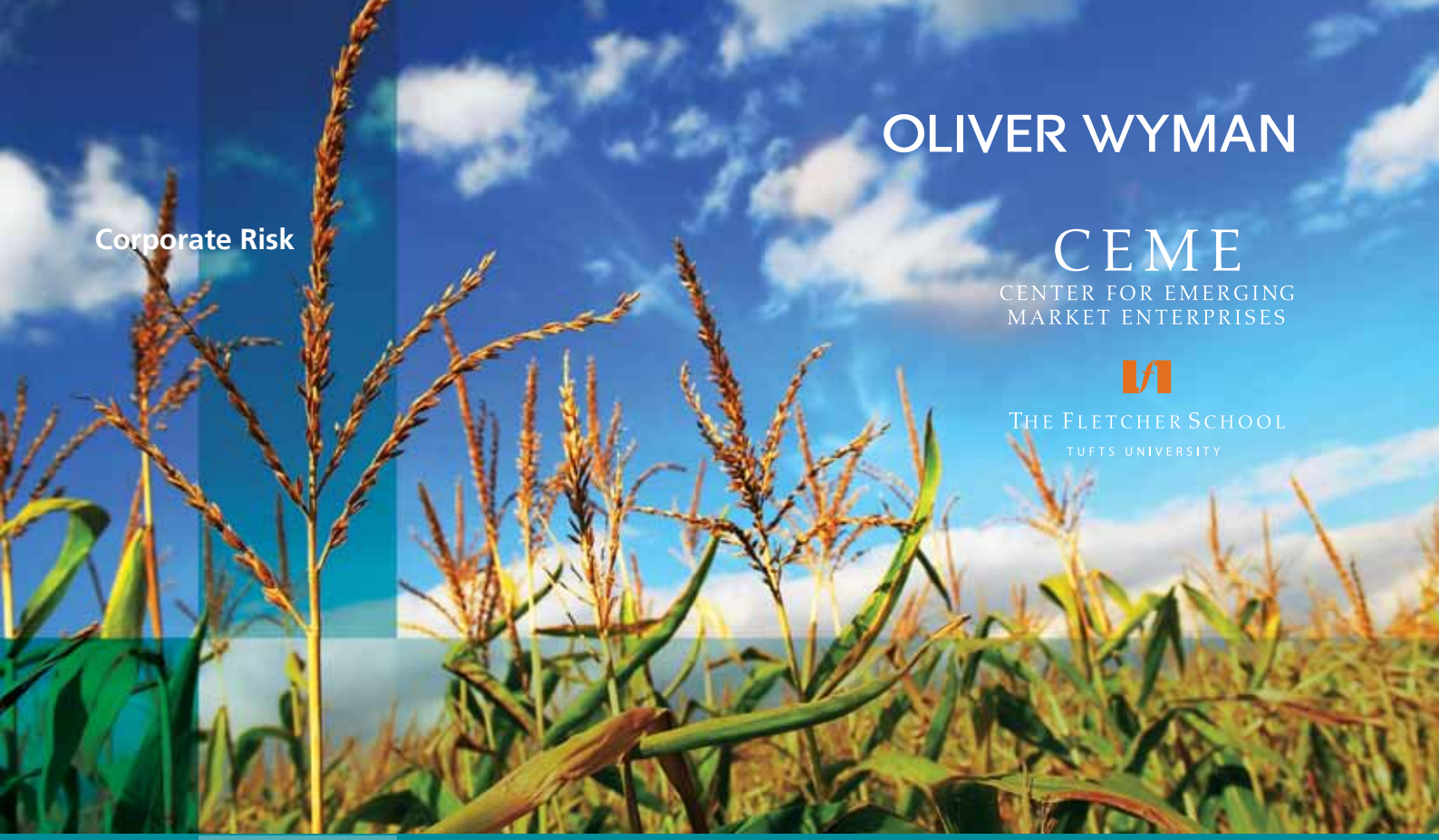

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Food/fuel price dynamics: Developing a framework for strategic investments

