CHAPTER

17

Sustainability and the Supply Chain

LEARNING OBJECTIVES

After reading this chapter, you will be able to

1. Understand the importance of sustainability in a supply chain.
2. Discuss the challenge to sustainability posed by the tragedy of the commons.
3. Describe key dimensions of sustainability for a supply chain.
4. Understand the role of incentives for successful sustainability efforts.

Sustainability has become a key priority in the design and operation of supply chains in the twenty-first century. A focus on sustainability allows a supply chain to better serve more environmentally conscious customers while often improving supply chain performance. In this chapter, we explore the importance of sustainability, some challenges to designing and operating more sustainable supply chains, and the role of different supply chain drivers in improving sustainability.

17.1 THE ROLE OF SUSTAINABILITY IN A SUPPLY CHAIN

This book has focused on designing and operating supply chains with a goal of growing the supply chain surplus. Each supply chain, however, is only a small part of the world in which it resides. Ultimately, the health and survival of every supply chain and every individual depend on the health of the surrounding world. It is thus important to expand the goal of a supply chain beyond the interests of its participants (which the supply chain surplus represents) to others that may be affected by supply chain decisions. It is in this context that the twenty-first century has seen a growing focus on sustainability. The Brundtland Commission of the United Nations defined *sustainable development* as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The 2005 World Summit of the United Nations introduced a framework identifying economic, environmental, and

social sustainability as the "three pillars" of sustainable development. All three pillars must be reconciled for sustainability to occur.

The focus on sustainability has increased as the economies in large countries such as Brazil, China, and India have grown. On the one hand, the growth of emerging markets is improving global living standards in a way that perhaps has not happened before in human history. On the other hand, this growth puts pressure on resources and the environment in a way that has also never happened. It has become increasingly clear that if supply chains do not become more sustainable than they have been in the past, the world's resources and environment will not be able to maintain this level of growth.

The factors driving an increased focus on supply chain sustainability can be divided into three distinct categories:

1. Reducing risk and improving the financial performance of the supply chain
2. Community pressures and government mandates
3. Attracting customers that value sustainability

Even though there has been a great deal of talk about all three categories, most concrete action has been observed in reducing risk for the supply chain and improving financial performance. The early part of the twenty-first century has seen an increase in community pressure and government mandates in some parts of the world. Much less success has been driven by customer demand or a firm desire to make the world more sustainable. It is interesting to note that significant opportunity exists even if supply chains focus only on reducing risk and improving financial performance. A McKinsey report (Creyts et al., 2007) focusing on greenhouse gas emissions reported, "Almost 40 percent of [greenhouse gas] abatement could be achieved at negative marginal costs, meaning that investing in these options would generate positive economic returns over their lifecycle." Despite the existence of financially viable opportunities to increase sustainability, activity has been slow because many of these actions require upfront investment that pays off in the long term. An example is the investment in light-emitting diode (LED) lighting by Walmart. Even though it has required upfront investment, installing LED lights has significantly reduced energy consumption at Walmart stores. Despite the long-term payoff, though, few other firms have followed Walmart because of the large upfront investment.

Although much still needs to be done, many companies have reported success in improving sustainability. Unilever, the Dutch–British consumer goods giant, has invested significant effort to help emerging economies such as Brazil and India wrestle with poverty, water scarcity, and climate change. In Brazil, the company helped tomato growers convert to drip irrigation to save water. The company sees almost half of its sales and the majority of its growth coming from emerging economies. It buys roughly "10 percent of the world's crops of tea and 30 percent of all spinach."[1] A focus on sustainability helps Unilever improve the environment and economic health of markets where it is likely to see most of its future growth, while simultaneously ensuring supply of products it needs to feed this growth.

Walmart started its focus on sustainability as a defensive move, given the criticism it was receiving from environmental activists. The company, however, has seen many benefits to its bottom line. Switching to more efficient light bulbs at its stores and adding skylights for natural light have helped significantly reduce its energy costs. Reducing packaging has helped reduce material costs and transportation costs. Another example is the redesign of the one-gallon milk jug by Walmart and Costco to use less material and increase packing density during transportation. Even though it took the public some time to accept the new design, the effort saved "10 to 20 cents a gallon compared to old jugs."[2]

Starbucks is another example of a company that has focused on sustainability for significant business reasons. In the late 1990s, the company realized that its growth plans could not be

[1]"Beyond the Green Corporation," *Business Week*, January 29, 2007.
[2]"Solution, or Mess? A Milk Jug for a Green Earth," *New York Times*, June 30, 2008.

sustained without helping coffee growers increase their production in a sustainable manner. The company thus started its coffee and farmer equity (C.A.F.E.) practices, which evaluate the sustainable production of coffee along four dimensions: product quality, economic accountability, social responsibility, and environmental leadership. According to the company, "the first two categories are prerequisites to participation in the program and ensure basic coffee quality and financial transparency, equity, and the viability of the coffee supply chain." Social responsibility measures the extent to which the working conditions are safe and humane. Environmental leadership measures the actions that suppliers are taking to "manage waste, protect water quality, conserve water and energy, preserve biodiversity and reduce agrochemical use." Applicants are given "preferred supplier" status based on the score they achieve across the four categories. Preferred suppliers get a pricing premium of $0.05 per pound along with favorable contract terms. The company claims that it sourced 95 percent of its coffee in 2013 from sources that were "third-party verified or certified through C.A.F.E. practices, Fairtrade or another externally audited system." Besides helping attract customers who care about sustainability, these efforts have helped Starbucks reduce supply risk and ensure an ongoing supply of high-quality coffee, the most critical input for its business.

Sustainability has presented more of a challenge when it requires efforts that do not provide obvious return on investment for a company. In fact, customers themselves have not always backed up their words about the importance of sustainability with a willingness to pay more for sustainable products or make more of an effort to support sustainability. As an example, Starbucks has been able to increase the percentage of beverages served in customer-owned tumblers from 1.4 percent in 2009 only to 1.8 percent in 2013. Of all the dimensions the company reported in its 2013 Global Responsibility Report, this was the dimension that saw the smallest improvement. In a survey, business leaders identified insufficient return on investment, customers' unwillingness to pay a premium for green products, and difficulty evaluating sustainability across a product life cycle as the major barriers to an increased focus on sustainability.[3] When the business rationale for an increased focus on sustainability is not clearly defined for individual firms, maintaining the focus needed for building more sustainable supply chains is much harder. As we discuss in the next section, one of the biggest challenges to building sustainable supply chains is that in the short to medium term, an improved focus on sustainability provides benefits that are shared but costs that may be local to a firm or individual, whereas the current status quo provides benefits that are local to firms or individuals but a cost that is global.

