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RATTLING SUPPLY CHAINS

The Effect of Environmental Trends on Input Costs for the Fast-Moving Consumer Goods Industry

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Executive Summary

In recent years, the world has experienced a remarkable rise in the prices of vital commodities, including energy and agricultural products. For example, between 2006 and 2008, the average world price for oil rose by 110 percent, rice by 217 percent, wheat by 136 percent, maize by 125 percent, and soybeans by 107 percent. The resulting economic impact on firms, households, and entire economies has renewed attention to the scarcity of natural resources and the best way of managing them in the twenty-first century.

The world's natural resources are under pressure, as approximately 60 percent of the benefits provided by natural ecosystems are being degraded or used unsustainably. As much as 20 percent of freshwater use exceeds the long-term sustainable supply, and between 15 and 35 percent of the withdrawal of water for irrigation is unsustainable, raising concerns about agricultural yields and costs. The current patterns of resource consumption are exemplified by the case of oil. North America and Europe consume more than 50 percent of this resource yet account for only 20 percent of the global population. At the same time, the growing populations of developing countries are realizing their desire for a better quality of life, which has led to increased consumption and thus greater demands on finite resources.

As global forces like changing demographics, growing environmental pressures, environmental regulation, and climate change interact to alter the future landscape of markets and industries, business leaders have recognized the need to understand their nature and magnitude. For large companies with global dimensions, this need for understanding is not limited to their direct operations but instead may rest primarily in their supply chains.

To illustrate the financial relevance of environmental issues, the World Resources Institute (WRI) and A.T. Kearney, Inc., collaborated to develop a future scenario of major environmental trends, including the physical impacts on the environment and the public policy response. We then determined the potential implications for a basket of commodity prices for energy and agricultural commodities, as well as the effects of those prices on the earnings of a representative set of companies in the fast-moving consumer goods (FMCG) sector.

Our scenario, which we named Ecoflation, shows a future in which policies and constraints on natural resources force firms to add to the cost of doing business the environmental costs previously borne by society. While this concept will inevitably increase costs in the near term, technological advances, efficiency gains, and reallocation of resources should ultimately lower costs to firms while reducing natural resource–related risks over the longer term.

Based on our scenario of more stringent climate change regulations, enhanced and enforceable forest policies, growing water scarcity in key agricultural regions, informed biofuel policies, and a greater consumer demand for green products, we estimated a reduction of 13 to 31 percent in earnings before interest and taxes (EBIT) by 2013 and 19 to 47 percent in

2018 for FMCG companies that do not develop strategies to mitigate the risks posed by environmental pressures. While we do not claim to be able to predict the future, and indeed our methodology has inherent limitations, our scenario is based on scientific knowledge and a sound understanding of policymaking. We believe that the magnitude of our estimated impact on earnings is not unrealistic for companies that do not act. Please see the accompanying technical document for further information about data sources and underlying assumptions of our methodology.[1]

Even though the earnings at risk for our selected sample are significant, we believe that companies have the ability to independently and collaboratively find solutions and transform their operations to mitigate this risk and also to take advantage of growth opportunities. We suggest the following actions for companies in the FMCG and other industries to address the emerging environmental risks to their supply chains:

- **First, understand environmental impacts and dependencies** by examining how cost drivers are exposed to emerging environmental trends and, when possible, seek substitutes with lower environmental impacts.
- **Take inventory of current environmental initiatives** through the value chain to see what the company, its suppliers, and its partners already are doing.
- **Rank environmental issues and opportunities** according to their current and future potential impact on costs, revenues, and reputation.
- **Chart a new course by embedding sustainability principles into an action plan,** by including externalities in the decision-making process and establishing the principal performance indicators.

Winners will generally be those companies that anticipate the implications of a changing landscape, collaborate with suppliers and other stakeholders, and make environmental sustainability one of their business principles. Hedging strategies or shifting suppliers will not be enough. We believe that in order to adapt to these challenges, companies will need to implement real structural changes, such as product innovation and restructured value chains, which will affect both the companies and millions of existing and new consumers.

Introduction

In 2008, the world's population reached 6.7 billion people and is expected to increase by 800 million within ten years.[2] This growing number of people will exacerbate the already significant pressures on global resources. Even more important, the high rate of resource consumption in North America and Europe is now being matched by Western-style consumption behavior in such large emerging markets as China and India.[3] At the same time, the physical state of the natural environment is being degraded, not least of all because of climate change, thereby raising the global demand for policies and action by the public and private sectors.

These pressures affect firms in an array of industries. Those companies unable to pass along the price increases driven by soaring commodity prices have seen their ability to deliver value to their shareholders hampered. Between 2006 and 2008, the average world price for oil rose by 110 percent, rice by 217 percent, wheat by 136 percent, maize by 125 percent, and soybeans by 107 percent.[4]

Firms face additional pressures. Customers and shareholders alike have become increasingly conscious of the strains being placed on the natural environment and consequently are looking to governments and corporations to develop environmentally sustainable policies and practices. These policies and practices can have financial repercussions, especially in the near term as industry responds to the new cost drivers. Over the long term, however, these measures should reduce risk and costs by either limiting or avoiding constraints on the environment and natural resources.

Although it is easy to see that these pressures are immense, it is difficult to understand what they collectively might mean to a particular company or industrial sector. Accordingly, WRI and A.T. Kearney set out to find out exactly how environmental trends will affect industry. To make our inquiry more tangible and specific, we decided to examine the potential environmental input cost to the fast-moving consumer goods (FMCG) industry, which usually refers to companies producing food, beverages, and various household items.

These environmental trends present an unprecedented challenge for companies to remain profitable by turning to operations that enhance, or at least do not degrade, the environmental resources on which the company depends. This "sustainability challenge" to companies is complex, in the variety of resources at risk, the potential implications to individual stakeholders, and the propagation of those risks and implications through the value chain. This report focuses on environmental trends, including both the physical impacts on the environment and the public policy responses, which are an important and strategic element of this larger sustainability challenge.

Using a hypothetical yet plausible scenario, our report shows the possible implications of and costs arising from environmental trends that are part of the sustainability challenge for

a particular group of stakeholders. By providing a reference case and an environmental scenario for the next five to ten years and outlining its implications for the costs of critical inputs, we offer a perspective on the impact to the profit margin of a set of industry actors. Our research is based on scientific knowledge, but we did not use our own economic model to derive our findings. The results are intended to enhance readers' understanding of the potential implications of environmental scarcity and environmental policies, both ongoing and future, for the cost of doing business. We view this report as an opportunity to contribute to this dynamic and evolving dialogue.

Study Methodology

This report is a pilot analysis: the methodology can be regularly updated, and the approach can be expanded and adapted to include other environmental issues, industries, and value chains.

To determine how environmental trends affect supply chains, we first selected a specific sector to examine. For this initial pilot analysis, we chose the fast-moving consumer goods (FMCG) industry for several reasons. It is a $1 trillion global industry that produces food, beverages, personal care items, and household care items.[5] Although the FMCG industry is not always in the headlines in regard to environmental or social issues, many of the commodities that serve as cost drivers for the industry are highly susceptible to changes in sustainability trends because they are tied to natural resources at risk from environmental pressures. The industry also is dependent on consumer values and shifting consumer behavior at a time when awareness of environmental issues is increasing. We also selected the FMCG industry because its products are an integral part of our day-to-day lives, and therefore the impacts on the firms' cost structures and the corresponding increases in retail prices are familiar to a wide audience.

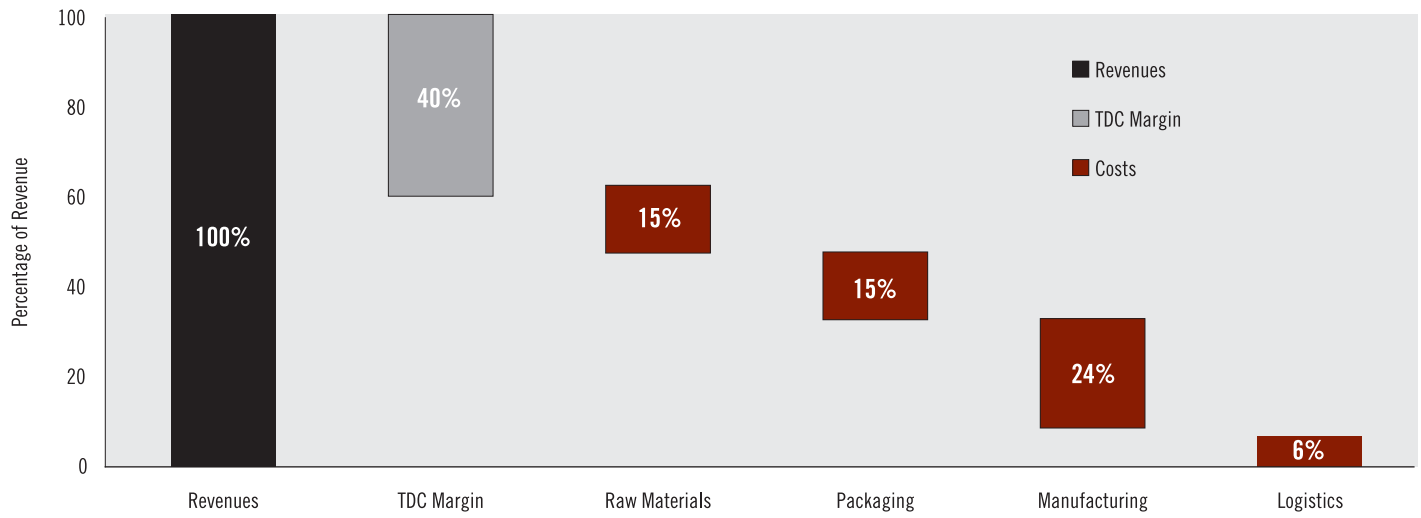
Our next step was to analyze the cost structure of a representative subset of firms in the FMCG industry. We chose six firms with a global presence, although the majority of their revenues and assets are in North America and Europe. We assessed the firms' total delivered costs (TDC), which includes the cost of goods sold (COGS) and logistics. This analysis is based on proprietary spending data and the companies' 2006 financial statements. As with any model, we had to simplify some of our assumptions and to use a number of sources in order to derive the cost drivers of raw materials and packaging. Because many of these sources do not reflect recent fluctuations in commodity prices, the analysis likely underestimates the proportion of raw material costs relative to other costs. Nonetheless, for consistency with the corporate financial data, we have reconstructed, to the best of our ability, the cost structures as they would have existed in 2006.

The typical firm we studied had a 40 percent TDC margin, which includes earnings before interest and taxes (EBIT), as well as selling, general, and administrative expense (SG&A), with logistics removed and accounted for in the TDC. As of 2006, raw materials and packaging costs each constituted 15 percent of revenues, manufacturing 24 percent, and logistics 6 percent of revenues (figure 1). Raw materials, packaging, manufacturing, and logistics were further subdivided into individual categories, and these categories' proportional contributions to TDC were determined.

The next step was to figure out to what extent basic commodities served as the building blocks for these TDC categories. In selecting commodities, we focused on eight that had one or more of the following characteristics:

1. Represents a large expense for FMCG firms, either directly or indirectly.
2. Is used at multiple points of the supply chain.

FIGURE 1. BREAKDOWN OF THE STUDIED FMCG FIRMS' AVERAGE TOTAL DELIVERED COSTS, 2006



Source: A.T. Kearney, Inc.

3. Is likely to be influenced by changes in policies addressing environmental trends.
4. Has concentrated production sites, which are most vulnerable to commodity price spikes resulting from locally extreme weather events.
5. Is vulnerable to water scarcity.

Table 1 illustrates the commodities we selected for the analysis and how they are aligned with the preceding five criteria. A short explanation of each commodity follows.