Introduction

At the height of the food and fuel price explosion in 2007 and early 2008, a heated debate arose about the relationship between these two commodities' markets. During the peak of the crisis, the prices of all commodities rose, but the direct impact of higher food and energy costs on citizens and companies captured the attention of governments, journalists, commentators and analysts. Most observers made assumptions about the food/energy relationship, the causes of the price fluctuations, and proposed solutions with a general view that rising energy costs and the increased use of biofuels were a core driver of rising food costs. Now that prices have stabilized, the relationship is getting much less press, but detailed research reveals that it is not as straightforward as it was portrayed during that food-fuel price spike.

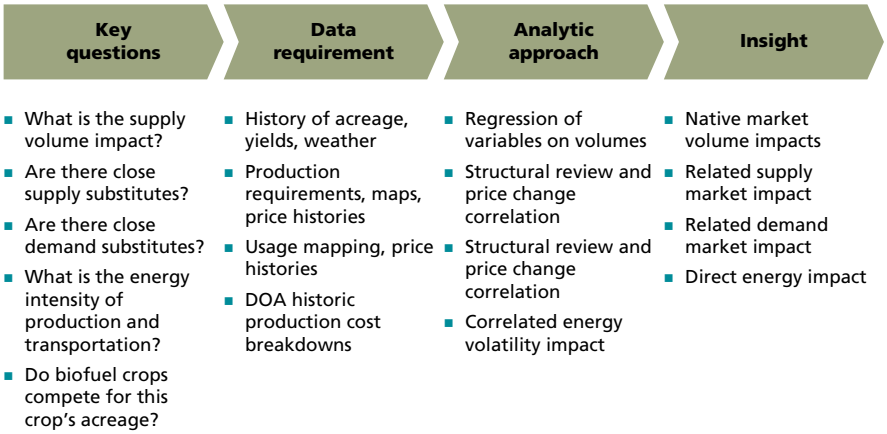
The potential for changing relationships among commodity group prices driven by the emergence of biofuels presents both new risks and new opportunities for many organizations. The purpose of this study is to strip away previously held conceptions about the relationship between the food and energy markets by testing some common hypotheses, specifically:

1. The recent commodity price spike signaled a new era of significantly increased prices
2. There is a strong correlation among commodity group prices, particularly meat and grain prices such as beef and corn
3. Increased use of biofuels will change the relationship between commodity groups with a significant impact on prices and demand

Our goal is to develop a thorough understanding of the relationship between these commodity markets, based on rigorous data analyses, to enable companies with different positions along the value chain to develop perspectives on how to manage the risks or take advantage of this dynamic environment.

This thorough understanding of the factors influencing commodity prices can then be incorporated into a structured data analysis process, such as the one shown on the following page. This was the process used in performing this study and the approach can be utilized whenever firms are confronted with strategic choices that may be impacted by events in these volatile and potentially interlinked markets.

Exhibit 1: Data analysis process



Mega-trends affecting food and fuel markets

In the long term, price dynamics of commodities are driven by large macroeconomic trends, many of them common for both food and energy. Global population growth, as well as an increase in GDP per capita, particularly in developing countries, has led to a growth in demand for energy as it is substituted for human labor. Increasing population and income levels have also driven demand for animal proteins, with secondary effects including raising demand for animal feed. Since the production of one pound of beef typically requires seven pounds of feed, increased demand for meat can dramatically drive up grain demand.

Resource constraints have also contributed to price volatility. For example, the already limited supply of economically accessible oil and natural gas is stressed by shifting geopolitics, carbon emission regulations, and water requirements. On the food side, arable land is limited, and that scarcity and highly variable fertilizer prices contribute to uncertainty. At the same time, technological advances such as energy efficiency, the emergence of renewable resources and increasing agricultural yields, offset some of the supply constraints.