17.2 THE TRAGEDY OF THE COMMONS

In an influential article, Hardin (1968) described the *tragedy of the commons* as a dilemma arising when the common good does not align perfectly with the good of individual entities. It is useful to study his example in somewhat greater detail. Consider a pasture that is open to all herders with cattle. Each herder attempts to maximize his gain from this public asset. When one herder's cattle feed in the pasture, that herder gains from their growth and all the gains accrue only to him. Any cost of overgrazing, however, is spread over all herders whose cattle feed at the pasture. Thus, overgrazing by the cattle of any herder provides a positive utility of +1 for that herder but a negative utility of only a fraction of –1 for the herder because the negative utility of –1 is spread over all herders. Thus, each rational herder continues to increase his herd because the positive utility to that herder of adding another animal exceeds the negative utility that he experiences from overgrazing. As Hardin writes, "Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all."

[3]Gibbs & Soell survey, accessed May 1, 2011, www.cnbc.com/id/42432191/

Hardin then describes how the issue of environmental pollution is essentially the tragedy of the commons. Every individual and every company releases waste and pollution into the environment in the form of sewage, chemicals, and carbon dioxide. The individual or the company would incur the entire cost of reducing the amount of waste it discards, whereas the cost of throwing waste into the environment is shared by the entire world. The common environment available to all at no cost makes it difficult to get every company to invest in waste reduction efforts, even though this waste hurts everybody.

This issue also appears at the country level. The Intergovernmental Panel on Climate Change, a United Nations body that has been assessing global warming since 1990, has written that even though most of the buildup of carbon dioxide in the atmosphere has come from the United States and Western Europe, poorer countries closer to the equator are likely to pay the biggest price. The risk of drought, disrupted water supplies, and the swelling of oceans from melting ice sheets as a result of global warming will be experienced mostly in Africa and the "crowded river deltas in southern Asia and Egypt, along with small island nations."[4] In such an environment, getting any agreement on action is difficult because the optimal joint action is not individually optimal, whether at the company or country level. No wonder that it has been almost impossible to negotiate a climate change agreement that every country is willing to adhere to! Other examples of the tragedy of the commons come from the overuse of natural resources such as fish, water, and forests. Overfishing of sturgeon in Russia and the destruction of salmon runs in rivers that have been dammed are well documented.

Every company and supply chain faces the challenge of the tragedy of the commons as it operates in a global environment. They must compete against others that may be extracting benefits from the environmental or resource commons without spending to maintain these commons. They must compete in a market in which customers often value low cost and are not willing to pay the price of a more sustainable solution, in the form of either a higher price or reduced consumption. Unless all consumers suddenly change their mindsets, it is difficult to imagine a sustainable solution emerging without some intervention. Whereas everyone agrees about the need for intervention, there is considerable disagreement on the required form of intervention.

What Are Some Solutions to This "Tragedy"?

In his article, Hardin focused on the problem arising from the fact that the commons are "free" to all. As he put it, no solution could be found without taking away some of the freedom that participants enjoyed in the commons. Regarding the national parks in the United States, he wrote, "We might sell them off as private property. We might keep them as public property, but allocate the right to enter them. The allocation might be on the basis of wealth, by the use of an auction system. It might be on the basis of merit, as defined by some agreed upon standards. It might be by lottery. Or it might be on a first-come, first-served basis, administered to long queues. These, I think, are all objectionable. But we must choose—or acquiesce in the destruction of the commons that we call our National Parks." Rather than focus on Hardin's many ideas, it is important to understand his point—the need for us to choose from options that are unlikely to be supported by all of their own free will.

In the article, Hardin introduces the idea of "mutual coercion," whereby social arrangements or mechanisms coerce all participants to behave in a way that helps the common good. Given that participants will not tend to the commons of their own free will, mutual coercion mechanisms that apply to all participants can encourage the appropriate behavior. Mutual coercion can be attempted through a command-and-control approach or market mechanisms. We introduce these approaches in this section but discuss them in greater detail in Section 17.6. As with Hardin's suggestions for the national parks, both command-and-control and market mechanisms have some aspects that are "objectionable." Despite the absence of a perfect solution, it is important to make a choice. Otherwise the environmental commons will continue to degrade.

[4]Andrew C. Revkin, "Poor Nations to Bear Brunt as World Warms." *New York Times*, April 1, 2007.

In a command-and-control approach, the government or regulators set standards that everybody must adhere to. An example is carbon monoxide emission standards set by the United States for new automobiles. Another example is the Waste Electrical and Electronic Equipment (WEEE) Directive from the European Union that is geared at proper recycling and landfill avoidance in the electrical and electronics industry. A third example is the use of higher fuel efficiency standards for the automobile industry. These standards increase the required fuel efficiency from about 29 miles per gallon in 2012 to 54.5 miles per gallon in 2025. The challenge with command-and-control approaches is that they tend to be inflexible and are not always cost effective. An example is the Environmental Protection Agency proposal to require carbon capture technologies at new coal-fired power plants. Besides increasing overall electricity costs, there is fear that this proposal is unlikely to be effective because of the high cost of carbon capture technology. The high cost of the mandate may push power plant operators away from coal-fired plants, which may slow down research in carbon capture and hurt future improvements in the area. Rather than improve performance in carbon capture, such a mandate may slow down future innovation in this space.

We give a couple of examples of market mechanisms that have been debated (but not yet implemented nationally in the United States as of October 2014) in the context of greenhouse gases, a problem that is only getting worse as supply chains become more global. Currently, there is no "charge" for emitting greenhouse gases and no explicit limits that are strictly enforced. The commons here is the environment, and the lack of any "mutual coercion" leads to excessive emission of greenhouse gases into the atmosphere. The hope is to set mechanisms in place that can sustainably address the problem.

