 8 percent more likely to require their suppliers to undertake specific environmental practices that reduce their environmental impacts (Arimura et al., 2011).

Non-regulatory information-based approaches rely on the interest of external stakeholders to encourage companies to reduce their environmental harm. Like VEPs, these approaches are voluntary and involve firms providing information to interested parties about their environmental activities. As an example, eco-labels are product seals or certifications that signal information to stakeholders about a product's or firm's sustainability attributes (Cashore, 2002; Darnall and Aragón-Correa, 2014). Eco-labels typically focus on a specific type of sustainability impact such as habitat conservation, organic production, biodegradability or energy consumption. They attempt to reduce stakeholder uncertainty about the validity of green product claims (Darnall et al., 2018; Darnall et al., 2017a). The US Department of Agriculture's Certified Organic label, the EPA's Green Lights label, and the EU Flower are examples. By 2017, there were more than 465 in existence (Ecolabel Index, 2017; Darnall et al., 2017a), as compared to 12 in 1990 (Delmas et al., 2013; Darnall and Aragón-Correa, 2014).

The supply chain implications of these labels are significant. Businesses that wish to

use eco-labels on their products often must adhere to strict requirements regarding the environmental impacts of their production inputs. For example, producers which wish to qualify to receive a “certified organic” food label must source natural fertilizers, such as compost, as opposed to chemical fertilizers. In other instances, businesses must consider the consumption impact of their products, as is the case for products that bear the US Energy Star eco-label. This eco-label identifies products that are more energy-efficient. In order to qualify for the label, some manufacturers are working more closely with their suppliers to redesign their products in a way that increases the product’s energy efficiency. For instance, Home Depot, the US’s largest home improvement specialty retailer, is working with its suppliers and consumers to increase the availability and purchase of Energy Star products. In 2013, by working closely with its suppliers, the company increased its offerings of Energy Star products. The change resulted in the sale of more than 125 million Energy Star certified products, nearly \$770 million in energy savings to consumers, and 4.7 million metric tons of greenhouse gas emission reductions during 2013 (Energy Star Awards, 2013)

Sustainable public procurement policies are another important non-regulatory approach that is used in the US, the EU, Japan and many other countries. These policies encourage government purchasers to consider the environmental impacts of goods and services at the point of purchase. The premise behind sustainable procurement policies relates to the fact that government purchasing accounts for between 21 percent and 23 percent of gross domestic product (World Bank, 2016). Within the US alone, cities annually purchase \$1.72 trillion (US Census Bureau, 2016) of goods such as chemicals, electronics and office materials. These purchases have a carbon footprint nine times greater than that of buildings and fleets (US General Services Administration, 2014). By purchasing climate-friendly products, cities not only reduce their climate footprint, but they also help to green their supply chain, thereby making it easier for other customers to purchase climate-friendly products as well (Darnall et al., 2017b). Governments are requiring sustainability as a purchasing criterion that is considered alongside cost, quality and other factors (Darnall et al., 2017c). In response, companies can gain competitive advantage by encouraging their suppliers and service providers to understand where environmental harm might be eliminated, identify alternatives, or develop new, safer alternatives. Table 30.1 summarizes the three major regulatory policy approaches that affect sustainable supply chains.

30.4 REGULATORY POLICY AS A DRIVER FOR SUSTAINABLE SUPPLY CHAINS

Regardless of their form, regulatory policy approaches are a primary driver for why companies adopt and implement sustainable supply chains (Zhu and Sarkis, 2006). They encourage companies to reduce their environmental impacts throughout the production and distribution process, from initial processing of raw materials to delivery to the customer (Linton et al., 2007). Companies do so by: (1) shifting their long-term risk; (2) utilizing natural resources more efficiently and thus increasing their production efficiencies (Rao and Holt, 2005); and (3) enhancing their legitimacy among critical stakeholders, thus increasing strategic opportunities.

Table 30.1 Types of regulatory policy

Policy example	Type of regulatory policy		
	Command-and-control	Market-based	Non-regulatory
Pollution bans	X		
Technology standards	X		
Performance standards	X		
Emissions trading policies		X	
Taxes		X	
Subsidies		X	
Information policies		X	X
Eco-labels			X
Sustainable procurement policies			X

30.4.1 Shifting Long-Term Risk

Corporations are increasingly mindful of the environmental regulations that govern their operations, since their inability to adhere to these regulatory pressures may result in serious penalties, including legal sanction, costly court proceedings, and environmental penalties and fines (Darnall, 2006). Purchasing inputs also means progressively acquiring waste from each supplier along the supply chain (Darnall et al., 2008); one purpose of sustainable supply chains, therefore, is to avoid inheriting suppliers' environmental risks (Klassen and Wybark, 1999). Doing so may improve their environmental reputation with regulators and other stakeholders.

The global automotive industry is an example of one sector that is collectively considering the environmental attributes of its suppliers to avoid inheriting environmental risks (Darnall, 2008). It has minimized its long-term environmental liabilities by using a rigorous supplier selection process (Darnall et al., 2008) and evaluating suppliers' plastic and steel components in their product design cycle (Gupta and Piero, 2003). Additionally, US automakers are requiring that their suppliers assess and continually improve their environmental performance to further reduce the risk of inheriting environmental liabilities associated with product inputs (Darnall et al., 2008).