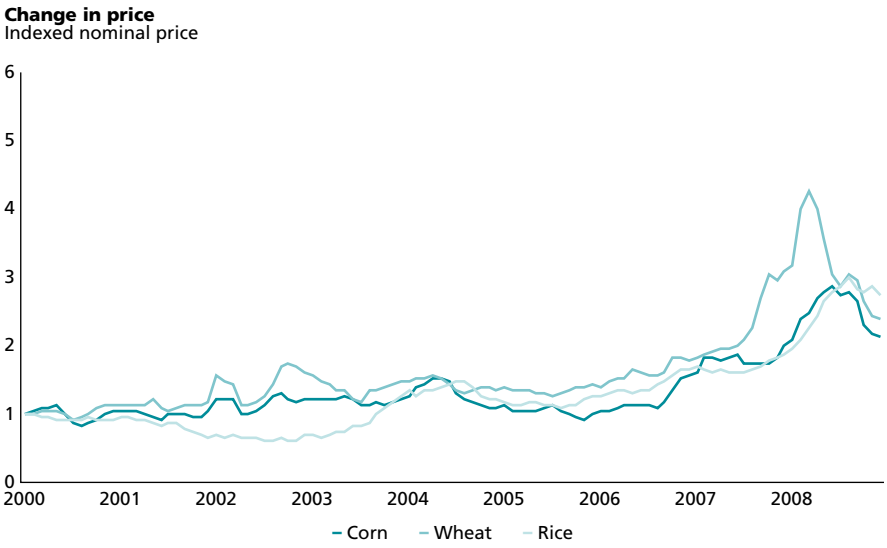
What goes up...?

In light of these factors, commodity prices appeared to be undergoing a structural shift to higher levels in the long term, with the prospect of significant future increases. However, an analysis of historical data helps put the 2007-2008 prices in context.

Hypothesis	The recent commodity price spike signaled a new era of significantly increased prices
Finding	Prices have returned to levels consistent with historical trends

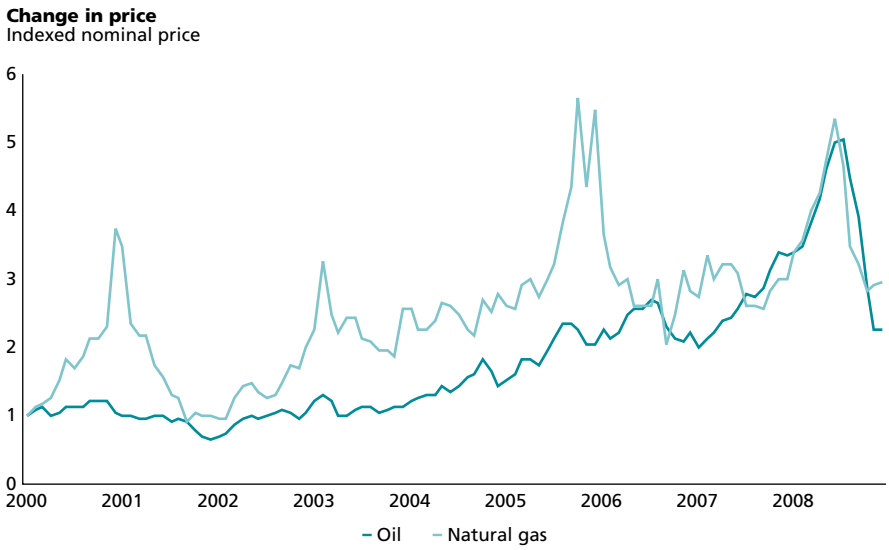
Following a long period of relative stability, in 2006 the prices of major crops had started to climb, almost tripling by mid-2008. However, recent price escalation notwithstanding, agricultural commodity and fuel price trends have been largely consistent over the past 50-plus years. In the last 30 years, grain prices appear to have followed a mean-reverting pattern, although it is hard to distill the precise governing process as nominal prices are affected by inflation and other factors. In real terms, grain prices have been falling since the early 20th century, though more recently prices have been relatively stable in nominal terms. It remains to be seen if this stable or declining environment will continue, in light of increasingly binding constraints driven by global warming and new uses of agricultural resources like biofuels. Nonetheless, while the 2007 spike was seen by some as the beginning of a structural shift in the price of commodities, the late 2008 price decline indicated that that assessment may be premature.