One mechanism, referred to as *cap-and-trade*, constrains the aggregate emissions by creating a limited number of tradable emission allowances that emission sources must secure and surrender in proportion to their emissions. Any failure to surrender the appropriate number of allowances leads to a significant fine. The mechanism starts with the government creating a limited number of total allowances that are distributed among all players in the economy. If players generate fewer emissions than the allowances they own, they can sell their surplus allowances to others that may be polluting above their limit and need additional allowances. The "price" of allowances in this mechanism is created by the supply and demand for allowances. Such a mechanism offers companies an incentive to reduce their emissions because they get a financial reward for this improvement by selling their additional allowances to those that cannot (or are unable to) reduce their emissions. The hope with this mechanism is that firms will choose the least expensive way to comply with the emissions limit by either implementing emissions reduction plans or buying allowances on the open market. This mechanism has been implemented by several regions, including the European Union (EU) and the state of California. The experience of the EU points to one of the challenges of implementing cap-and-trade. The Emissions Trading Scheme (ETS) was launched by the EU in 2005 with a distribution of free permits or allowances. Once trading started, the price of these allowances peaked around 30 euro a ton in April 2006 before collapsing to below 5 euro a ton by 2013. The drop in price took away any incentive for firms to make further improvements in emissions. This failure of the market was linked to the distribution of too many free allowances and the setting of caps that were easily reached using the improvements made by firms. California, which started its cap-and-trade program in 2013, distributed a fraction of the permits free and has auctioned off the rest. California has also established a floor on the price of these permits during the auctions. The use of auctions with a floor price to release permits has allowed for a better equilibrium that is less likely to collapse. The EU has also changed its plans and moved from free allocations to auctions as the method for allocating allowances. The Acid Rain Program is another market-based initiative by the U.S. Environmental Protection Agency that has had success in reducing overall levels of sulfur dioxide and nitrogen oxides in the atmosphere.

A second mechanism to control emissions is an emission tax. Each entity generating greenhouse gases is charged a tax proportional to the size of the emissions. This is similar in

principle to the congestion-based toll we discussed to manage traffic congestion (see Chapter 14). A charge for emissions encourages companies to reduce their emissions using all ideas whose marginal cost is less than the charge. As a result of an emission tax, the total amount of greenhouse gases produced will decrease. These taxes are often implemented on fossil fuels related to carbon content. For example, India introduced a nationwide carbon tax of 50 rupees per metric ton of coal both produced and imported into India.[5] Similarly, Japan has introduced a tax on oil, natural gas, and coal that is expected to cost utilities about 80 billion yen annually from 2016.[6] One problem with a carbon tax, though, is that it tends to be regressive and hurt low-income groups to a greater extent.

We discuss the pros and cons of cap-and-trade versus a carbon tax in greater detail in Section 17.6. There is still considerable debate among experts about the relative merits of the two approaches. Unfortunately, this debate has slowed the implementation of either approach across the globe. The challenge of tending the environmental commons is magnified because the state of the environment is affected by every region of the world. To be effective, mutual coercion must have the same global reach as the environment. Solutions are unlikely to be effective unless there is global coordination in the implementation of any mutual coercion mechanisms. The need for coordination is evident even in the experience of the EU with cap-and-trade. After starting with national caps that created problems, the EU had to shift to EU-wide caps. There is concern that the introduction of cap-and-trade in California may result in some firms moving out of the state. In the absence of global coordination, it will be difficult to get market mechanisms to be very effective in controlling emissions. The need for global coordination is particularly important given that although most of the existing emissions have come from the developed world, an increasing share of future emissions is likely to come from economies that are still developing. It will not be enough to have solutions that are limited to the developed world.

17.3 KEY PILLARS OF SUSTAINABILITY

Sustainability in a supply chain can be viewed along three pillars—social, environmental, and economic. Major global corporations such as Walmart and Starbucks report their economic performance in their annual reports and their social and environmental performance in their global responsibility reports (also called corporate social responsibility reports). As we mentioned earlier, many actions taken in a supply chain can improve performance in all three dimensions. For example, the use of modular design by IKEA allows the company to tightly pack its parts when they are shipped from the production location to its retail stores. Modular design allows the company to simultaneously reduce emissions as well as its transportation costs. SC Johnson, a manufacturer of cleaning supplies and other consumer goods, has reported that between 1990 and 1999 the company used its eco-efficiency efforts to cut more than 420 million pounds of waste and save $125 million. The majority of sustainability-related efforts, however, have a cost that the supply chain incurs for a benefit that may be more universal. In such situations, measuring performance along all three pillars is required to evaluate the impact of sustainability-related efforts in the supply chain.

Two fundamental challenges exist in a supply chain in the measurement and reporting of the social and environmental pillars. The first challenge relates to the scope over which a category is measured. Consider a company that reports only energy consumption within its own operations. If it decides to outsource some production to an offshore supplier, its own energy consumption will show a decline even though the energy consumption in the entire supply chain may have increased. If it decides to bring some production in-house and onshore, the energy consumption within its operations will show an increase even if the energy consumption for the

[5]Krittivas Mukherjee, "India Eyes Millions in Green Funds from Coal Tax," Reuters, February 26, 2010.
[6]Risa Maeda, "Japan's New Carbon Tax to Cost Utilities $1 Billion Annually," Reuters, October 10, 2012.

entire supply chain has decreased. Thus, it is important to clearly define the scope across which all metrics are measured and reported. In the context of greenhouse gas emission, the Greenhouse Gas Protocol (GHG Protocol) initiative[7] defines three scope levels. Scope 1 refers to emissions from GHG sources that are owned or controlled by the reporting entity, also referred to as *direct emissions*. Scope 2 refers to the inclusion of indirect emissions from grid-sourced electricity and other utility services, including heat, steam, and cooling. Scope 3 refers to the inclusion of other indirect emissions coming from the production of purchased materials, outsourced activities, contractor-owned vehicles, waste disposal, and employee business travel. For most firms, the extent of direct emissions is typically only a small fraction of the extent of indirect emissions in the supply chain. For example, a detailed analysis by the pharmaceutical company Abbott indicated that its indirect emissions were about 6 to 14 times its direct emissions. For a typical retailer, only about 7 percent of the environmental impact is direct, with the remaining 93 percent coming from other parts of the supply chain. It is thus crucial to measure the social, environmental, and economic impacts across the entire supply chain.

The second challenge in measurement and reporting relates to the use of absolute or relative measures of performance. An absolute measure reports the total amount of energy consumption, whereas a relative measure may report the energy consumed per unit of output. The advantage of using an absolute measure is that it reports the full impact of the supply chain (assuming we use scope 3) along the category being measured. The disadvantage is that a drop in supply chain sales and production will show a lower absolute measure of energy consumption even though the company may not have improved anything. This was the case in Europe around 2012, when the economic slowdown resulted in lower emissions even when firms had made no improvements. A relative measure of performance, such as emissions per ton of output, is more effective at capturing improvement. The challenge with using a relative measure is the choice of basic unit because each category can be measured relative to a variety of units, such as dollars of sales, kilograms of output, or square feet of space. In general, it is better for firms to measure and report both absolute and relative measures to get a true picture of their performance.

Next, we elaborate on different dimensions of the social and environmental pillars using Walmart and Starbucks as examples.

Social Pillar

The social pillar measures a firm's ability to address issues that are important for its workforce, customers, and society. Workforce-related factors include employment quality, health and safety, training and development, and diversity and opportunity. Customer-related factors include accurate product information and labeling, along with the impact of the product on the customer's health and safety. Social issues include human rights and the impact on local communities.