TABLE 1. Key Commodities in the FMCG Industry and Sustainability Exposure

COMMODITIES	Significant Spend	Several Levels of Exposure	Policy Changes Proposed	Concentrated Production	Water Scarcity
Oil	■	■	■		
Natural Gas	■	■	■		
Electricity	■	■	■		■
Cereals & Grains	■	■	■	■	■
Soy				■	
Sugar				■	
Palm Oil			■	■	
Timber		■	■		

Source: A.T. Kearney, Inc. ■ Firms face risk due to

COMMODITIES ASSESSED

OIL

Despite its being viewed by the general public as primarily a source of energy for transportation, oil also is important to the industrial sector. Combustible oil is a direct-energy source in manufacturing and a fuel source for generating electricity. In addition, petroleum serves as a key feedstock for the plastics and personal care industries. Whether combusted as fuel or used as raw material, oil was found to constitute up to 15 percent of the TDC of the firms we analyzed in 2006. Approximately 2 percent of this 15 percent was attributable to the firm's direct transportation of goods, and the remainder was used for transporting inbound goods and as a raw material in items like plastic packaging.

NATURAL GAS

Natural gas serves as an energy source for the industrial sector and as an ingredient in the production of fertilizers, both of which indirectly affect FMCG producers that rely on agricultural commodities. In addition, natural gas is part of the generation and cost of electricity.

ELECTRICITY

FMCG firms spent between 1 to 3 percent of TDC directly on electricity in 2006, and across the whole supply chain, electricity is one of the industry's main cost drivers (3 to 6 percent of TDC, including direct spending). Coal and natural gas are among the main drivers of electricity prices in the United States and Europe. The various inputs of electricity generation creating synergies between the push toward cleaner energy and the desire to be less dependent on the current price volatility are a subject for public debate concerning environmental and energy security.

CEREALS, GRAINS, AND SOY

As a direct ingredient of food and beverage products, the significance of cereals and grains to TDC is evident. Cereals and grains also serve as the principal feedstock for livestock: approximately eight kilograms of cereals and grains are required to yield one kilogram of beef.[6] In recent years, the use of cereals and grains for feed, food, or fuel has been widely debated by social and environmental interest groups. In addition to increasing the demand for cereals and grains, several of the key cost drivers—including the use of natural gas for fertilizers and fuel for energy and the transportation of goods—face long-term supply constraints and are susceptible to price increases.

SUGAR

Interest in the use of sugar is growing, because as a biofuel it is considered to be more energy efficient to produce than are other first-generation biofuels, such as corn.[7] Conversely, an expansion of biofuels production will likely face the same concerns as those regarding changes in direct and indirect land use and the impact of deforestation.

PALM OIL

Palm oil is widely used in food, personal care, and household care products and also is used for biodiesel, although this last use currently accounts for only a small percentage of its total consumption.[8] The recent rapid increase in palm oil production, however, has become a pressing concern as palm oil plantations have replaced forests and contributed to climate change. In addition, because 88 percent of palm oil is produced in Indonesia or Malaysia,[9] the concentration of its production makes it susceptible to local climate events that could result in price shocks.

TIMBER

As a key packaging material for raw materials and finished goods, timber is important to the FMCG industry. This packaging can be at the item level (e.g., paper wrappers or cardboard boxes) or the freight level (e.g., pallets) and collectively accounted for between 3 and 4 percent of TDC in 2006 in the companies we studied. Even though wood serves as a convenient packaging option, there is great debate and concern over the practices of the forestry industry and its impacts on deforestation, climate change, and local communities.

Using this information about the TDC categories and the underlying cost inputs from the companies we selected, we then examined how changes to these inputs could alter the cost structure of an FMCG firm. To do so, we created a reference case to analyze the sensitivity of earnings to price changes in key commodity inputs and also to provide a reference point for the "Ecoflation" scenario.[10] This "Base Case" applies to the industry's cost structure the existing price forecasts for energy and agricultural commodities from the U.S. Department of Energy's Energy Information Administration (EIA) and the Food and Agricultural Policy Research Institute (FAPRI).[11] In essence, the Base Case presents a vision of how the leading forecasting agencies expect future commodity prices to trend.

Because the Base Case is based on existing readily available price forecasts, it shows major changes in macroeconomic and demographic drivers that will profoundly affect the FMCG industry, including increased consumer spending in the emerging middle classes of China and India. By design, however, these forecasts do not contain forward-looking assumptions for environmental trends, such as anticipated changes in weather patterns and public policy. Specifically, both FAPRI and EIA assume that existing public policies will remain unchanged and that average historic weather patterns will continue. In theory, at least, climatic patterns are expected to change and thus should be part of both the Base Case and the Ecoflation scenario. As we noted earlier, though, this is not currently the case for traditional price forecasts based on EIA and FAPRI data. As a result, physical climate change is included only in the Ecoflation scenario.[12] Please see the accompanying technical document for further information on the assumptions underlying the Base Case available at http://www.wri.org/publication/rattling-supply-chains.

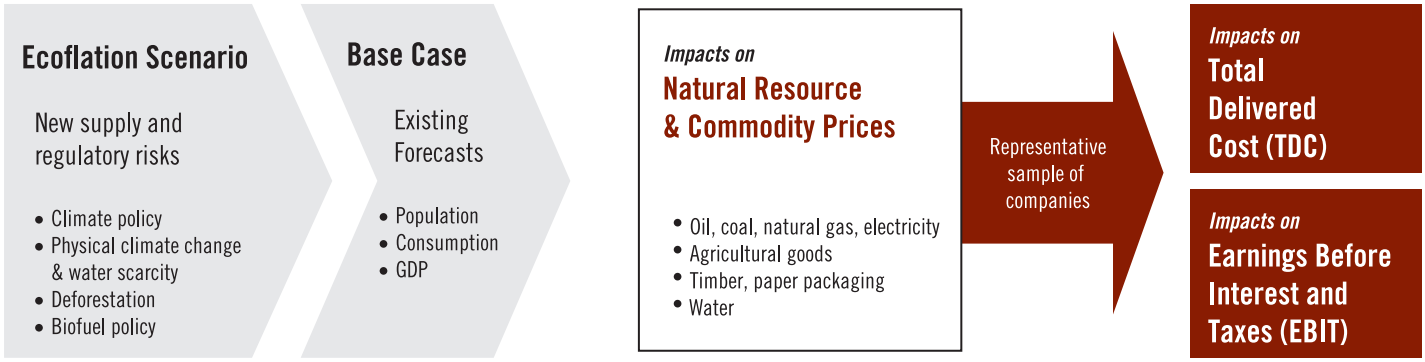
Building upon our proposed Base Case, Ecoflation imagines a future in five and ten years in which growing environmental concerns lead to a set of aggressive yet plausible policies at the international, national, and local levels to protect and sustain natural resources. Acknowledging the need to secure and sustain key resources, the public and private sectors

readily embrace environmental policies, and consumers demand environmentally preferable goods and services. Ecoflation represents the view that in the future as natural resources become scarcer and sustainability issues become more pressing, environmental costs will increasingly be borne by those responsible, thus creating an "ecoflation" that is not currently priced into economic transactions. In other words, our scenario envisions a world in which costs that are currently borne by society are internalized in firms.

Building on the expected macroeconomic and demographic changes predicted under the Base Case, the Ecoflation scenario introduces new public policies to protect natural resources that are likely to affect the supply chains of FMCG companies. In the near and medium terms, these policies initially will result in higher prices for primary commodities. But over the long term, technological innovation, efficiency improvements, changes in consumption patterns and production practices, and climate change adaptation strategies are likely to reduce or retract many of these costs. Furthermore, in the Ecoflation scenario we included changes in the physical climate that were not incorporated in the Base Case's data sources. Note that the price impacts related to changes in physical climate also apply to the Base Case and are likely to become more pronounced without appropriate mitigation policies.

Using the Ecoflation scenario to explore the cost impacts on a basket of key commodities, we then calculated their effect on the total delivered costs (TDC) to our representative firms. Based on these, we finally calculated the effects of environmental trends on Earnings Before Interest and Taxes (EBIT). Figure 2 shows our methodology.

FIGURE 2. OUR STUDY METHODOLOGY



Although we attempted to trace the cost impacts of environmental trends from major policy developments through to the prices of natural resources, manufactured goods and logistics, and ultimately the effects on TDC and EBIT, we should point out what our methodology did not do. We did not develop a new macroeconomic model; rather, we used existing forecasts from leading institutions and then applied assumptions about how policy changes would alter their modeling results in order to create the Ecoflation scenario. Consequently, our study and methodology (1) do not model demand elasticity and product substitution; (2) do not assess potential geographic shifts in production, or their extent, that may result from policies and prices; and (3) do not assess firms' ability to pass on costs to customers and

the effects that this may have. Nonetheless, we realize that economic models usually try to account for these issues, so we may analyze these impacts in the future.

ECOFLATION SCENARIO THEMES

The four key environmental themes that drive physical and policy changes in the Ecoflation scenario are as follows:

Climate Change Policy

1. The U.S. implements comprehensive climate change policy, inviting international cooperation and participation on climate regulation, which results in a global price for greenhouse gas (GHG) emissions in most economies.

The 2009 U.S. presidential administration proposes a comprehensive climate change policy framework similar to the 2008 Lieberman–Warner bill that should be approved in 2009 and go into effect by 2013.[13] The policy's aggressive targets are to set a substantial price on greenhouse gas emissions and to raise funds (though the auction/sale of allowances) to finance programs and funds for international adaptation to climate change, technology deployment, and forest protection. These important goodwill measures are meant to convince developing countries to take action while at the same time the European Union (EU) and other Organization for Economic Cooperation and Development (OECD) countries continue to establish tough, long-term climate change policy measures that align with or and, in many cases, exceed in stringency, those of the United States. In addition, some countries in the industrialized bubble (e.g. Mexico, South Korea) will institute national greenhouse gas reduction targets over the next five years that are comparable in stringency to those of the United States.

Importantly, China also takes action to address climate change in this scenario. Although China does not set a cap on greenhouse gas emissions, it does take climate change seriously because of the projected negative physical impacts, and it has enacted strong renewable energy and energy efficiency targets and major technology investments, such as carbon capture and storage (CCS). China also taxes oil, coal, and natural gas, based primarily on energy security concerns, with climate as a complementary concern. This tax is comparable to that in the United States and the EU. Now that China is acting on climate change, some but not all developing countries have followed suit, but using taxes, not cap and trade. As a result, the world's major economies will converge around a global price on a carbon dioxide equivalent of $30/tonne in 2013 and $50/tonne in 2018.

Physical Climate Change and Water Scarcity

2. Climate changes increase water scarcity in major agricultural regions, leading to higher production costs and declining yields.

Although climate change mitigation policies are expected to lessen the physical impacts of climate change over the medium and long terms, they will not affect current trends in the near term. Anticipated changes in temperature and precipitation patterns, and the consequential increase in weather variability and uncertainty, will intensify the impacts of water scarcity in some agricultural regions by 2018. As a result, irrigation will be increased to maintain yields, thereby raising the energy costs of production. At the same time, the growing competition for water resources will bring government rollbacks of current subsidies for water in order to encourage conservation and promote more equitable access to water resources. The threat of water scarcity also will hurt manufacturing facilities in regions fac-

Box 1. Water Scarcity and Manufacturing

Industry (excluding agriculture) currently accounts for about 20 percent of worldwide water use and usually has to compete with the public for water, as companies tend to be located in populated areas.[1] This close proximity creates a situation in which the use of water by industry is more highly scrutinized than the use by agriculture. Examples of firms under such scrutiny are Coca-Cola, Nestlé, and many other heavy water users.

Water scarcity can affect all aspects of the value chain. Perhaps of greatest concern is the impact of idle assets due to water scarcity, rather than the price associated with its consumption. In France, several nuclear power plants have had to be shut down owing to drought conditions during which they could no longer cool their reactors. Similar conditions experienced by the Tennessee Valley Authority also required the shutdown of nuclear power plants. Not only can this spike electricity prices or even prevent companies from using electricity during these times, but it also can shut down manufacturers' operations for similar reasons. The dent that idle assets can make in companies' profit margin is significantly larger than that resulting from the increased cost of production owing to the inflation in water prices.