Exhibit 2: Historical grain prices



Source: United States Department of Agriculture (USDA)

Exhibit 3: Historical energy prices



Source: Energy Information Administration (EIA)

Organizations active in the energy or food production sectors have long expected to see short-term price fluctuations, but grains have now clearly broken away from their long-term historical price behavior. Volatilities have increased somewhat as supplies of many commodities have grown increasingly stressed, but this is not universally observed. Corn in particular has remained fairly stable. Now, models and assumptions used for key decision support might still be based on historical patterns, but stress tested using extreme price changes such as those seen in the 2007-2009 period.

Correlations and causality

Commodities prices have always been, and are expected to remain, volatile in the short term, and the level of volatility and correlations exhibit several discernible characteristics. This is true within both the energy and agricultural sectors.

Exhibit 4: Annualized volatilities

Crude oil	29%
Gasoline	36%
Diesel	30%
Natural gas	52%
Ethanol	37%
Corn	20%
Rice	16%
Wheat	24%
Pork	16%
Beef	16%
Chicken	20%

Source: EIA and USDA data 2001-2008

Energy commodities have long exhibited the highest degree of price volatility. Grains follow, and proteins exhibit the lowest historical levels of price volatility. This may be explained, at least in part, by the cost of processing each good relative to the input cost.

The correlations between the different commodity prices can be broadly understood to mean the extent to

which the prices move together. It is important for organizations to understand how their input and output prices may change, both individually and cohesively, in order to effectively plan and deal with the risks in these markets.

During the recent food/energy price crisis, many commentators attributed the rising food prices to rising energy, particularly fuel, prices. Data analysis refutes the view that fuel prices were the sole, or even a major, driver of food prices.

Hypothesis	There is a strong correlation among commodity group prices, particularly meat and grain prices such as beef and corn
Finding	Price correlations are naturally higher within commodity groups, and the price correlation between commodity groups is unexpectedly low

Given that many drivers, particularly on the demand and monetary side, are common for all commodities, it is no surprise that all commodity prices show some level of positive historical correlation, though it is surprising that some of the correlations are not stronger.

Exhibit 5: Correlations within energy commodities

	Crude oil	Gasoline	Diesel	Ethanol
Gasoline	0.97			
Diesel	0.99	0.98		
Ethanol	0.81	0.86	0.84	
Natural gas	0.73	0.74	0.77	0.68

Price correlations within commodity groups are naturally high. The energy commodities group has historically shown the highest internal price correlations, and within these it is clear that the petroleum products are the most closely related components.

The food commodities also exhibit higher correlations within their groups, although the relationship among the grains is significantly stronger than that among the proteins.

Exhibit 6: Correlations within food commodity groups

	Corn	Rice
Rice	0.88	
Wheat	0.91	0.81

	Pork	Beef
Beef	0.49	
Chicken	0.49	0.53

The factor driving these food price correlation levels appears to be fungibility, and the low level of substitution among proteins may be

somewhat surprising. This may indicate that human consumption patterns of these proteins are not primarily economic, but a function of preferences, culture, and habit. As a result, rising beef prices do not lead directly to increases in chicken consumption.

Similarly, the low correlation between meat and feedstock prices was also unexpected, and may be due in part to different storage characteristics (i.e., costs and storage lives). Overall, the recent increases in corn prices had a limited impact on feed prices, which are composed of many grains, some of them highly substitutable. The data show that the increases in meat and poultry prices were significantly lower than the price increases for crops (with one result being a significantly reduced margin for meat and poultry farmers).