In their global responsibility reports, both Walmart and Starbucks report on each of these social factors. Walmart and Starbucks source significant amounts of product from third parties all over the world. Thus, their performance with regards to workforce must include their suppliers. Walmart has focused on issues related to worker safety, women's empowerment, and anti-human trafficking at its suppliers. It has created "Standards for Suppliers" that require suppliers to eliminate forced or child labor, offer wages and labor hours consistent with local law, and look after the health and safety of workers. When third parties are involved, it is not enough to set standards; the company must perform credible audits to ensure that the standards are being followed. Walmart claims to audit each facility every 6 to 24 months. Some audits are performed by the company, but most audits are performed through third-party organizations. The company claims that it performed 11,568 audits in 2012 and that "our suppliers were required to cease production in 214 factories due to serious violations."[8] Similarly, Starbucks claims to have

[7]Accessed May 2, 2011, from www.ghgprotocol.org
[8]Walmart Global Responsibility Report 2013.

sourced 95 percent of its coffee in 2013 "through C.A.F.E. practices, Fairtrade or another externally audited system."[9] Besides standards and audits, it is important for large firms such as Walmart and Starbucks to provide support to their (often much smaller) suppliers in emerging economies as they move on their journey toward greater sustainability. Simply setting standards followed by audits may not suffice if suppliers do not have the capability to make changes on their own. A 2013 study by the Global Supply Chain Management Forum at Stanford University found that "supplier collaboration and capability building" seem to be "strongly associated with social and environmental responsibility performance improvement and lower operating costs."

The cost of audits and capability building at suppliers are often borne by a firm, whereas the benefits from supplier improvement accrue to all that use the supplier. As discussed in the tragedy of the commons, large firms do not spend sufficient effort on audits and capability building at suppliers because of the absence of effective mechanisms for "mutual coercion." This can be a challenge even with the best of intentions. For example, Western retailers and apparel brands reacted to public outrage resulting from the collapse of the Rana Plaza factory near Dhaka, Bangladesh, in 2013 by starting a major push to improve building safety. Instead of coordinating this effort, however, they formed two distinct groups. One group—the Bangladesh Accord for Fire and Building Safety—included many European brands, such as H&M, Carrefour, and Mango, whereas the other group—the Alliance for Bangladesh Worker Safety—included 26 companies from Canada and the United States. The two groups often clashed, detracting from the overall effort. "Some members of the American-dominated alliance said that their side had performed more inspections than the European-dominated accord, while some accord members asserted that the alliance's inspections were less rigorous."[10] Clearly, the absence of coordinated action hurt outcomes in Bangladesh even though the companies involved may have had the best of intentions.

Environmental Pillar

The environmental pillar measures a firm's impact on the environment, including air, land, water, and ecosystems. Firm activities that improve the environmental pillar can be categorized as resource reduction, emission reduction, and product innovation. Resource reduction activities result in a more efficient use of natural resources in the supply chain. Starbucks' ability to reduce water consumption in company-operated stores by 21 percent between 2008 and 2013 is an example of resource reduction. Emission reduction activities reduce hazardous air emissions (e.g., greenhouse gases), waste, water discharges, or the environmental impact of the company in the community. Walmart's ability to reduce greenhouse gas emissions in its 2005 adjusted base of stores by more than 20 percent is an example of emission reduction. Product innovation reflects a company's ability to reduce the environmental costs and burden for its customers through the development of eco-efficient products or services. The high-efficiency toilet, for example, is a product innovation that allows users to significantly reduce their water discharge.

Resources used by firms include materials, energy, water, and land. Starbucks has reduced water consumption at its North American stores from 24.35 gallons per square foot/month/store in 2008 to 19.22 gallons in 2013 through the use of efficient fixtures and equipment, along with active monitoring of consumption. To reduce its energy consumption, Walmart has focused on its HVAC, refrigeration, and lighting. The installation of LED freezer case lighting by the company followed by the rollout of LED sales floor lighting has allowed the company to reduce energy consumption at its stores. According to its 2013 Global Responsibility Report, Walmart reduced fuel consumption in 2012 and "delivered 297 million more cases while driving 11 million fewer miles." Resource reduction activities not only help the environment, but they also save money for a company. For example, Walmart claimed that the improved fuel and delivery efficiency of its fleet "saved the company and our customers almost $130 million."

[9]Starbucks Global Responsibility Report 2013.
[10]Steven Greenhouse and Elizabeth A. Harris, "Battling for a Safer Bangladesh,"*New York Times*, April 21, 2014.

Emissions from a firm that may harm the environment include greenhouses gases, carbon dioxide, ozone-depleting substances, nitrogen and sulfur oxides, waste, and water discharges. Given that about 80 percent of Starbucks' direct greenhouse gas emissions come from the energy used to power its stores and facilities, the company has focused on building new company-operated stores to the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) certification standards. In 2012 and 2013, about 65 percent of the new stores built were LEED certified. Single-use shopping bags are a significant source of waste; retailers have made a concerted effort to get customers to start using multi-use bags. This effort has been fairly successful in most parts of the world where it has been implemented. Walmart claimed to have reduced its plastic shopping bag waste per store by more than 38 percent between 2007 and 2013. Emission reduction activities can be more challenging to implement because they often require upfront investment and changes in behavior from employees and customers.

Although there are several examples of environmentally friendly product innovation, this is also an area in which most claims should be skeptically viewed. According to a study led by marketing consultancy TerraChoice, "more than 98 percent of supposedly natural and environmentally friendly products on U.S. supermarket shelves are making potentially false or misleading claims, and 22 percent of products are making green claims that have no inherent meaning."[11] The term *greenwashing* is often used to refer to products and practices that seem green but fundamentally aim to grow profits.

The Institute for Local Self-Reliance (ILSR) has questioned whether Walmart's claims with regard to environmental responsibility are entirely justified. It points to the fact that Walmart's demands for lower prices from its suppliers has driven down the quality and durability of consumer goods. This has sped up the "flow of goods from factory to landfill, vastly expanding the amount of stuff Americans buy and discard."[12] It also notes that Americans "throw away an average of 83 pounds of textiles per person, mostly discarded apparel, each year." The issues cited by ILSR have some validity and point to the difficulty of assessing claims on environmental responsibility. Should Walmart be held responsible for the things customers throw away? Or should customers bear the responsibility of wanting cheaper products, which may be less durable? It also points to the importance of expanding the scope of analysis to the entire supply chain, from the customer to the last supplier, when evaluating the environmental impact of an action.