1. Food and Agriculture Organization of the United Nations (FAO) Land and Water Development Division, "AQUASTAT Information System on Water and Agriculture: Online Database" (Rome: FAO, 2005), available at http://www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastat/dbase/index.stm.

ing water constraints (box 1). We did not include this risk in our analysis, however, because of the detailed data required to assess water scarcity for manufacturing facilities across the industry.

Water is essential to all agricultural production, with the average human consumption of calories requiring about 3,000 liters of water per day.[14] Furthermore, agricultural irrigation accounts for 70 percent of the world's consumption of fresh water.[15] The combined effects of climate change, growth in population and consumption, lower water table levels, higher energy costs, water pollution, and erosion ensure that the cost of water will increase in the future. This contrasts sharply with the current situation, in which the extraction and opportunity costs of water are rarely, if ever, paid by the agricultural industry (box 2).

Water use varies dramatically for crops and agricultural practices, whereas water resources vary by region. Over the long term, comparative advantage will increasingly be defined by water resources, with the production regions for major commodities shifting according to

Box 2. Water Subsidies and the True Price of Water

Water subsidies can be found in nearly every single market throughout the world and often are hidden in unexpected ways. Determining the full cost of water requires factoring in many aspects of water that are usually not considered. Most subsidies enable farmers to avoid paying even the energy costs of transporting water. Besides the energy costs, the maintenance of the infrastructure is subsidized; the capital investments to develop the infrastructure are subsidized; the opportunity costs and economic externalities are not effectively priced; and environmental externalities are not included.

Examples of water subsidies are numerous. The Central Valley Project in California receives $100 million in energy subsidies, allowing customers to pay less than one cent per kilowatt-hour to power irrigation systems. As energy prices climb, governments will no longer be able to maintain large and unsustainable water subsidies. Although the United States and Europe are notorious for their generous support of water use, Mexico (11 percent of full cost), Indonesia (13 percent of full cost), Pakistan (13 percent of full cost), and, to some degree, nearly all other countries also support similar subsidies.[1] Because companies' dependency on water subsidies may dramatically affect their profit margins, investing in water efficiency is a step toward managing these water-related risks.

1. S. Postel, *Last Oasis: Facing Water Scarcity* (New York: Norton, 1992).

their water needs and availability. Although some migration will occur in the near term, most is expected beyond the ten-year horizon of the Ecoflation scenario, owing to the necessary capital investments and infrastructure development, and so is not included in this analysis.

In addition to the impact of water scarcity, climate change is expected to increase the frequency and intensity of extreme weather events like droughts, floods, storms, and heat waves. Such weather events increase the risks to commodity supply and their associated price shocks. Because these events will periodically affect commodity prices, rather than fundamentally change the price trajectories over the longer term, we also did not include them in the Ecoflation scenario. From a strategic perspective, however, it is important to consider the increased risk from price shocks due to extreme weather events and the potential to create expensive disruptions in production (box 3).

Deforestation

3. In response to public concerns about deforestation, consumer products companies in the United States and EU voluntarily agree to source all wood and fiber from sustainability-certified forests and to increase the use of recycled fiber for all paper packaging and products.

The success of efforts such as the Lacey Act in the United States, as well as environmental nongovernmental organization (NGO) campaigns for forest protection, have led major consumer products manufacturers to agree voluntarily to increase the use of fiber certified to come from sustainably managed forests and postconsumer recycled content.[16] By 2018, all paper packaging in the FMCG sector will be either certified by a major certification scheme or contain at least 80 percent postconsumer content.

Currently, most of the pulpwood and pulp production used for specialty packaging is heavily concentrated in industrialized nations.[17] But by 2018, the supply of pulp is expected to shift to industrializing countries, particularly China, Brazil, and Russia.[18] These countries are emerging key players in the global pulp market and will attract the attention of U.S. and European consumers to illegal logging, particularly in Russia and China.

Sustainable forestry certification is one of the most widely recognized methods to ensure the legality and environmental attributes of forest raw materials. In our Ecoflation scenario, consumer-facing industries favor certification programs that have brand recognition. As a result, a certified pulp market will be established to meet the higher demand, which will carry a premium over traditional fiber.

Recovered fiber markets also divert demand away from unsustainable forest practices. Recovered fiber, however, requires more energy and chemicals to process than virgin fiber does. Globally, the use of recovered fiber is projected to grow by 100 million tons over the next ten years, with the growth projected to be based on the rising demand in China.[19] The infrastructure for recovered fiber will accordingly need to be greatly enhanced and to expand into developing regions to meet the growing demand.

Box 3. The Climate Change Wild Card

Climate change is expected to increase the occurrence of extreme weather events like heat waves, hurricanes, severe storms, droughts, and floods, as well as disruptive agents like pests, viruses, and fires. The Intergovernmental Panel on Climate Change (IPCC) predicts with high confidence that "projected changes in the frequency and severity of extreme climate events have significant consequences for food and forestry production in addition to the impacts of the projected mean climate."[1] One study cited in the report found that the increased incidence of heavy rainfall in the United States would double the losses in agricultural production from excess moisture in soils, valued at $3 billion/year by 2030.[2]

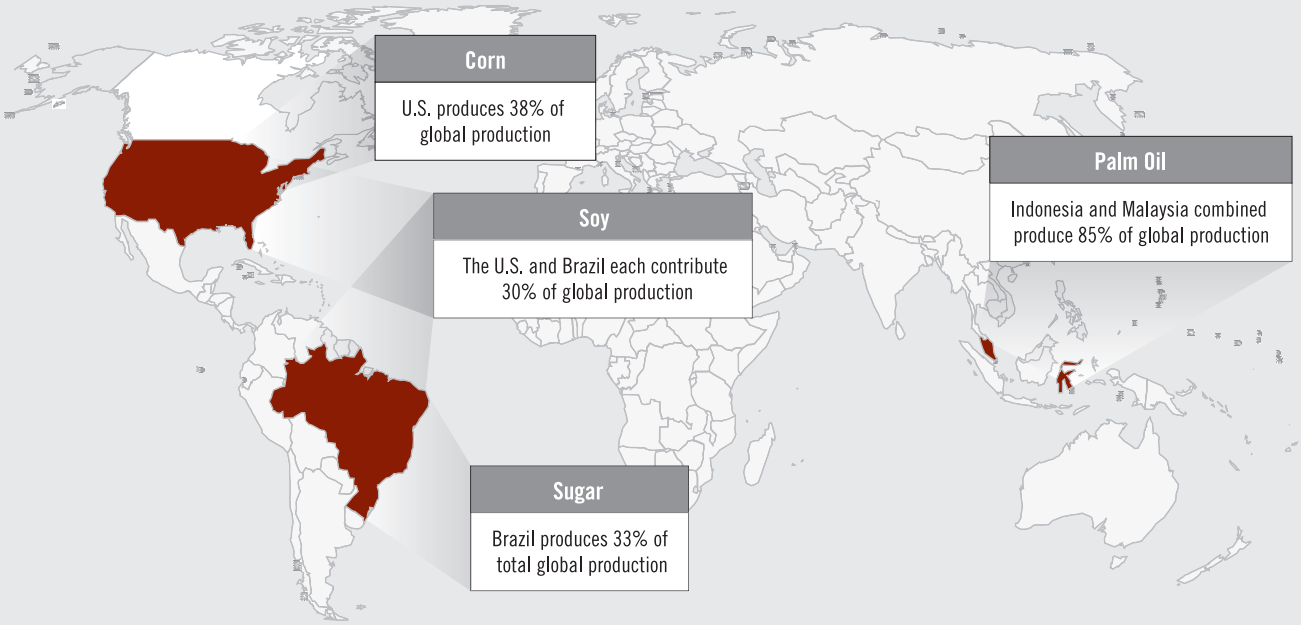
Such losses are not without precedence. In 2008, extreme precipitation events in Iowa contributed to the flooding of more than 5 million acres of corn and soybeans and led to the immediate rise in the commodity prices of corn and soybeans. With more than $3 billion in crop losses, an estimated 10 percent of the corn harvest and 20 percent of the soybean harvest were lost, with ripple effects throughout the economy.[3] The events in Iowa in 2008 also coincided with the continuing drought in Australia and the U.S. Southwest.

By 2018, extreme weather events, such as those of 2008, are likely to occur more frequently.[4] Already, rising temperatures have increased the atmosphere's water-holding capacity, which created the severe drought that has affected the U.S. Southwest, China, and India. Such climate events do not usually occur in isolation, and so the current drought conditions have coincided with a massive flood in the U.S. Midwest as well as typhoons in Brazil, Indonesia, Malaysia, and the Philippines.

Crops in concentrated production areas are most vulnerable to commodity price spikes from extreme weather events. In our analysis, each agricultural commodity we considered is highly concentrated and therefore vulnerable to wildcard climate events (figure 3).

1. IPCC Fourth Assessment Report, Working Group II, chap. 5.
2. Rosenzweig et al., "Increased Crop Damage in the US from Increased Precipitation under Climate Change," *Global Environmental Change* 12(2002):187–202.
3. Rick Mattoon, "Accessing the Midwest Floods of 2008 (and 1993)" (Chicago: Federal Reserve Bank of Chicago, 2008), available at http://midwest.chicagofedblogs.org/archives/2008/07/mattoon_flood_b.html; TimeTurk, "South Australian Drought Worsens," 2008, available at http://en.timeturk.com/South-Australia-drought-worsens-5908-haberi.html; Drought Conditions in the West, "Reclamation: Managing Water in the West" (2008), available at http://www.usbr.gov/uc/feature/drought.html.
4. IPCC Fourth Assessment Report, Working Group II, chap. 5.

FIGURE 3. COMMODITIES PRODUCTION IN CONCENTRATED REGIONS



Source: FAOSTAT for commodity production data.

Box 4. Will Forest Protection Restrict Agricultural Expansion?

Forests contain 70 percent of the world's biodiversity, provide vital ecosystem services such as flood control and soil protection, and support the subsistence livelihoods of as many as 300 million people.[1] To date, efforts to combat deforestation have failed to halt the rapid loss of the world's forests, despite some local successes.[2] Between 2000 and 2005, roughly 13 million hectares of forest disappeared each year, driven primarily by agricultural expansion in the developing world's tropical forests.[3]

The threat of climate change has created a new imperative to protect tropical forests' values and services. The Intergovernmental Panel on Climate Change (IPCC) estimates that deforestation contributes 15 to 20 percent of global greenhouse gas emissions.[4] Even so, the forestry sector was largely excluded from the Kyoto Protocol's first commitment period, partly owing to the challenges of measuring and monitoring land use change in developing countries. But advances in remote-sensing technology—plus the growing urgency surrounding climate change—have created a mechanism (REDD) to compensate reduced emissions from deforestation and forest degradation in developing countries, and it is a likely addition to the post-Kyoto climate agreement set to start after 2012.[5]

Under a REDD mechanism, forest owners—governments, communities, companies, or individuals—would be compensated if they are able to lower the rate of carbon dioxide emissions from forest loss below an established baseline or reference scenario. Under most REDD proposals, compensation would be financed by the sale of these emission reductions as "carbon offsets" to be used by regulated countries or companies to remain within their emissions limits. Although cost estimates vary, a conservative carbon value of $10 per ton suggests annual revenue of up to $12 billion for developing countries.[6] In the high environmental impact scenario, in which carbon prices are significantly higher, these payments might even shift the balance away from the economic incentives currently favoring deforestation, such as the demand for timber and agricultural production.