Similarly, in response to pressures associated with inheriting regulatory risk, computer companies are establishing internal policies for supply chain management that emphasize sustainability by way of supplier codes of conduct that reduce their supply chain risks (Darnall et al., 2008). Supplier codes of conduct are important, because if an upstream supplier has its operating permit revoked due to an environmental violation, or if a critical supplier shuts down (even temporarily) because of an environmental accident, the entire supply chain can come to a halt (Lamming and Hampson 1996; Darnall et al., 2009). Avoiding these related regulatory risks has created greater business certainty for more proactive firms.

Other risks stem from suppliers' processes that affect the environmental impacts of their products, but have no direct bearing on the purchasing firm's environmental liability. For instance, some US furniture manufacturers are requiring that their wood suppliers use

sustainable forestry practices (Darnall et al., 2008). While these supplier mandates may not reduce the furniture producer's environmental waste, they reduce the environmental impacts associated with non-sustainable growing practices. Since external stakeholders (including regulators, community organizations, customers and environmental groups) often do not distinguish between a company's environmental practices and the practices of its suppliers (Rao, 2002), reducing these types of supply chain impacts may help to further improve a firm's overall environmental reputation (Darnall et al., 2008).

30.4.2 Increasing Production Efficiencies

Regulatory policies also collectively encourage suppliers to adopt more eco-friendly designs (Zailani et al., 2012) by encouraging suppliers to substitute regulated materials with less polluting materials (Handfield et al., 2005). For instance, in developing 3M's product stewardship program, its Valley, Nebraska facility recognized an opportunity to reduce its supplier waste (Kurapatskie and Darnall, 2013). By working with its supplier, shipments now incorporate reusable packaging. In the first year the modification reduced shipping waste at this single 3M facility by 8 tons and eliminated the associated landfill fees (Darnall, 2008).

In other instances, regulatory policies have encouraged companies to develop more sophisticated sustainable supply chain assessment strategies. For instance, some firms may implement life cycle cost analysis to assess their activities at each step of their supply chain, from raw materials access to disposition of used products (Allenby, 1991; Darnall, 2006). These more advanced environmental strategies leverage basic pollution prevention principles and extend them by integrating external stakeholders into product design and development processes (Hart, 2005). By using these techniques, firms can exit environmentally hazardous businesses, redesign existing product systems to reduce life cycle impacts, and develop new products with lower life cycle costs (Hart, 1995). Doing so can create significant strategic advantages related to how companies market and position their products.

30.4.3 Enhancing Strategic Opportunities

Regulatory policies also create significant strategic opportunities for proactive firms. These companies tend to view regulation and the threat of regulation as an opportunity (Dutton and Jackson, 1987; Miles and Snow, 1978), as well as a pathway for competitive advantage. They invest in specific resources and capabilities (Lin and Darnall, 2015; Miles and Snow, 1978), including strong supplier relationships that allow them to adapt quickly to a changing social and political landscape. Proactive firms recognize the potential business value associated with the formation of mandatory regulations because they have developed strategies that would benefit from more stringent regulation.

For instance, related to command-and-control regulation, Entergy, DuPont, Imperial Chemicals, Sampra Energy, Alcoa, GE and PG&E are pressing for mandatory climate change regulation at the US federal government level, because it is in their direct economic interest to do so (Kim and Darnall, 2016). These companies have developed products and technologies that would gain a substantive foothold in the market if comprehensive climate legislation were passed (Kim and Darnall, 2016). Such changes are often depend-

ent on a company's ability to manage its increasingly complex supplier relationships (Darnall et al., 2008). The outcome of the tighter regulation would mean that competing firms would have to step up their game, or else risk losing their competitiveness (Lin and Darnall, 2010). Proactive firms benefit from first-mover advantages.

In other instances, companies create strategic opportunities by redesigning their products, thus eliminating pollution. The outcome is that existing environmental regulations – of all sorts – may not be relevant to them (Kurapatskie and Darnall, 2013). Related to command-and-control regulation specifically, companies that reduce and maintain their environmental impacts below mandatory thresholds may no longer need to apply for costly operating permits or undergo expensive monitoring and reporting of specific environmental activities (Porter and van der Linde, 1995). For instance, when Leff-Marvin's Cleaners, Inc., of Pittsburgh, Pennsylvania, replaced its old dry-cleaning equipment with new cold-water-chilled closed-loop systems that recycle perchloroethylene (PERC), it no longer had to apply for a state environmental permit (Kurapatskie and Darnall, 2013). The company's new equipment eliminated most of its regulated emissions and reduced its use of PERC from 200 gallons per month to 40 gallons per month (US Environmental Protection Agency, 2011).