When starting on its sustainability improvement journey, it is best for a firm to first focus on resource reduction activities. Whether reducing packaging material, energy use, or transportation, resource reduction activities are most likely to provide a win–win outcome that helps the environment while improving profits. Such successes can provide the momentum for more challenging sustainability activities. The push for resource reduction is likely to be aided by the increase in fuel and shipping costs. As shipping costs grow, supply chain networks are likely to become somewhat more regional, helping reduce emissions from transportation. In the long run, however, the biggest benefits to society are likely to accrue when firms include the social and environmental pillars when making their sourcing decisions. The biggest challenge to social and environmental improvements is likely to be the fact that most of the effort is local to a firm (and maybe its supply chain), whereas the benefits are more widely distributed. The tragedy of the commons and the difficulty of measuring change across the entire scope of the supply chain are likely to make real progress slow while companies continue to claim large improvements related to sustainability.

17.4 SUSTAINABILITY AND SUPPLY CHAIN DRIVERS

Opportunities for improving supply chain sustainability can be identified by matching the social (workforce, customer, society) and environmental (resource reduction, emission reduction, product innovation) pillars we have described with the various supply chain drivers discussed in this

[11]Erica Orange, "From Eco-Friendly to Eco-Intelligent," *The Futurist*, September–October 2010.
[12]"Top Ten Ways Walmart Fails on Sustainability," Institute for Local Self-Reliance, April 2012.

text. The goal is for every firm to measure its environmental impact for each driver along each of the social and environmental categories. In this section, we discuss some of the opportunities available for each driver and provide some examples.

Facilities

Facilities tend to be significant consumers of energy and water and emitters of waste and greenhouse gases and thus offer significant opportunities for profitable improvement. Once a firm measures the direct impact of each facility in terms of energy, water, emissions, and waste, it should separate the improvement opportunities into those that generate positive cash flows and those that do not. Successful companies start by identifying and implementing the profitable projects first. According to its 2011 Corporate Social Responsibility (CSR) report, Walmart has designed and opened a viable store prototype that is up to 25 to 30 percent more energy efficient and produces up to 30 percent fewer greenhouse gas emissions compared with the 2005 baseline. Using more energy-efficient light bulbs and building skylights for natural light has cut energy consumption at its existing stores. Walmart has also worked to convert waste management at its stores from a cost to a profit generator. The company reported that in 2011 it prevented more than 80 percent of waste generated by its stores and distribution centers from going to landfills. Most of this success came from "working with vendors to eliminate materials from becoming part of the waste or recycling stream in the first place."

Another example of profitable improvement comes from using technology to balance the peak load for energy across a chain of convenience stores. By suitably staggering the time that air conditioners and freezers at its stores are turned on, the chain can reduce the peak demand for energy across the store network, resulting in lower costs for the chain and a reduced demand for peak load in the grid. Several companies are designing the hardware and software necessary to operate such systems. Efforts to reduce peak load are likely to be most successful when utilities include a peak charge, thus rewarding customers that reduce peak consumption.

Production facilities often have significant opportunity to reuse heat energy generated and reduce water usage during the process. Coca-Cola has worked hard to reuse heat energy from boilers in its production process and reduce its total water footprint. Lee (2010) gives the example of Posco, which worked with its equipment supplier, Siemens VAI, to create a new production process that cut costs and emissions without hurting product quality by using local iron ore that was of lower quality but less expensive. As a result, Posco reduced the cost of a new mill by 6 percent to 17 percent and decreased its operating costs by 15 percent while producing lower levels of greenhouse gases and other waste. As these examples illustrate, facilities often offer the best opportunity to simultaneously improve the environmental and financial performances through innovation.

Inventory

Most supply chains focus on raw materials, work in process, and finished goods inventory, as we have done in this text. Although this form of inventory is viewed as an asset and included in the financials, few firms even consider the inventory sitting in a typical landfill. When a firm's product is discarded in a landfill after use, the cost of this inventory is borne collectively by society. Even though the inventory in the landfill may not show up in a firm's balance sheet, it does show up as one of the most damaging aspects from a sustainability perspective. The damage may be in the form of harmful additives or in the form of valuable energy and materials that are still locked in the landfill. Arguably, the most significant waste in any supply chain occurs when a product is thrown into a landfill because both materials and energy used to produce the product are now lost forever, potentially doing harm. The goal of every supply chain should be to track its landfill inventory and separate it in terms of harmful additives and unused value. Life-cycle assessment can be used to assess the environmental impacts associated with a product's life from cradle to grave. The goal should be to reduce (or at least limit) the harmful inventory and unlock the

unused value in products when they are discarded. In Section 17.5, we discuss the challenges of designing closed-loop supply chains that reduce landfill inventory through effective recycling or remanufacturing.

McDonough and Braungart (2002) discuss the importance of "cradle to cradle" design if we are to truly limit the landfill inventory generated by a supply chain. They suggest designing products "that, when their useful life is over, do not become useless waste but can be tossed onto the ground to decompose and become food for plants and animals and nutrients for soil; or, alternately, they can return to industrial cycles to supply high quality raw materials for new products." For example, Cyberpac, a British company, has developed several products that seek to replace plastic packaging with compostable equivalents using starch-based resources and hydro-degradable plastic. The Bioplastics Feedstock Alliance, formed by several companies and the World Wildlife Fund, encourages the development of plastics from plant matter.

Transportation

Transportation is another driver with which firms are likely to find several positive cash flow opportunities that improve environmental performance through resource as well as emission reduction. Any supply chain design innovation that lowers transportation costs also tends to reduce fuel consumption, as well as emissions and waste generated from transportation. As fuel costs increase in the future, firms are likely to restructure their products and supply chains to reduce transportation costs. Along with a decrease in transportation costs, these changes (such as near-shoring or onshoring) are also likely to decrease fuel use and emissions. In its 2011 CSR report, Walmart reported that in the United States, it decreased the amount of fuel used to deliver a case of product by 65 percent between 2005 and 2010. This improvement—through increased aggregation, a more efficient loading of transportation vehicles, and an increase in their fuel efficiency—cuts both costs and environmental damage. Lee (2010) cites four companies—Hewlett-Packard, Electrolux, Sony, and Braun—that have formed a joint venture, the European Recycling Platform, to gain better economies of scale in their recycling efforts. Lee reports that HP's cost of recycling digital cameras is only 1 or 2 euro cents in countries with the environmental platform, compared with 7 euro cents to 1.24 euros in countries without the platform. Ocean Spray and Tropicana, with presence in Massachusetts and Florida, respectively, have collaborated to take advantage of empty delivery trucks to backhaul each other's product along the U.S. East Coast, saving both fuel and money.