Many uncertainties remain regarding the design, implementation, and effectiveness of REDD mechanisms. If successful, the final REDD mechanism will encourage stronger national policies to reduce deforestation in developing countries while at the same time introducing new financial and technical resources to support this effort, thereby making the conversion of forests for alternative land uses, such as agriculture, more difficult and expensive with the potential increases in the prices of agricultural and forest goods.

1. Millennium Ecosystem Assessment, "Ecosystems and Human Well-Being: Current State & Trends" (Washington, DC: World Resources Institute, 2005).
2. FAO, "Global Forest Resources Assessment 2005."
3. Ibid.
4. IPCC Fourth Assessment Report, "Climate Change 2007."
5. Launched initially as avoided deforestation, the initiative has had several name changes. We use the REDD term as used in the UNFCCC working group in Tokyo, July 2008.
6. Center for International Forestry Research (CIFOR), "Do Trees Grow on Money? Implications for Policies and Further Research to Support REDD" (Bogor, Indonesia: CIFOR, 2007).

Over the next five to ten years, international efforts to reduce deforestation in developing countries also are likely to be strengthened. If successful, these policies will lead to more competition for agricultural and forest lands as new incentives and programs limit expansion into tropical forests. We are not able to predict the extent to which forest protection programs will restrict agricultural expansion and impact global supplies, if at all, because the impacts of these policies have not yet been modeled. In addition, further research is needed to understand exactly which commodities are driving tropical deforestation. In any case, soy, sugar, and palm oil could face even greater competition for land as forest protection measures are strengthened (box 4).

Biofuel Policy

4. By 2013, the major biofuel-consuming countries retreat from existing biofuel mandates and instead apply sustainability requirements to all relevant biofuel government policies.

Soaring food prices and environmental concerns have recently generated a backlash against biofuel policies, particularly in the United States and EU. The dialogue concerning the "sustainability" of global biofuel production thus will be strengthened and influence future policy

conversations about renewable fuels. By 2013, these concerns will escalate and force a retreat from existing production and consumption mandates.

Until recently, one of the EU's primary arguments for expanding the production of biofuels has been the mitigation of climate change. That is, when crops grow, they absorb carbon dioxide from the atmosphere, thus canceling out any greenhouse gas emissions that result from burning biofuels. However, planting, fertilizing, and harvesting the crop, as well as fermentation, distillation, and transportation, require machinery that uses fossil fuels. In addition, recent research suggests that if emissions from land use change were included in the analysis, greenhouse gas emissions savings could be significantly lower or even negative, particularly for feedstocks grown in countries with a high risk of deforestation, such as palm oil in Indonesia and soybeans in Brazil.[20] Moreover, the potential land appetite of the world's 800 million car owners is vast: it would require roughly one-third of U.S. land to replace only 10 percent of U.S. transport fuel consumption with biofuels.[21]

There also is great concern about the impacts on food prices of diverting potential food and feed crops to biofuel production. Although the relative contribution of the greater demand for biofuels to current food price inflation is uncertain, the world's skyrocketing food prices—up almost 50 percent since last year—have triggered riots across the developing world. At an increased risk of malnutrition are the more than 800 million food-insecure people who live on less than $1 per day and an additional 2 billion to 2.5 billion people living on $1 to $2 per day.[22] On average, poor households spend between 60 to 80 percent of their income on food, compared with only 10 to 20 percent for people living in most of the industrialized countries.

Most major economies currently have in place biofuel policies that are driving ethanol and biodiesel production, as well as contributing to higher prices for corn, soy, sugar, and palm oil feedstocks. Current soaring food prices have led to debate on this subject, resulting in a wide range of estimations of price impacts from biofuels on agricultural commodities. For example, the U.S. Department of Agriculture determined that biofuel production was responsible for only 2 to 3 percent of the increase in global food prices, but other agricultural research organizations put this figure closer to 30 percent for grain prices.[23]

Historically, biofuel production has been driven by policy support; however, because ethanol and biodiesel offer substitutes for gasoline and diesel, higher oil prices may drive market demand. In June 2008, a study was released showing that the impacts of higher oil prices on biofuel demand and subsequent commodity price changes in the United States were roughly equivalent to the price impacts of current biofuel policies.[24] But it is unlikely that high oil prices could increase biofuel production much beyond existing policy targets, owing to supply constraints on land availability and yield potential.[25]

The Impact of "Ecoflation" on Cost Drivers

Our analysis of our Ecoflation scenario shows a significant impact on the cost of commodities, due to a variety of factors including climate policy, climate change (and increased water scarcity), deforestation, and biofuel policy.[26] While the collective impacts will vary by the individual firms' product portfolios and supply chains, the intensified environmental factors and associated public responses will certainly affect firms' profit margins. In the following section, we examine the drivers underlying the price impacts on our selected commodities. We did not include every issue presented in our scenario themes because of a lack of data, studies, and models to inform potential price impacts. These issues are still important, though, when considering appropriate risk mitigation and value creation strategies for the industry.

COMMODITY PRICES

ENERGY PRICES

Issue	Description	Price Impact
Climate Change Policy	Price for carbon dioxide emissions will raise the cost of all fossil fuels combusted for energy. It will also drive investments in efficiency, alternative fuels, and new infrastructure over the long term to lessen price impacts.	↑
Physical Climate Change / Water Scarcity	Extreme climate events will likely cause increasing disruptions and could raise prices in the short term.	↑
	May impact some power plants in water-scarce regions. May change priorities regarding future hydro development.	↑
Deforestation	Not likely to have a direct impact.	↔
Biofuel Policy	Biofuel consumption offsets gasoline and diesel consumption and lessens demand pressures on oil price. A rollback of biofuel policies in major markets may increase gasoline and diesel consumption and have the opposite impact on oil price.	↑↓

A price for carbon dioxide emissions will increase the price of fossil-fuel energy, and the impacts will vary in accordance with the policy design and location.

In the Ecoflation scenario, most major global economies converge around a carbon dioxide equivalent price of $30/tonne in 2013 and $50/tonne in 2018, based on the premise that the United States will adopt a national cap-and-trade system similar to the recent Lieberman–Warner bill. Several studies have modeled the potential impacts of the Warner–Lieberman bill on carbon and fossil-fuel prices. Overall, our U.S. scenario price of $30/tonne in 2013 and $50/tonne in 2018 of carbon dioxide equivalents is less than or equal to the prices for carbon dioxide emissions predicted by a MIT[27] study and falls between the scenarios in a study by the U.S. Energy Information Administration.[28]

The increase in energy prices from a $30/tonne and a $50/tonne price for greenhouse gas emissions would be 15 and 22 percent for oil, 25 and 40 percent for natural gas, and 24 and 45 percent for electricity.[29] These increases in energy prices would be felt throughout the value chains of every company we studied. In addition, we incorporated them into the price impacts on cereals, soy, sugar, palm oil, and timber.

CEREAL PRICES

Issue	Description	Price Impact
Climate Change Policy	Price for carbon will increase production and transport costs and may drive corn demand for ethanol.	↑
Physical Climate Change / Water Scarcity	Cereal production is susceptible to increased droughts and floods in wheat- and corn-producing regions.	↑
	Wheat and corn crops tend not to be heavily irrigated, but they can be grown in many temperate regions and need less water than most other crops.	↑
Deforestation	Not likely to have a direct impact, but because soybeans and cereals are grown in the same regions, limits on agricultural expansion in Brazil could have indirect impacts.	↔
Biofuel Policy	Biofuel policy increases the demand for corn as an ethanol feedstock in the short term, thereby increasing the pressure on all cereal prices. Any future rollback of U.S. biofuel policy may lower prices by reducing corn demand, especially when tariffs are removed.	↑↓

The United States' biofuel policy may be the most significant environmental price driver for cereals, although in our scenario, the price effect of rolling back biofuel policy is offset by a price on carbon.

For simplicity, we focused on wheat and corn as the primary drivers of cereal markets. The United States accounts for approximately 40 percent of global maize production and contributes 55 to 60 percent of the global trade in maize.[30] As a result, the quantity of maize grown and the share of domestic consumption versus exports have a significant impact on international maize prices. In 2008, the United States produced more than 90 percent of all corn-based ethanol worldwide, with Chinese and Canadian producers coming in a distant second and third.[31] Accordingly, our analysis will focus on U.S. biofuels policy as the primary policy driver of global maize prices.

In recent years, the rapid growth in U.S. maize plantings has come at the expense of the soybean growing area as well as agricultural lands that had previously been removed from production for conservation programs under the U.S. farm bill.[32] This discovery has led to social issues regarding rising food prices (for both maize and soybeans) as well as environmental concerns.

In the Ecoflation scenario, these sustainability concerns drive the United States to remove its ethanol target as well as its ethanol tax incentives and tariffs. A model developed by FAPRI[33] estimates that this would reduce domestic producer prices of maize by 14 percent compared with our Base Case scenario, which assumes that the United States will comply with current biofuel production mandates. A high price for oil would lessen this impact somewhat, resulting in maize prices only 9 percent lower than in the Base Case scenario. This would translate into an even smaller impact on international cereal prices. Furthermore, higher gasoline prices, driven by U.S. climate policy, are likely to raise the demand for ethanol independently of policy support. We therefore assume that in our Ecoflation scenario, the overall impact on cereal production is negligible.

Another cost driver considered in the analysis is the expected cost impact of climate change on the amount of water available for irrigation.

To illustrate the vulnerability for water scarcity in the value chain under the Ecoflation scenario, we mapped production areas for our key agricultural commodities against future predictions for climate change–induced water scarcity. Using this information, we estimated the additional energy costs resulting from expanding irrigation systems in areas where they currently exist, in order to maintain agricultural production levels as water becomes more scarce. This approach is somewhat conservative, as it does not include establishing irrigation where it currently does *not* exist.

We do, however, use a "water scarcity" variable to approximate the likely rise in water prices owing to the growing competition when the scarcity increases. Under this assumption, agricultural users are required to pay a value that is closer to the full economic costs of water, including a greater portion of operation and maintenance (O&M) costs, pumping costs, capital costs, opportunity costs, and environmental costs and externalities. Although this factor is highly variable, we used a value of 50-fold because it reflects the O&M costs in the lowest-cost scenario presented in a study demonstrating the overall costs of water. [34] Farmers seldom pay the full cost of O&M in many OECD countries, and irrigators even less often repay the capital costs associated with developing irrigation schemes.[35] Because of the low recovery rates of O&M and capital costs, a factor of 50 is somewhat conservative, therefore, especially when considered with opportunity costs and environmental costs, which make up a greater proportion of the cost of water than O&M and capital costs do.[36]

With water prices so low, even a 50-fold increase would not really be "dramatic" in terms of total delivered costs (TDC). So yes, prices will go up—partly because subsidies will go down—but the inflationary impact itself will be relatively minor. The disruption impact of potential weather events, however, will not be so insignificant.

Our assessment found that of the agricultural commodities assessed, the production of wheat and corn is most at risk of being affected by water scarcity, with price increases of 6 percent in 2013 and 13 percent in 2018. Again, this assessment does not include possible climate change "wild card" events, including the greater frequency of droughts and floods, which may have dramatic impacts on short-term prices.

SOY PRICES

Issue	Description	Price Impact
Climate Change Policy	Price for carbon will increase production and transport costs and may drive the demand for soybean oil for biodiesel.	↑
Physical Climate Change / Water Scarcity	Soybean production susceptible to more droughts and floods in producing regions.	↑
	Soybeans are not heavily irrigated and are grown in moderate climates that are not anticipated to experience dramatic declines in precipitation.	↔
Deforestation	Soybean production is a major driver of Amazon deforestation[a] and is likely to be a focus of international efforts to protect forests. Effective measures should restrict expansion of soybean crops beyond the Base Case's projections with possible impacts on commodity prices.	↑
Biofuel Policy	Demand for soybeans is indirectly affected by the substitution effects of the increased U.S. demand for corn-based ethanol and is directly affected by the EU's demand for soy-based biodiesel, both with inflationary impacts on price. Any rollback of U.S. or EU biofuel policy may reduce prices by reducing biodiesel demand.	↑↓

Note: a R. L. Naylor, A. J. Liska, M. B. Burke, W. P. Falcon, J. C. Gaskell, S. D. Rozelle, and K. G. Cassman, "The Ripple Effect: Biofuels, Food Security, and the Environment," *Environment* 49(9):30–43.