Other strategic opportunities relate to environmental technologies. Producers with more environmental technologies may support their suppliers by providing them with these technologies or offering technical assistance in order for suppliers to fulfill regulatory standards (Hall and Matos, 2010). For instance, Kraft Foods Inc. partnered with the Rainforest Alliance and small coffee farmers in Central and South America (Kurapatskie and Darnall, 2013) to deliver sustainable coffee production training to growers and pay a fair wage for their labor. The result of this partnership was that Kraft secured 13 million pounds of sustainably grown coffee, allowing it to be competitive in the growing market for fair trade coffee (Kurapatskie and Darnall, 2013). Additionally, rural growers benefitted from greater economic stability and improved knowledge of more sustainable farming practices.

Companies have also benefitted from taking advantage of indirect outcomes from regulation. For instance, because of command-and-control policies such as city recycling mandates, many cities have an abundance of recyclable low-cost plastic. Walden Paddlers recognized this and used the opportunity to develop the first kayak made of 100 percent recycled materials (Darnall, 2008). By working in partnership with its suppliers to innovate its product design, Walden Paddlers was able to capitalize on the cheap supply of recycled plastic by making a product that was more durable than other kayaks on the market and at a price that was significantly less than its competitors (Darnall, 2008).

Opportunities are also created when companies respond to regulations by creating a strategic alliance with their suppliers. For instance, to avoid environmental risks from its suppliers, Dow Chemical, one of the largest global producers of chlorine, partnered with its transportation supplier to design rail cars with walls that were double the thickness required by US regulations. The company's decision was based on a discovery that, in the event of a derailment, the rail car had a significant probability of puncturing upon impact and placing neighboring communities and ecological systems at risk (Darnall et al., 2008). However, Dow lacked the internal expertise to address the problem on its own. By collaborating with its transportation supplier to design an innovative car that would not rupture, the new rail car soon became the industry standard (Darnall et al.,

		Market opportunities	
		<i>Low</i>	<i>High</i>
Regulatory risk	<i>Low</i>	Minimal	Mixed
	<i>High</i>	Mixed	Significant

Figure 30.2 Firms' likelihood of pursuing sustainable supply chain options

2008). Consequently, Dow Chemical established a leadership position and increased its credibility with both regulators and industry peers.

30.4.4 Which Firms Are More Likely to Pursue Sustainable Supply Chains?

The evidence shows that regulatory policy of all sorts – command-and-control, market-based and non-regulatory – encourages the development of sustainable supply chains that can shift firms' long-term risk, increase production efficiencies and enhance their strategic opportunities. However, when confronted with regulatory pressure, firms do not always respond similarly (Oliver, 1991). Two factors are likely to prompt firms to pursue a sustainable supply chain: market opportunities and regulatory risk.

Market opportunities relate to a company's ability to identify its potential customers and meet their needs before their competitors. These opportunities often hinge on the company's internal capabilities and its ability to innovate and adapt quickly. Regulatory risk relates to the potential that a change in regulatory policy will affect a company by increasing its cost of doing business, thus reducing its competitive position. Regulatory risk can also affect a company's asset value. For instance, companies that sell their products in multiple jurisdictions bear greater risk than firms that sell their products within a single jurisdiction.

When both market opportunities and regulatory risk are high, companies are more likely to pursue sustainable supply chain options (see Figure 30.2). The combination of increased opportunities from potentially expanding their market share, coupled with the coercive pressure associated with shouldering unwanted regulatory risk, are compelling reasons for firms to pursue sustainable supply chain options.

However, when market opportunities and regulatory risk are low, firms are far less likely to invest in greening their supply chain, because they lack sufficient strategic advantages for doing so. In instances where either market opportunities or regulatory risk is low, but the other is high, more heterogeneous and less predictable responses are likely.

30.5 FUTURE OPPORTUNITIES AND CONCLUSION

Regulatory policies have the potential to increase regulatory risk and firms' market opportunities. These factors also influence the prevalence of sustainable supply chains. What remains less known is whether all types of regulations influence sustainable supply chains similarly. For instance, it is unclear whether command-and-control regulations encourage sustainable supply chains in the same way as market-based policies. Additionally, even

among similar types of regulatory policies, it is uncertain which types lead to more sustainable supply chains. Among the non-regulatory approaches, for example, it is unclear whether VEPs are more successful than information-based policies at encouraging sustainable supply chains. Additional research is needed to explore these issues.

Similarly, we know little about which types of regulatory approaches are associated with greater shifts in firms' long-term risk, production efficiencies and strategic opportunities. Understanding why some firms are able to better manage their supply chain regulatory risk, for example, would be an important contribution to our understanding of supply chain sustainability. Future research could also examine the interactive and potentially reinforcing effects across long-term risk management, resource efficiency and strategic opportunities.

While there is still much to explore related to regulations and sustainable supply chains, what is clear is that regulations of all sorts influence supply chain sustainability. This relationship is likely to become stronger as concerns about global climate change grow, and international climate agreements become more stringent over time.

NOTE

1. In contrast to the emissions tax, subsidies are market-based instruments that lower a firm's production costs (EPA, 2010). For instance, the US Conservation Reserve Program provides subsidies to farmers to reduce their environmental impacts (Feng et al., 2003).

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