Product design can also play a significant role in reducing transportation cost and emissions by reducing packaging and allowing greater density during transportation. IKEA has always worked hard to design products that can be shipped flat to achieve high volume and weight density during transportation. As a result, the company not only lowers its transportation costs, but it also reduces emissions and energy use.

Sourcing

For most firms, the greatest social and environmental impact occurs in the extended supply chain outside their own enterprise. This impact has grown as firms have increased their global sourcing, especially from low-cost countries. Thus, to truly have an impact on sustainability, powerful players must look at the extended supply chain and work with their suppliers to improve performance. As we have mentioned earlier, the C.A.F.E. program at Starbucks encourages suppliers to improve their environmental and social responsibility scores by providing a price premium. Walmart and IKEA have also set aggressive targets for their suppliers to improve overall supply chain sustainability. Failure to work with suppliers on sustainability should also be viewed as a potential source of risk that can cause considerable damage to the reputation and sales of a firm. The presence of lead paint in some of its most popular toys, for instance, forced Mattel to recall hundreds of thousands of toys sold between April and July 2007.[13]

[13]Louise Story, "Lead Paint Prompts Mattel to Recall 967,000 Toys." *New York Times*, August 2, 2007.

Verifying and tracking supplier performance with regard to sustainability, however, continues to be a major challenge for most firms. This challenge arises, at least partially, because of the tragedy of the commons. After all, the benefits from improved social and environmental responsibility at suppliers are shared, whereas the verification and tracking efforts are often concentrated. As a result, firms rarely put in as much effort in this regard as they should. It often requires outside activists and third parties focused on social and environmental improvement to push a company to change. The journey of Nike is a classic example. It took revelations by activist Jeff Ballinger, protests at the Barcelona Olympics, and protests by students on college campuses to end the use of sweatshops by the company. The company has since moved on to become a leader in social responsibility. Given the challenge of the tragedy of the commons, activists will always have a significant role to play in pushing firms to consider the social and environmental pillars when making sourcing decisions.

Information

Good information continues to be one of the biggest challenges to improved supply chain sustainability. The absence of standards for measurement and reporting has led to claims of improvement that are often not verifiable. In the short term, this has led to company-specific standards and an explosion of certifications and certifying agencies. Companies talk of working toward a common set of standards, but it is unlikely that such standards will emerge because incentives are not aligned across different firms. This poses a challenge both within firms and across supply chains when it comes to improving sustainability. The C.A.F.E. standards and supplier rating are an effort by Starbucks to encourage suppliers to focus on sustainability. Plambeck (2007) describes efforts within Walmart to measure and motivate both suppliers and associates. To reduce packaging, Walmart implemented a web-based scorecard that evaluated the packaging of each product along nine metrics, such as cube utilization and recycled content. This scorecard was used to measure and recognize improvements in packaging. Even though universal standards may not be possible, the use of consistent scorecards within a supply chain can go a long way toward aligning the sustainability efforts of all members of the extended supply chain.

Pricing

As discussed in Chapter 16, intelligent use of differential pricing can improve the utilization of assets, leading to resource reduction. Planes that are fuller through differential pricing improve airline profits while reducing the fuel consumption and emissions per passenger. This also delays the need for additional capacity in the form of new planes. Consumption visibility and differential pricing by load or time of day have the potential to make a significant difference in the usage of energy by consumers. Some studies have found that when people can see how much electricity they are using and the impact of turning off different appliances, their usage decreases by between 10 to 15 percent. If this visibility is simultaneously coupled with lower-price off-peak electricity, there is a potential to reduce peak load demand. In general, lower peaks and improved utilization of assets through differential pricing improves both the environmental and economic performance of a firm.

One of the biggest challenges to improved sustainability of a supply chain is changing the customer's willingness to pay for a product that is produced and distributed by a supply chain in a more sustainable manner but ends up costing more. According to a 2011 survey conducted by the market research firm Mintel for the food service industry, customers are willing to pay a mere 1 to 5 percent more for sustainable fare. The lack of willingness to pay also extends to corporations when making supply chain choices. For example, Walmart has not hit its targets for the use of renewable energy because these sources have higher costs compared with other sources of energy. Walmart's use of renewable energy in 2013 declined relative to 2012 because it was "unable to renegotiate an expiring contract with competitive pricing." Similarly, Starbucks classified its use of renewable energy as an area that "needs improvement" in its 2013 global responsibility report.

In the short term, government incentives can encourage customers and firms to behave more sustainably. In the long term, however, efforts toward increased sustainability will pick up speed only when customers place greater value on it, allowing supply chains to grow the supply chain surplus by being sustainable (despite higher costs).

17.5 CLOSED-LOOP SUPPLY CHAINS

As we discussed earlier, supply chains typically cause significant harm to the environment when their output ends up in a landfill. One of the biggest opportunities to improve sustainability is for firms to design products that use fewer resources and can be recycled and remanufactured after use. An example of a commonly remanufactured product is retreaded tires. Retreaded tires are used in trucks, buses, heavy construction and agricultural equipment, aircraft, and passenger vehicles. Retreaded tires are cheaper to produce and tires can be retreaded multiple times. Despite these advantages, retreaded tires accounted for only "about 3 percent of total sales by U.S. firms within the tires sector" between 2009 and 2011.[14] In 2011, production at U.S. tire retreaders was limited by the availability of used tire casings. The example of tires raises two important questions that arise in every industry: Why do we not see more instances of remanufacturing? What can be done to increase the return of used product (like tire casings)? The extent of recycling or remanufacturing depends on the following factors:

- The incentive to recycle or remanufacture
- The cost to recycle or remanufacture

Unless they are forced to, manufacturers have typically limited their efforts to design recyclable/remanufacturable products. Even when such products have been designed, recycling rates have often been low because of the lack of customer and manufacturer effort. The absence of successful recycling and remanufacturing can be explained by the tragedy of the commons, manufacturer concerns that remanufactured products may cannibalize demand from new products, and the lack of effort from customers to return used product. The cost of a product ending up in a landfill is borne by society (until recently, it has been free for manufacturers), whereas the additional cost of recyclable products is borne by each manufacturer. This decreases any incentive for manufacturers to make this effort. Calcott and Walls (2000) discuss theoretical models for the design of incentives to encourage design of products that are environmentally friendly. To encourage the appropriate behavior in supply chains, it is important that the polluter pays the cost inflicted on society (referred to as the *polluter pays principle*). Policies that are consistent with this idea include take-back mandates, advance disposal fees, and deposit–refund programs. The WEEE Directive is an example of a take-back mandate in which producers bear responsibility for end-of-life electrical and electronic waste in Europe. Producers bear both the financial and physical responsibility for meeting recycling or recovery targets. Advance disposal fees have been used for materials such as motor oil, antifreeze, tires, and solvents that are hard to dispose of. California charges an electronic waste recycling fee for any product sold with a screen. Deposit–refund programs are used for cans and bottles when customers pay a fixed deposit when they purchase soda or beer. A refund is then provided when customers bring back empty cans or bottles. In each example cited here, the goal is to put a cost in place that encourages reduction of waste and a positive incentive that encourages increased recycling.