A significant environmental concern comes from soybean cultivation in Brazil and its indirect impacts on the deforestation of the Amazon rainforest. But impacts on prices are unclear, as the effects of biofuel and deforestation policy on agricultural expansion have not been modeled.

Our baseline data source for agricultural commodity prices is FAPRI's "2008 Agricultural Outlook." On the supply side, the model assumes a steady increase in productivity and the hectares under production to meet demand. In reality, agriculture will face supply constraints that will be partly based on limits on agricultural expansion from population growth, climate change, land degradation, and environmental restrictions.

According to FAPRI's forecast, the land in Brazil set aside for soybean production is expected to expand by nearly 25 percent between 2008 and 2018. This expansion has moved northward over the last thirty years, and some analysts project that it could shrink the Amazonian rainforest by 40 percent by 2050.[37] Two levers may slow the expansion of soybean production in Brazil: international and national mechanisms to reduce deforestation and fewer biofuel mandates.

Under international programs to reduce deforestation, governments will offer financial incentives to conserve intact forests. The ultimate design and effectiveness of such programs are unknown, but if the incentives are large enough, they could reduce the agricultural expansion into the Amazon. Their effects also are not clear, as it is not known to what extent such programs may restrict global supply.

If the United States, Argentina, and Brazil remove their biodiesel mandates, both the consumption of soybean oil for biodiesel and the price of soybeans will decline. In addition, removing the U.S. mandate for conventional ethanol will reduce land competition between maize and soy, thereby also alleviating current high prices. Although a high price for oil will reverse these impacts to some extent, soybean oil prices will likely remain slightly below the Base Case's price.

SUGAR PRICES

Issue	Description	Price Impact
Climate Change Policy	Price for carbon will increase production and transport costs and may drive demand for sugarcane for ethanol.	↑
Physical Climate Change / Water Scarcity	Because sugar beets, grown in northern countries, can be substituted for sugarcane, grown in tropical countries, supply is relatively geographically diversified.	↔
	Brazil is the world's largest producer of sugarcane and is not expected to suffer a scarcity of water under climate change.	↔
Deforestation	Sugarcane production is an indirect driver of Amazon deforestation and could be a focus of international efforts to protect forests. Effective measures should constrain sugar expansion beyond Base Case projections, with possible impacts on commodity prices.	↑
Biofuel Policy	From a greenhouse gas perspective to an energy-content perspective, ethanol made from sugarcane is one of the most efficient biofuels. How this balances against deforestation issues in future biofuel policy will determine the impact on prices.	↑↓

As with cereals, a price decrease from a rollback of biofuel policy will be offset by the higher demand for ethanol based on the price for carbon dioxide emissions.

Sugar commodities include both sugarcane and sugar beets, but our analysis concentrates on sugarcane. Each year, nearly half of Brazil's sugarcane crop—equivalent to roughly 15 percent of global sugarcane production—is destined for ethanol, accounting for 40 percent of Brazil's fuel use for transportation. Sugarcane is grown in south-central Brazil and does not contribute directly to deforestation in the Amazon. But some analysts believe that expanding the cultivation of sugarcane could indirectly contribute to deforestation by pushing soybean cultivation and livestock grazing northward into the Amazon.[38]

Although the Brazilian government has set a goal of zero deforestation, much more than 10,000 square kilometers of forest continue to be lost each year, partly owing to agricultural expansion.[39] In order to accommodate the level of ethanol production projected in the Base Case scenario, which assumes that all countries meet their existing biofuel targets, the area of sugarcane harvested will have to increase by roughly 25 percent, or about 15,000 square kilometers.[40] Strengthened policies in Brazil, in addition to a greater international commitment to reducing greenhouse gas emissions from deforestation, could make it difficult to continue expanding agricultural land into the Amazon rainforest. The resulting constraints in agricultural land availability could affect sugarcane production, at least indirectly through competition with other crops for scarce land resources. High oil prices, however, will raise the demand for domestic ethanol and, more important, strengthen export markets. Compared with the Base Case scenario, the Ecoflation scenario assumes that the countervailing effects of these environmental issues, on the one hand, and high oil prices, on the other, are likely to have a negligible impact on sugarcane ethanol production.

PALM OIL PRICES

Issue	Description	Price Impact
Climate Change Policy	Price for carbon may drive demand for palm oil for biodiesel.	↑
Physical Climate Change / Water Scarcity	Production concentrated in Southeast Asia makes palm oil susceptible to floods, droughts, and fires.	↑
	Irrigation is required for some palm oil plantations, but Southeast Asia is not expected to suffer greatly from a scarcity of water under climate change projections, because Indonesia and Malaysia are likely to have *more* precipitation.	↔
Deforestation	Palm oil production in Indonesia is driving deforestation in the region and is a major focus of international efforts to reverse this trend. Vast areas of degraded land in the region, however, could permit some expansion without additional deforestation.	↑
Biofuel Policy	Palm oil is a feedstock for biodiesel produced in Europe, although it is not a primary driver of palm oil prices, as most of EU palm oil imports are used for food and consumer products. Growing concern about deforestation in Indonesia caused by palm oil plantations could reduce the EU's demand for biodiesel and reverse any price impacts.	↑↓

Oil prices, driven in part by a price for carbon, are likely to be a major driver of the palm oil production that feeds biodiesel demand. A change in the EU's biofuel policy may reduce this impact.

Malaysia and Indonesia are the major producers of palm oil, together accounting for about 88 percent of global production.[41] The current utilization of palm oil for biodiesel production is relatively small—less than 2 percent in Indonesia and less than 1 percent in Malaysia—and is not projected to grow substantially in the Base Case scenario, owing to the sustained high price of palm oil.[42] A high price for oil, however, could encourage development of the emerging biofuel-processing sectors in these and other countries.

From a climate change perspective, palm oil is one of the least sustainable biofuel feedcrops, owing to its significant role in driving deforestation in Indonesia's carbon-rich peatlands. In fact, Indonesia was the fourth largest emitter of carbon dioxide in the world (behind the United States, China, and the EU), and its emissions are almost entirely attributable to deforestation. In a world that is serious about mitigating climate change, biodiesel produced from palm oil on former peat soils is not a sustainable alternative to petroleum. Without export markets for palm oil–based biodiesel, Indonesian and Malaysian production is likely to decline significantly. But since biodiesel currently accounts for such a small percentage of palm oil utilization in these countries, the impacts on the international commodity price are likely to be small.

TIMBER PRICES

Issue	Description	Price Impact
Climate Change Policy	Energy is one of the most important cost drivers for the production of packaging material. While current mills are heavy utility users, fuels can be produced from biomass and thereby decrease dependence on fossil-fuel power.	↑
Physical Climate Change / Water Scarcity	Forests will be increasingly susceptible to fires, pests, and viruses. The mountain pine beetle epidemic in British Columbia is an example of a climate change–related disturbance driving up softwood prices in North America.	↑
	Forests are not irrigated and tend to be resilient to small changes in precipitation. But the impacts on water supply from a smaller snowpack and other effects of climate change may reduce productivity.	↔
Deforestation	Pulp used by the FMCG industry is currently produced in the United States and western Europe, where illegal logging is not a primary concern. But this may change if Russia increases its exports of pulp in the future. Currently, a reduction in illegal logging will have a greater impact on solid wood than on pulpwood prices.	↑
Biofuel Policy	Currently, pulp and solid wood prices are not directly affected by bioenergy policy. Timber could provide feedstocks for cellulosic ethanol, although this would be beyond our analysis's time frame. Wood-based biofuels face the same sustainability concerns that are likely to reduce public support for biofuel development.	↔

Although consumer values regarding forest protection can lead a change toward the use of certified pulp and recovered fiber, increases in energy prices from a price on carbon will have the greatest impact on the price of paper packaging.

Illegal logging is not a significant issue in North America and Europe. Indonesia and Russia, though, which account for approximately 8 percent of the world's pulpwood exports, have had significant problems with illegal logging.[43] As the global production of pulp shifts to these countries and others, concerns over illegal logging will become more prevalent.

Illegal logging is believed to suppress global timber prices, as it is obviously less expensive to produce than is sustainably managed timber.[44] Models suggest that a reduction in illegal logging would result in an increase of solid wood prices by 7 and 16 percent on a global average.[45] In the extreme case of Indonesia, where illegal logging supplies a large portion of the raw materials for pulp production, pulp prices increased by 25 percent from 2007 to 2008 as the government has cracked down on illegal logging.[46] Overall, pulp production in Indonesia is expected to be down by 75 percent for 2008.[47]

In response to illegal logging, in the Ecoflation scenario nearly all paper packaging in the FMCG sector becomes sustainably certified or contains at least 80 percent postconsumer fiber. The impacts on pulp prices from certification are likely to be small. For instance, many materials certified by the Forest Stewardship Council (FSC), one of the two major certification systems, currently sell for the same price as non FSC products. Although the costs of certification vary greatly by scale, region, and forest, one estimate for forests in North America is that FSC-certified softwoods cost 2 to 3 percent more to produce and that FSC-certified hardwoods are generally comparable in price to their noncertified counterparts.[48] But this cost is likely to increase in the future as demand drives new forests to become certified, many of which will likely be more expensive to certify if lower-cost options have already been certified. As a result, in our scenario we assume an increase from 2 to 5 percent in softwood pulpwood costs for certified packaging and labels.

Prices for packaging paper made from recovered fiber vary. The manufacturing costs using recovered fibers include several elements such as the availability of used paper; the costs of collecting, sorting, and transporting the paper; and the technical capacities of the manufacturing mills.[49] Although the price of recovered fibers has fallen sharply over the past decade, price premiums in North America, for example, vary from 7 to 10 percent for different paper

grades.[50] The makers of corrugated boxes, at least in the United States, do not, however, charge a price premium for recycled content.[51] We therefore assume no price impact from greater recycled content.

Changes in energy prices, especially electricity, will have a significant impact on pulp and packaging prices. On average, electricity represents up to 20 percent of pulp production costs, but the energy consumption for recovered fiber is much higher, at 33 percent. The Ecoflation scenario determines the combined impact of a slight increase in pulp prices and electricity prices based on climate policy to bring a 7 percent increase in wood and paper product prices in 2013 and nearly 13 percent by 2018.

Pulp manufacturing also requires large amounts of water and may be exposed to water supply and quality issues resulting from physical climate changes. But because this risk is specific to manufacturing location, we do not address it in the analysis.

TOTAL DELIVERED COST (TDC)

The Ecoflation scenario leads to a significant increase in TDC.

We forecast the impacts of changes in commodity prices on FMCG firms' total delivered costs based on (1) the cost structures of a sample set of representative firms; (2) the probable cost drivers of individual raw materials, packaging, and energy/utility expenses; and (3) the projected impacts on cost drivers according to our Ecoflation scenario.