The fear of cannibalization of demand for new products is a major deterrent to remanufacturing. Manufacturers are concerned that sales of the remanufactured product will reduce demand for new products, thus hurting firm profitability. The impact of cannibalization depends on the presence of distinct customer segments for the product. If there are at least two distinct customer segments, remanufacturing can be used to target the lower-price segment while new products

[14]U.S. International Trade Commission, "Remanufactured Goods: An Overview of the U.S. and Global Industries, Markets, and Trade," October 2012.

target the higher-price segment (see Chapter 16). This strategy is used by tire manufacturers for truck tires, as remanufacturing allows strong brands to compete with lower-end brands without diluting the value of the new product. When there are two distinct segments, remanufacturing can help rather than hurt profits. However, when this distinction between segments is not feasible, customers are likely to be strategic and purchase the remanufactured product at a lower price, leading to cannibalization of demand for new products.

If a customer could be charged for pollution based on the precise cost to society, customers are likely to return recyclable products at a high rate. The challenge, however, is that most people pay a fixed monthly fee for collection, hauling, and dumping of trash. In such a setting, people have a lower incentive to recycle. A "pay as you throw" (PAYT) model, in which the cost incurred is proportional to the amount of garbage thrown out, is likely to increase recycling. Most communities with PAYT require customers to use specific garbage bags, for which they are charged. This approach links people's spending on garbage to the number of bags they use, thus rewarding them for recycling a product rather than dumping it with the garbage.

Even when the right incentives are in place, the actual cost of recycling or remanufacturing has a significant impact on the extent of recycling. Much of the cost in such instances is linked to the logistics cost of collection and transportation. Consumer electronics are a classic example for which the high cost of collection and transportation hurts recycling and remanufacturing. Most of the consumer electronics are manufactured in Asia, with large consumer markets in Europe and North America. Not only is it expensive to recover used electronics from customers, but it is also very expensive to ship any recycled parts back to Asia for remanufacturing. This makes the cost high enough that remanufactured products are often not cheaper to produce than new ones. One company that is working to reduce the cost of remanufacturing smartphones is Brightstar, one of the biggest providers of refurbishing services for the telecom sector. As smartphone hardware becomes more standardized and subject to less change (with most of the change shifting to software), Brightstar, with local refurbishing centers in North America, is hoping to provide low-cost refurbished handsets. The use of standardized parts that make the remanufacturing process cheap, along with local presence that lowers transportation cost, increase the likelihood of successful remanufacturing in this space.

Single-use cameras were one of the most successful examples of a closed-loop supply chain with remanufacturing. This was an instance in which remanufacturing was successful because all the incentives were right and the costs were low. The cost of collection was low because customers naturally brought their single-use cameras to a retailer for printing pictures. No further incentives were needed to encourage customer returns. Manufacturers had the right incentive because remanufacturing saved the manufacturers money and there was no difference in price between a remanufactured camera and a new one. There are few other examples, however, with the same success. The right incentives for both manufacturers and customers, along with well-developed reverse supply chains, will be required for greater use of recycling and remanufacturing.

17.6 THE PRICING OF SUSTAINABILITY

For individuals and firms to focus on sustainability, it is crucial that they internalize the "monetary value" of the social or environmental cost of their actions. Firms are structured to naturally account for all factors that they have to pay for. Every effort is put into place to reduce these costs. For example, firms optimize the use of water based on its cost. This cost does not, however, include the impact of a water shortage on the firm as well as the surrounding community. As a result, firms use more water than they would if they had to internalize the cost of future shortages on society. Similar inefficiencies exist along a variety of social and environmental factors. To improve sustainability in the supply chain, it is thus important to incorporate suitable prices for the social and environmental impacts of different actions such as emissions. There are, however, significant challenges to setting these prices appropriately. We discuss some of these challenges in the context of emission pricing.

Pricing of Emissions

Decision makers all over the world have devoted significant attention to reducing GHG emissions. As discussed in the tragedy of the commons, firms will not put sufficient effort into reducing GHGs unless they are "forced" to reduce emissions or required to pay for the social cost of their emission. The policies proposed include technology mandates, performance standards, and emissions pricing. The theoretical attraction of emissions pricing is that it has the potential to achieve emissions reduction at lower cost than other approaches. A study by the OECD found that charging for emissions was more cost effective than subsidies or mandates in reducing carbon dioxide emissions.[15] Even though there is general agreement on the need for emissions pricing, finding the right price is challenging.

Two approaches used to price emissions are a carbon tax and a cap-and-trade system. By charging for emissions, both methods encourage firms to reduce emissions per unit of output. The prices in the two cases, however, are set differently. Under a carbon tax, the price of emissions is the tax rate set directly by the regulatory authority. A carbon tax fixes the price of emissions, but the quantity of emissions is decided by the emitters. Under a cap-and-trade system, the total quantity of emissions is set by the regulatory authority and the price is set indirectly. The regulatory authority sets an overall limit on the quantity of emissions by providing allowances equal to this limit. Firms that emit less than their share of allowances can sell the surplus allowances to firms that emit more than their share. This market for allowances then yields a price of emissions. A cap-and-trade system fixes the quantity of emissions through the allowances but the price of emissions is allowed to change. A seminal paper discussing the relative merits of setting prices versus quantities was written by Martin Weitzman in 1974. The difficulty in both approaches arises because regulators do not have sufficient information of the cost to individual firms of reducing emissions or the cost to society of emissions. In the carbon tax approach, this lack of information makes it difficult to set the correct tax. Setting a tax that is too low results in insufficient effort by firms to reduce emissions. In contrast, setting a tax that is too high forces firms to make emission reduction efforts that are too expensive. In the cap-and-trade approach, the lack of information makes it difficult to decide the quota of emission allowances. Too large a quota results in too low a price of emissions, whereas too small a quota results in too high a price.