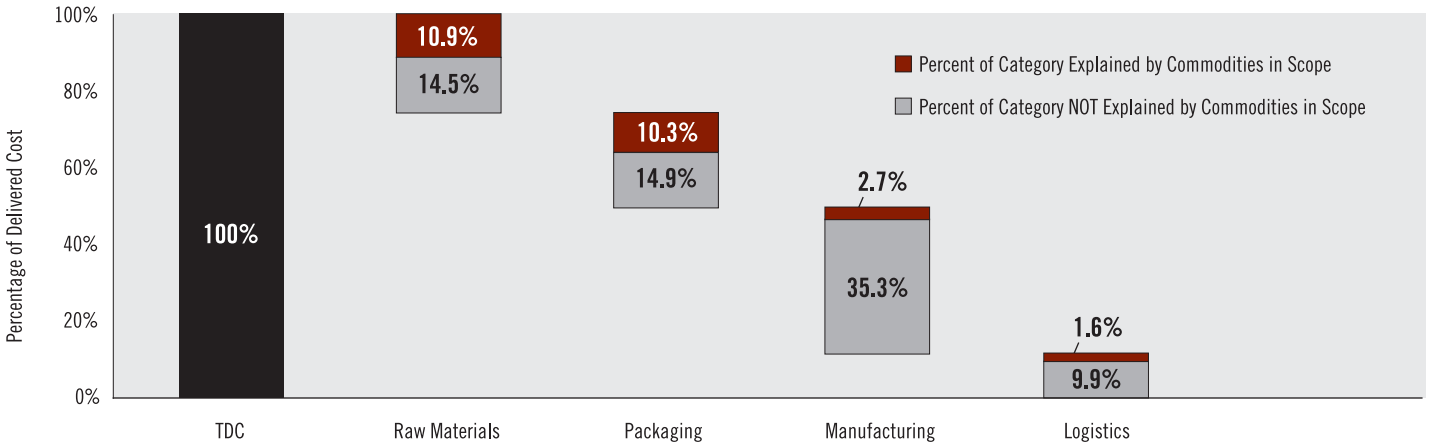
We were not able to derive a price impact for each environmental issue across all commodities, as explained earlier. Across the commodities assessed, the impacts on energy prices were the most dramatic, followed by the changes in the prices of cereals and wood/paper products. (Table 2).

TABLE 2. The Ecoflation Scenario's Price Increases Compared with the Base Case Price Increases

	2013 (%)	2018 (%)
Oil for energy	15	22
Natural gas for energy[a]	25	40
Coal[a]	198	378
Electricity[b]	24	45
Cereals	6	13
Soybeans	1	3
Wood and paper products	7	13

Notes: [a] U.S. average.
[b] U.S. and EU averages.

FIGURE 4. COMMODITY INPUTS TO THE MAJOR COMPONENTS OF TDC



Source: A.T. Kearney, Inc.

Based on our understanding of the relative cost structure of companies in the FMCG sector, we separated total delivery costs (TDC) into four categories for each firm in the sample: (1) raw materials, (2) manufacturing, (3) packaging, and (4) logistics.[52] Then through literature research and interviews with experts and company representatives, we developed a model to explain the contribution of our basket of commodities to the four cost categories.

The basket of commodities we studied constituted approximately 25 percent of the TDC of representative firms in 2006, as illustrated in figure 4. The raw materials and packaging segments of TDC account for a large majority of the commodity inputs and, therefore, the commodity price risk. In comparison, manufacturing and logistics costs are relatively independent of our basket of commodities. These cost areas tend to be more dependent on other inputs, for example, labor.

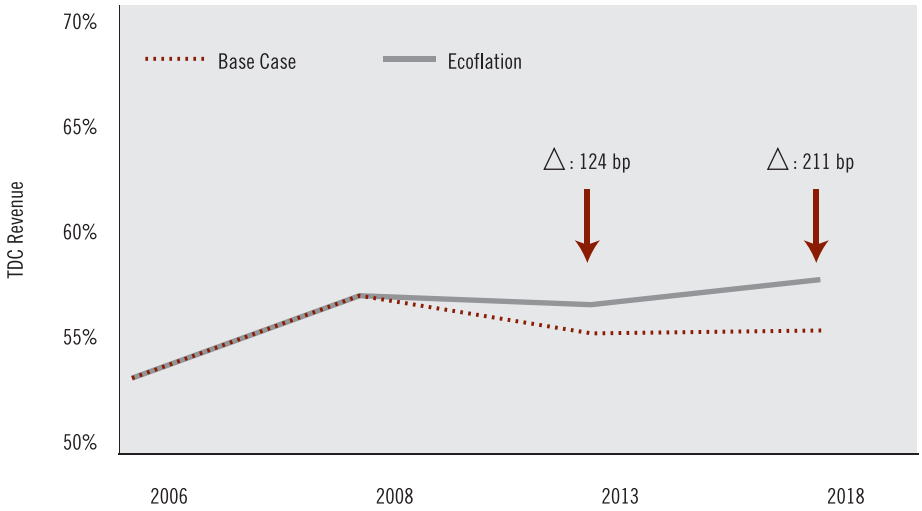
EARNINGS BEFORE INTEREST AND TAXES (EBIT)

Reductions in EBIT from the Ecoflation Scenario range from 13 to 31 percent in 2013 and from 19 to 47 percent in 2018.

Based on the exposure of firms' TDC to the commodity price changes from the Base Case and Ecoflation scenario, we next calculated the effect of TDC increases on earnings before interest and taxes (EBIT). Compared with 2006, we estimated that the firms we studied would experience an increase of 425 to 739 basis points in TDC.[53] Of this increase, the Ecoflation scenario accounted for 95 to 166 (with an average of 124) basis points (figure 5).

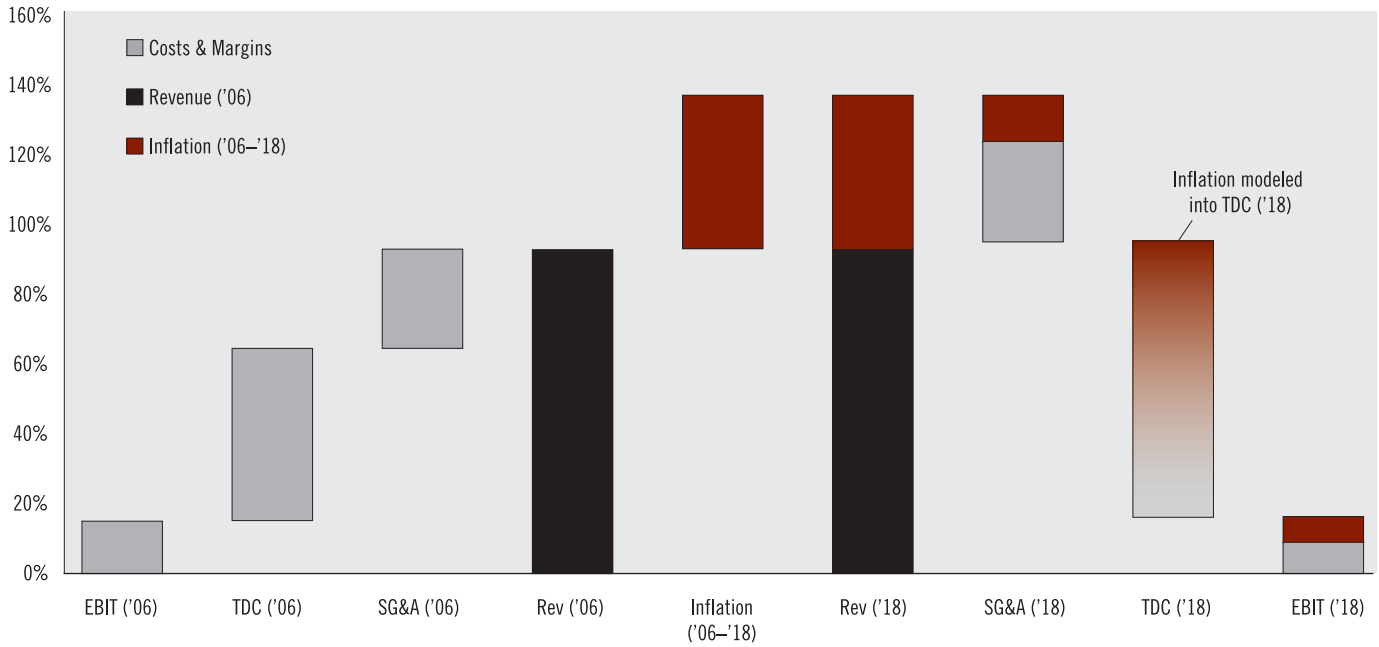
Industry stakeholders first should ask what these predicted trends in scarcity of natural resources, climate change, environmental degradation, and the related public policy responses may mean to a firm's profitability. To answer that question, we examined the EBIT corresponding to the expense data collected. We raised each firm's revenues, the TDC not explained by the modeled commodities (figure 4), the non-TDC expenses, and the EBIT by inflation (forecast to be 3.3% for 2009–2012 and 3.2% for 2013–2018). The TDC explained by the commodities in scope were increased at the rates determined in the forecasts (figure 6).

FIGURE 5. IMPACT OF BASE CASE AND ECOFLATION SCENARIOS ON TDC



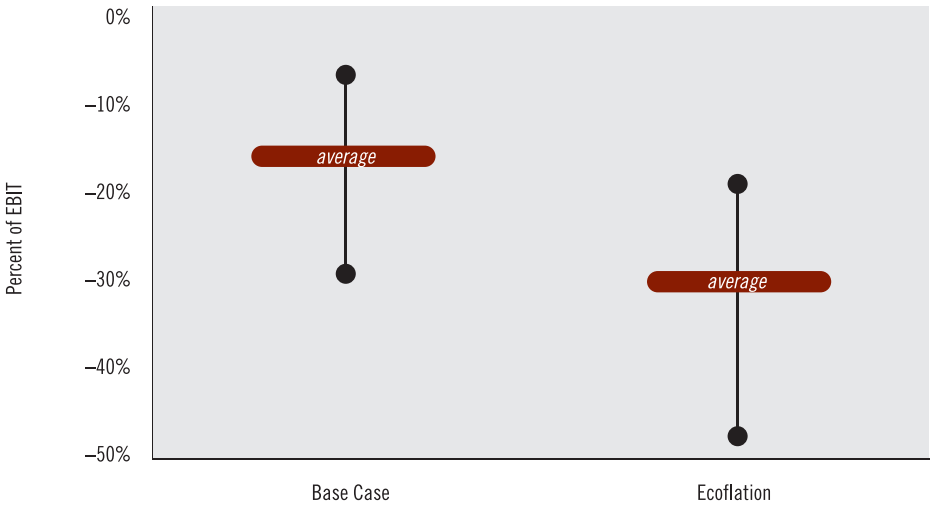
Source: A.T. Kearney, Inc.

FIGURE 6. CALCULATION OF IMPACT ON EBIT IN 2018



Source: A.T. Kearney, Inc.

FIGURE 7. RANGE OF ESTIMATED REDUCTIONS IN EBIT IN 2018



Source: A.T.Kearney, Inc.

We expect that in the Base Case, companies in the FMCG sector can collectively see an 8 to 24 percent reduction of EBIT in 2013 and an 8 to 29 percent reduction in EBIT in 2018. These values are exacerbated in the Ecoflation scenario, in which we modeled a reduction in EBIT of 13 to 31 percent in 2013 and 19 to 47 percent in 2018 (figure 7). This range represents our best guess of the most likely impact if the industry does not address these risks and if the additional costs, beyond those associated with inflation, are not passed on to the consumer. Overall, the relatively dramatic impact on EBIT from seemingly small increases in TDC is explained by the tight profit margins under which the industry operates.

Discussion: Charting a Sustainable Path for Supply Chains

Our analysis shows that current trends in environmental trends and policy responses have significant implications for businesses. In fact, in the Ecoflation scenario, the scope of our methodology and some of its assumptions may be overly conservative and understate the impact of commodity price changes. For example, owing to this great uncertainty, we did not analyze event-driven business disruptions, such as floods and other weather-related events that may result from climate change. These "eco-shocks" could be significant as well. Also, we examined only a subset of commodities, even though many of them are important to the FMCG sector. Finally, our approach focuses on environmental trends and does not reflect social and other pressing sustainability issues, such as labor and community relations, nutrition, and postconsumer waste.

Further analysis of the issues presented in this report is recommended. A valuable next step would be a macroeconomic or general equilibrium modeling exercise to frame the uncertainty and range of potential impacts arising from future environmental trends with more precision.