Goulder and Schein (2013) provide an excellent review of both a carbon tax and cap-and-trade. Rather than a pure cap-and-trade mechanism, in which the market sets prices under all circumstances, they recommend a hybrid version of the cap-and-trade, in which the traded allowances have a floor price as well as a ceiling. The ceiling is enforced by adding extra allowances when the ceiling price is hit (the regulatory authority sells unlimited allowances at the ceiling price), whereas the floor is enforced by removing allowances (the regulatory authority purchases any number of allowances available for sale at the floor price). A major advantage of the hybrid cap-and-trade relative to a pure cap-and-trade is that it limits the volatility in the price of emissions allowing businesses to better plan their environmental activities. Goulder and Schein discuss the following dimensions along which any emissions pricing mechanism should be evaluated:

- ***Cost of administration:*** The cost of administering an emissions pricing policy depends on the number of sources that need to be monitored. Charging the ultimate emitters can be very cumbersome, given the millions of such entities. It can be cheaper to charge the upstream suppliers (such as energy supply companies) whose products end up as emissions because there are fewer of them (compared with the ultimate emitters). Both carbon taxes and cap-and-trade can potentially be applied to upstream suppliers.
- ***Price volatility:*** Businesses tend to prefer low price volatility because it allows them to better plan their sustainability activities. A carbon tax fixes the price of emissions, whereas a cap-and-trade system displays price volatility. A hybrid cap-and-trade system limits price

[15]"Climate and Carbon: Aligning Prices and Policies," OECD Environment Policy Paper No. 1, October 2013.

volatility, given a floor and ceiling price. Price volatility in a cap-and-trade system can be reduced by allowing intertemporal banking, in which firms can apply future allowances to current emissions or save current allowances for future emissions.

- ***Emission uncertainty:*** A cap-and-trade system caps the emissions (except when the ceiling price is hit), whereas a carbon tax can potentially have high emissions if the cost of reducing emissions is greater than the tax. Some environmental activists have opposed the carbon tax because it does not guarantee a drop in emissions.
- ***New information uncertainty:*** As new information becomes available about the costs and benefits of emission reduction (for example, with the introduction of new technology), the price of emissions should adjust accordingly. A hybrid cap-and-trade mechanism with the possibility of intertemporal banking (for allowances to be saved for the future or borrowed from the future) is better able to adjust the price of emissions based on new information compared with a carbon tax.
- ***Industry competitiveness:*** A country or state that is further along on emission pricing can potentially hurt the competitiveness of its own emission intensive firms relative to firms operating outside its borders. In theory, a tax at the border for imported goods (based on origin) and an allowance for exported goods (based on destination) can level the playing field. In practice, however, such an approach is administratively complex in most instances because it requires different levels of tax based on origin of imports and destination for exports. This complexity makes border adjustments very difficult to implement in practice.
- ***Wealth transfer to energy-exporting countries:*** For a country that imports most of its energy supplies, a cap-and-trade system has the potential to shift wealth to energy-exporting countries. The price on emissions is designed to encourage lower consumption of fuels like crude oil. A cartel of oil-producing countries can potentially take advantage of a cap-and-trade mechanism by reducing supply of crude below the level that would be achieved with a price on emissions. This would lower the price of emissions under cap-and-trade to zero because the demand for allowances would be less than the supply. The oil producers would gain revenue because the reduced supply would raise the price of oil. Instead of the local government gaining revenue from the auction of allowances, the oil producers would extract that revenue in the form of higher oil prices. This transfer of wealth does not occur with a carbon tax and is limited by a hybrid cap-and-trade system. Such an outcome is also limited if the energy supply market is competitive, because supply cannot be constrained in a competitive market.
- ***Revenue neutrality:*** Several studies have indicated that the costs of emission pricing policies are minimized if any government revenue from these policies (in the form of a tax or revenue from auctioning emission allowances) is returned to the consumers in the form of a reduction in the marginal rates of pre-existing income or sales taxes.

There is general agreement that putting an explicit price on emissions is more cost effective than other policy choices in reducing emissions. In this context, carbon taxes are simple to administer and provide a fixed price that businesses can plan for. They do not, however, guarantee a decrease in emissions and it is difficult for the regulatory authority to determine the optimal tax rate. Cap-and-trade mechanisms can be used to limit emissions and are flexible enough to incorporate new information as it becomes available but may display significant price volatility. To limit price volatility, it is best to implement cap-and-trade with a price floor as well as ceiling and allow intertemporal banking of emission allowances.

17.7 SUMMARY OF LEARNING OBJECTIVES

1. ***Understand the importance of sustainability in a supply chain.*** As supply chains have globalized and emerging countries have grown, it has become increasingly clear that the world's resources and environment will not be able to support this growth unless supply chains

become more sustainable. Besides the need to make the world more sustainable, an increased focus on sustainability has allowed some supply chains to reduce risk, become more efficient, and attract some customers who value these efforts.

2. ***Discuss the challenge to sustainability posed by the tragedy of the commons.*** Many actions that improve sustainability of a supply chain impose costs that are local (to an individual, a firm, supply chain, or country) but provide common benefits that are more global. In contrast, a disregard for sustainability provides benefits that are local but costs that are shared globally. As a result, encouraging sustainability without some external pressure, in the form of either a public mandate or an economic incentive, can be difficult.

3. ***Describe key dimensions of sustainability for a supply chain.*** Supply chain sustainability can be evaluated in terms of social, environmental, and economic impacts. The social pillar includes the impact on the workforce, customers, and society. The environmental pillar includes resource reduction, emission reduction, and environmental product innovation.

4. ***Understand the role of incentives for successful sustainability efforts.*** The tragedy of the commons makes it difficult to improve sustainability efforts by firms and individuals without some external pressure. To decrease resource consumption and increase recycling and remanufacturing, a suitable approach is to tax the producer to encourage resource reduction and reward the recycler to increase the percentage recycled. A price on emissions is the most cost-effective way of reducing emissions. Emissions can be priced through either a carbon tax or a hybrid cap-and-trade mechanism.

Discussion Questions

1. What are some benefits to improved sustainability of a supply chain?
2. What are some challenges that limit the effort put in by supply chains to improve sustainability?
3. Describe the "tragedy of the commons" in the context of supply chain sustainability. What are some "mutually coercive" mechanisms that could be implemented to encourage supply chain sustainability?
4. What are some problems with firms reporting their sustainability performance based on metrics that do not consider their extended supply chain?
5. Study the CSR reports for a couple of firms. Identify actions across a few supply chain drivers that have improved sustainability. Which areas has the company found challenging to improve?
6. Discuss some reasons that we do not see more recycling or remanufacturing of products.
7. The European Union emission trading scheme saw a lot of price volatility in Phase I. Many academics pointed out that much of the price volatility occurred because the program prevented the banking of allowances from the first phase to the second. Discuss why the banking of allowances over time may reduce price volatility in a cap-and-trade scheme.

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