We provided our results for the FMCG industry in aggregate rather than for individual companies, which vary significantly. For example, a company producing beverages may be exposed primarily to inputs like sugar, coffee, water, and oil, whereas a personal care company may be more exposed to electricity, oil, pulp, and palm oil. Despite these differences, we believe that the environmental risks and exposures are material for most FMCG companies.

Supply chains are complex, and our analysis shows the interconnected nature of the four areas of TDC: raw materials, packaging, manufacturing, and logistics. Understanding the different impacts of environmental trends and policy responses on these areas is important when determining a company's strategic options to respond.

This study does not purport to be a "crystal ball" or suggest that the environmental issues confronting the FMCG and other sectors have easy solutions. But the challenges are real and significant, and the responses require action. To each company, our study asks a simple question: Are you prepared to face these challenges?

Companies that respond creatively with innovative approaches will be better positioned to navigate risk and meet the challenges ahead. We looked at published measures taken by companies and analyzed their possible effect on an industry average EBIT (see box 5). These measures generally could improve the EBIT by 3 to 8 percent. When deciding on strategies to confront soaring prices and the higher demand for environmentally preferable products, companies thus should look at all key commodities and settle on an overarching strategy. They also should share that knowledge, since reducing costs across the supply chain may mean lower costs for downstream firms and end users, hence the imperative for companies to collaborate. Resource conservation strategies will be crucial to dealing with rising costs over the long term.

Box 5. Translating Sustainability Goals in Earnings

Companies now readily communicate their accomplishments toward sustainability goals. Investors and other critical stakeholders should recognize these efforts, as they offer some insights into the environmental and social issues that these companies face and what their actions may mean in fiscal terms. In its "2007 Sustainability Report," Procter & Gamble projected a 10 percent reduction in energy usage per unit of production between 2007 and 2008, with a cumulative reduction of 40 percent for the decade.[1] If such an FMCG firm were able to spread this knowledge across its supply chain and thereby reduce the supply chain's energy usage in 2008 by 8 to 10 percent, the one-year reduction in energy usage would be an increase of approximately 37 to 48 basis points (bp) in EBIT. In addition to lowering their energy use directly, firms are trying to alter their energy profile. For example, Anheuser-Busch wants to raise its use of renewable fuels from 8 to 15 percent.[2]

Another of companies' strategies pertains to raw materials and packaging. For example, Clorox has decreased its use of resin by 5 million pounds and, on average, has reduced the packaging for Glad bag products by 45 percent, which we estimate will yield a 125-bp increase in EBIT. Companies are investigating the use of rail and barge to increase fuel efficiency. In 2008, if oil cost $140 per barrel, a 20 percent rise in fuel efficiency could mean a 73-bp increase in EBIT.

1. http://www.pg.com/company/our_commitment/pdfs/gsr07_Web.pdf.

2. http://www.abehsreport.com/documents/ABI_Summary_eng.pdf.

The question for the FMCG and other sectors is, how should they, either individually or collectively, address these trends in sustainability? It is important to note that these actions are not short-term tactical decisions but require long-term strategic planning.

We hope this report will help business leaders enact existing initiatives or support impending initiatives. We believe that beginning a dialogue about the issues we outlined or others specific to your organization will help you find a variety of ways of creating value for your organization, which will likely extend beyond managing the risk of rising commodity costs.

In this section, we offer a road map to begin addressing the issues in this report and to chart a sustainable path for business leaders. Sustainable solutions will mean engaging nontraditional internal and external resources, such as different functions across a company and outside resources like academics, suppliers, and NGOs. Along the way, setting and meeting near-term goals will provide "quick wins" to promote belief in the efforts and to generate further momentum. Yet it also is important to extend goals and analysis beyond immediate operational boundaries and first-tier suppliers, as well as the time horizon to five and ten years into the future. Business leaders must understand not just the symptoms of environmental and social issues but also the underlying drivers and systems that need to be addressed. This understanding should help a company move from short-term solutions, such as hedging or shifting suppliers, to developing longer-term, sustainable strategies.

The following is a four-step process to determine the extent of a company's sustainability challenges and opportunities:

1. Understand the environmental impacts and dependencies.

Understanding the environmental impacts and dependencies is the first step in charting a sustainable path. Multiple stakeholders along the value chain—from the providers of raw materials, packaging, and logistics, to the end consumers—will be affected by changing trends in sustainability. Firms should identify the issues that each key stakeholder faces. To

do this, they might draw a map of their value chain that shows both the visible and the hidden dependencies of commodities, issues, and stakeholders.

For a beverage company, a map of the value chain will likely reveal a dependency on clean water and sugar. This company can also look at its cost structure and the underlying cost drivers in order to determine which are exposed to environmental risks from issues ranging from carbon pricing to deforestation policy and physical climate change. If this company stopped there, however, it might miss certain shadow dependencies or future issues. By looking more deeply into its supply chain, this company might realize that the input of sugar creates a far greater dependency on water than previously thought.

In order to produce a liter of soft drink, more than 200 liters of water may be required to grow the sugarcane, compared with the 2.5 liters of water used in its bottling plants.[54] If this company is to truly understand its dependencies, it will need to calculate the relative distribution of its sugarcane between rain-fed and irrigated production to find the possible cost impacts. Furthermore, the practices of the farmers or the watersheds where the sugarcane is grown will generate different issues and risks. In this case, a beverage company may start by asking the following questions:

- Who are the other users of water in this area?
- Are water resources in this area stressed or likely to become stressed in the future?
- Is the local government likely to impose restrictions or charges on its use?

In seeking answers, it will begin to understand the extent of vulnerabilities, identify relevant stakeholders, and discover opportunities for action.

This endeavor must be forward looking and anticipate trends that might change current perceptions of environmental impacts. In the example of a manufacturer of personal care products, CO_2 emissions may currently not be a concern, since U.S. markets have no clear regulations. But in five to ten years, these emissions may add an incremental cost or become a barrier to selling products in markets under climate change mitigation programs. Hence, what first seemed not to be an issue may later become a challenge. Interestingly, in this case as in others, addressing production processes can benefit all parties through the reduction of both costs and greenhouse gas emissions, which also may help lower the future costs of addressing the effects of climate change.[55]

Besides identifying potential impacts, they must be quantified. For example, according to a recent report by Green Transportation & Logistics North America, 60 percent of supply chain executives recognize the need to quantify and reduce greenhouse gas emissions and are increasingly measuring their emissions from logistics and transportation.[56] Developing such a baseline will require close collaboration with logistics providers and others in the supply chain that may deliver some of these services.

As companies analyze the issues and find opportunities such as using substitute materials, they should also conduct appropriate analyses, such as life-cycle analysis (LCA) to establish that the alternative is indeed better. For example, a company may decide to switch to a flex-

fuel fleet that runs on ethanol, since it is "greener" than gasoline. The environmental benefits of this switch will depend on the source of the ethanol. If the ethanol is corn based, further analysis may prove the contrary. After calculating the additional fuel needed to travel a given distance, approximately 50 percent more, and the additional environmental pressures as well as the contribution to food shortages, this seemingly green alternative begins to look somewhat brown.[57] But if this ethanol is based on wastes from sustainably managed forests, the answer may look greener. The point is to use robust analytical tools, such as a credible LCA, to ensure that the right conclusions are reached.

2. Take an inventory of current initiatives.

As surveys conducted by A.T. Kearney indicate, many corporations do not have a central group responsible for coordinating sustainability initiatives. Instead, different departments often have independent strategies to address only a few issues or opportunities relevant to their functions. Without a centralized group, and considering the poor communication in numerous organizations across departments and throughout supply chains, the need to take an inventory of current initiatives is obvious. In order not to waste resources, companies will want to know what is being addressed within the firm and throughout the value chain and where gaps may exist.

After the analysis, workshops and interactions should be planned to determine environmental impacts and dependencies, and a team should identify and categorize all internal initiatives to address these issues. Companies may want to establish a process by which future initiatives are communicated to a committee or department to manage sustainability initiatives. During this process of learning, the team should go outside headquarters and reach further into the organization to look for unexpected initiatives. Similarly, the organization should become familiar with the different actions being taken by suppliers to address those environmental challenges, not only from existing suppliers, but also from future sourcing suppliers.

Transparency during this process is important to elicit a list of initiatives and also information about the effectiveness and robustness of these strategies. For example, in the case of Clorox, the National Advertising Division of the Council of Better Business Bureaus reviewed the performance test results of Clorox Green Works and decided that its advertisement required clarification, suggesting that some claims were misleading.[58] Sustainability initiatives must achieve the desired results and not prove to be ineffective or, worse, fraudulent when they are scrutinized by pressure groups, government agencies, industry groups, and others. This is true especially if consumers begin to suffer from "green fatigue" in European and North American markets, with media and civil society groups increasingly accusing consumer products companies of "greenwashing."

3. Prioritize issues and opportunities.

By delving into environmental dependencies, environmental impacts, and critical inputs, as recommended in the first step, a firm can decide how its business is or will be affected by cost or availability constraints as well as risks related to operations, investments, products, and services. Sustainability does not present just challenges; it also offers opportunities to corporations. Determining dependencies and understanding the issues will also highlight

numerous possibilities, from designing products that rely less on nonrenewable resources, to designing production processes that are more efficient, to creating new products that address emerging sustainability challenges.

Managing exposures and impacts can also reveal differences with competitors that might be appealing to consumers and could increase demand and brand loyalty. Besides chances to address specific challenges, companies that use a holistic approach will, as others have, begin to enjoy other benefits, such as improved employee morale, less turnover, more opportunities with retailers, and a strengthened role in defining the future of their industry, as opposed to having legislators or retailers define it for them.

Not all environmental issues and opportunities are "created equal" for each company. Whereas CO_2 emissions or water may be important to one company, they may be minor for another. Alternatively, a seemingly minor exposure may become significant one under changing circumstances in the future. Palm oil, for example, may comprise only a fraction of a company's commodity purchases, but price changes driven by European biodiesel policy and international efforts to curb deforestation in Southeast Asia or West Africa could change production economics for particular items that depend on palm oil. Likewise, not all consumers may respond to a "greener" product unless they perceive additional value, as some consumer products companies have found out.

After cataloging issues, opportunities, and current initiatives, they could be organized as follows:

- Efficiency measures. General Mills reduced the size of Hamburger Helper packages by 20 percent, which lowered the cost of materials and eliminated the need for 500 distribution trucks each year.
- Substitution measures. ConAgra Foods incorporated 30 to 40 percent postconsumer recycled plastic in its frozen meal trays, which removed 8 million pounds of plastic from landfills.
- Operations improvement measures. Carrefour uses sales and operations planning (S&OP) methodologies, inventory analyses, and shared logistics to reduce fuel consumption and emissions and to identify appropriate locations for manufacturing plants given the materials used, the location of suppliers, and future trends in key input availabilities such as water and energy.
- Product innovation measures. The FMCG has yet to realize important product innovation measures, for example:
  - Can food products be developed that maximize the ratio of product to input, especially as the stress on cereals and grains grows with meat consumption rising around the world?
  - Can a detergent manufacturer join a clothing company to find clothing materials that can be cleaned with a dry product to reduce water consumption?
  - Can everyday household products be sold in reusable containers to avoid waste?

The next step will be to calculate the impact on the corporation, the effort required to implement it, and the partners required to implement each initiative, so as to find the most pressing issues and opportunities. In determining priorities, companies may discover that a particular strategy will require it to work closely with governmental agencies and civil society groups to address complex and sometimes controversial issues. If that is the case, the issue of time must be considered in order to set reasonable expectations of completion dates. In other cases, a company will recognize that an issue is best addressed with other partners or competitors in its value chain and that therefore education and outreach may be required. In certain instances, the industry as a whole may have a productive role to play in facilitating this education and outreach to participants in its value chain that span more than one company.

Considering that one company may not be able to tackle all issues, it is critical to decide which are most relevant to the company's stakeholders—be they employees, consumers, or shareholders—so as to include their relevance as an important criterion for prioritization.

4. Chart a new course: Make sustainability principles part of an action plan.

Whether it is a factory retrofit to increase energy efficiency, a formulation redesign to reduce dependency on volatile commodities, or less packaging to lower paper and transportation costs, each priority action must be based on a clear and compelling business case and have an appropriate action plan with clearly outlined metrics and milestones to measure progress. This portfolio of actions should include an appropriate mix of short-term and long-term strategies, such as short-term efficiency improvements and longer-term process transformation for step-change improvements. Hedging strategies or generating supplier competition will not provide sustainable results for the challenges that we have outlined in this report. Although developing a compelling business case is not a new idea for any competent executive, if a company truly wants to adopt sustainability principles, it should use nontraditional tools to make the business case.

These nontraditional tools include collaborative development, scenario planning, life-cycle analysis, and externalities factored into financial models.[59] Collaborative development with multifunctional teams, nontraditional partners like NGOs and/or academics will help companies find strategies to resolve the complexities of environmental challenges and extend beyond the symptoms of underlying problems. Scenario planning will help companies research the future to inform the present and to test assumptions and develop appropriate risk management plans or adopt option portfolios that account for uncertainties. Life-cycle analysis will help determine whether a plan is indeed beneficial from cradle to cradle, that is, from the origin of the input through the reuse or recycling of the product or its packaging. Factoring externalities into financial models will force companies to test whether their strategy will benefit all relevant stakeholders.

The record of winners and losers usually is defined by companies' ability to anticipate the implications of the changing landscape, collaborate with suppliers and other stakeholders, and make sustainability one of their core business principles. Supported by the analysis in this report and informed by a deep understanding of emerging environmental trends, we believe that if they are to adapt to these challenges, companies will need to make real

structural changes, such as product innovation, and to restructure their value chains. There is much at stake, as corporate responses to sustainability challenges will affect not only the companies themselves but also millions of existing and new consumers and the natural resources on which everyone depends.

Notes

1. http://www.wri.org/publication/rattling-supply-chains.
2. Population Reference Bureau, "2008 World Population Data Sheet," August 2008.
3. Jonathan Ablett et al., "Bird of Gold," McKinsey Global Institute, May 2007; and Diana Farrell et al., "'From Made in China' to 'Sold in China': The Rise of the Chinese Urban Consumer," McKinsey Global Institute, November 2006.
4. Calculated from NYMEX and the Chicago Board of Trade data, January 2006 to June 2008.
5. "The Forbes Global 2000," *Forbes Magazine*, April 2008.
6. Food and Agriculture Organization (FAO), "Livestock's Long Shadow" (Rome: FAO, 2006).
7. R. L. Naylor, A. J. Liska, M. B. Burke, W. P. Falcon, J. C. Gaskell, S. D. Rozelle, and K. G. Cassman, "The Ripple Effect: Biofuels, Food Security, and the Environment," *Environment* 49(9):30–43.
8. Calculated from the Food and Agricultural Policy Research Institute, "2008 Agricultural Outlook" (Ames Iowa: Iowa State University, 2008).
9. Ibid.
10. Derived from "eco" plus "inflation."
11. Oil, coal, and natural gas price projections were obtained from the Energy Information Administration's *Annual Energy Outlook 2008*. Agricultural commodity price forecasts are from FARPI's *2008 Agricultural Outlook*.
12. In appreciation of the complexity of the EIA's and the FAPRI's undertakings, we have not deviated from the price points modeled by these groups, since we are not able to manipulate the models' inputs themselves. But for maximum disclosure, we do outline the underlying assumption, in the technical document available at http://www.wri.org/publication/rattling-supply-chains.
13. Also known as the America's Climate Security Act of 2007 (S 2191), this bill would create a national cap-and-trade scheme for greenhouse gas emissions, in which most polluters would be allocated right-to-emit credits based on how much greenhouse gas they currently emit. The cap would tighten over time, until by 2050, emissions would be reduced to 63 percent below 2005 levels.
14. Comprehensive Assessment of Water Management in Agriculture, *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture* (London: Earthscan, and Colombo: International Water Management Institute, 2007).
15. W. B. Solley, R. R. Pierce, and H. A. Pearlman, "US Global Change Research Program," 1998, available at http://www.usgcrp.gov/usgcrp/library/nationalassessment/14c.pdf.
16. In May 2008, an amendment to the Lacey Act was enacted by the U.S. Congress to require all goods imported into the United States that contained any plant content to declare the species and origin of the plant, in order to ensure its legality.
17. Seneca Creek Associates, LLC, and Wood Resources International, LLC, "Wood for Paper: Fiber Sourcing in the Global Pulp and Paper Industry," paper prepared for the American Forest and Paper Association, 2007, available at http://www.afandpa.org/temp/AFPAFiberSourcingPape12-07.pdf (8/22/08).

18. Brazilian Pulp and Paper Association (Bracelpa), "Brazilian Pulp and Paper Industry: Industry Overview," 2008, available at http://www.bracelpa.org.br/eng/estatisticas/pdf/booklet/Booklet%20Coletiva%20-%20Dezembro%202007%20Ingl%C3%AAs.pdf (7/22/08); PriceWaterhouseCoopers, "Risks and Rewards: Forest, Paper and Packaging in South America," 2007, available at http://www.pwc.com/Extweb/onlineforms.nsf/docid/CA1F9C0804C4CA348525730D007BC094?opendocument; C. Barr and C. Cossalter, "How Competitive is Wood Pulp Production in South China?" CIFOR, 2004, presentation at the meeting China and the Global Forest Products and Trade: Strengthening Production and Policy, available at http://www.forest-trends.org/resources/meetings.htm#B32006; PriceWaterhouseCoopers, "Risks and Rewards: Forest, Paper and Packaging in Russia," 2006, available at http://www.pwc.com/Extweb/industry.nsf/docid/8044514ABA5FEDE78025712200647AB6.
19. Liz Dixon Smith, "Realising the Value of Recovered Paper," Waste & Resources Action Programme, 2007.
20. T. Searchinger et al., "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases through Emissions from Land-Use Change," *Science* 319(5867):1238–40.
21. M. Von Lampe, *Agricultural Market Impacts of Future Growth in the Production of Biofuels* (Paris: Working Party on Agricultural Policies and Markets, AGR/CA/APM(2005)24/FINAL, Committee on Agriculture, OECD, 2006).
22. Naylor et al., "The Ripple Effect,"30–43.
23. M. W. Rosengrant, *Biofuel and Grain Prices: Impacts and Policy Responses: Testimony before the U.S. Senate Committee on Homeland Security and Governmental Affairs*, May 7, 2008; available at http://www.ifpri.org/pubs/testimony/Rosegrant20080507.asp.
24. Food and Agricultural Policy Research Institute (FAPRI), "Biofuels: Impact of Selected Farm Bill Provisions and Other Biofuel Policy Options," FAPRI-MU Report 06-08.
25. Naylor et al., "The Ripple Effect," 30–43.
26. More information about the issues, data sources, assumptions, and price impacts of the scenarios can be found in a technical document on WRI's website, http://www.wri.org/publication/rattling-supply-chains.
27. Sergey Paltsev et al., "Assessment of U.S. Cap-and-Trade Proposals, Appendix D: Analysis of the Cap and Trade Features of the Lieberman–Warner Climate Security Act (S.2191)," MIT Joint Program on the Science and Policy of Global Change, Report 146, 2007.
28. Energy Information Administration (EIA), "Energy Market and Economic Impacts of S2191, the Lieberman–Warner Climate Security Act of 2007," April 2008.
29. In the Ecoflation scenario, we calculate energy prices by adding the carbon price directly to the price of oil, coal, and natural gas based on the carbon content of each fuel and assumed no consequent price adjustments in response to the likely downward demand response. The base scenario price is applied for fossil fuel use as a raw material, as is consistent with the MIT, but not the EIA, findings. It is important to understand that these prices reflect only first-order impacts to fuel prices and do not incorporate changes in demand, efficiency gains, infrastructure costs, substitution effects, and other variables that would ultimately determine the price of oil and electricity. This, combined with more recent energy price projections from the Energy Information Administration (June 2008), means that our oil prices are higher than those predicted by both the EIA and MIT and that our electricity prices are lower than all but the EIA's "core" scenario.
30. Rosengrant, "Biofuel and Grain Prices."
31. Calculated from FAPRI, "2008 Agricultural Outlook."
32. Naylor et al., "The Ripple Effect," 30–43.
33. FAPRI, "Biofuels."
34. P. Rogers, A. Bhatia, and A. Huber, "Water as a Social and Economic Good: How to Put the Principle into Practice," (Stockholm: Global Water Partnership, 1996).
35. OECD, "The Price of Water: Trends in OECD Countries" (Paris: OECD, 1999).
36. Rogers et al., "Water as a Social and Economic Good."
37. D.C. Morton et al., "Cropland Expansion Changes Deforestation Dynamics in the Southern Brazilian Amazon," *Proceedings of the National Academy of Sciences* (103:39 2006): 14637-14641.
38. Interview with Dan Nepstad of the Woods Hole Research Center, "U.S. Ethanol May Drive Amazon Deforestation," May 17, 2007, available at http://news.mongabay.com/2007/0516-ethanol_amazon.html.
39. "Deforestation in the Amazon," data from the National Institute of Space Research (INPE), available at http://www.mongabay.com/brazil.html.

40. Roughly estimated based on Brazilian sugar supply and utilization projections provided by FAPRI.
41. Calculated from FAPRI, "2008 Agricultural Outlook."
42. Ibid.
43. Seneca Creek Associates, LLC, and Wood Resources International, LLC, "Wood for Paper: Fiber Sourcing in the Global Pulp and Paper Industry," paper prepared for the American Forest and Paper Association, 2007, available at http://www.afandpa.org/temp/AFPAFiberSourcingPape12-07.pdf (8/22/08).
44. Ibid.
45. Ibid.
46. Wood Resources International, "Wood Fiber Shortage Reduces Pulp Production in Indonesia in the 4Q," April 3, 2008.
47. Ibid.
48. M. Ohrenschall, "GREEN: Sustainably Managed Forest Products," *Builder News Magazine*, April.
49. Paper Task Force, "Recommendations for Purchasing and Using Environmentally Preferable Paper," Environmental Defense Fund, 1995.
50. Environmental Paper Network, Caledonian Shanks Centre for Waste Management, 2000.
51. Paper Task Force, "Recommendations for Purchasing and Using Environmentally Preferable Paper," Environmental Defense Fund, 1995.
52. Note that raw materials include not only directly utilized materials, such as grains in alcohol and oil in plastic, but also their indirect use. For example, in the case of dairy, grains and soybeans are consumed by the cow; electricity is used to power the processing facilities; and oil is combusted to transport the goods. In addition, petroleum products are used to produce chemicals and fertilizer, which increase crop yields to feed the cows. All these inputs are accounted for in the raw materials category.
53. A basis point is equal to 1/100th of 1 percent.
54. http://www.time.com/time/magazine/article/0,9171,1814261,00.html.
55. http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_Report.cfm.
56. http://www.environmentalleader.com/2008/08/14/green-efforts-hampered-by-broken-supply-chains/.
57. http://www.usatoday.com/tech/columnist/andrewkantor/2005-06-24-green-tech_x.htm.
58. http://www.environmentalleader.com/2008/08/17/nad-tells-clorox-to-clean-up-ads/.
59. One such tool is the Corporate Ecosystem Services Review (ESR), developed by The World Resources Institute, the Meridian Institute, and the World Business Council for Sustainable Development. The ESR is a methodology to help corporate managers proactively develop strategies to manage business risks and opportunities arising from their company's dependence and impact on natural ecosystems.

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