Exhibit 7: Correlations across food commodity groups

	Corn	Rice	Wheat
Pork	0.29	0.51	0.17
Beef	0.50	0.65	0.46
Chicken	0.47	0.45	0.38

Perhaps most relevant to the food/fuel debate are the price correlations between these two groups. Here we observe that the price of ethanol has a higher correlation with petroleum products than with corn, indicating that the demand linkage between ethanol and gasoline is at least as, if not more, important than the cost structure linkage between this feedstock (corn) and product (ethanol). This is further demonstrated in the volumes demanded between 1999 and 2007, when consumption of ethanol quintupled, without any concurrent major increase in corn prices.

Exhibit 8: Correlations between food and fuel commodities

	Corn	Rice	Wheat	Pork	Beef	Chicken
Crude oil	0.82	0.87	0.85	0.48	0.61	0.35
Gasoline	0.76	0.82	0.77	0.55	0.66	0.40
Diesel	0.79	0.86	0.82	0.50	0.63	0.35
Natural gas	0.50	0.61	0.52	0.39	0.65	0.31
Ethanol	0.56	0.73	0.58	0.53	0.64	0.29

Examining the cost structure of corn as an example of how energy costs could impact corn prices, it is true that two-thirds of operating production expenses are directly or indirectly driven by fertilizer, chemicals, or fuels. But the total operating expenses are roughly half of total production costs and the direct fuel component alone is only 7-8% of the total costs. What these cost structures mean for a company specializing in agriculture and food products is that the prices of their

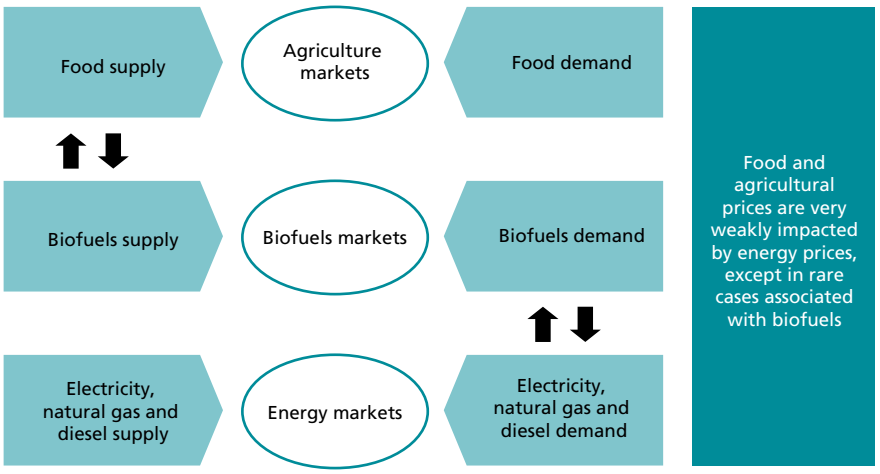
end products do show some correlation with fuel costs and this effect is more pronounced for grains than for proteins, as shown above.

Furthermore, it also suggests that rising energy costs alone cannot account for the spike in food prices that put pressure on many of the world's poor through 2007 and 2008, and created increased uncertainty regarding investments and strategic choices in both the food and energy sectors.

Decision support framework

A deliberate and robust decision framework is essential to cut through the fog of these food/energy price dynamics and quantify the real relationships and market behaviors that will govern the success or failure of large-scale investments in the long term. Organizations throughout the supply chain can use this framework to understand the sensitivity of their output prices to their input costs and the interrelatedness of their products. Understanding volatility medium-term can assist with large capital decisions, such as the construction of new factories or introductions of new product lines. In addition to understanding the volatility itself, a firm grasp of commodity correlations is useful in recognizing how the volatilities of the various factors in the value chain impact one another.

Exhibit 9: Decision support framework



In the case of energy markets, only transportation fuels are linked to the biofuels markets, and a complex regulatory infrastructure tends to govern the demand side of these markets. However, as the demand for biofuels increases, it threatens to change the game significantly.

Biofuels: Changing the game

Hypothesis	Increased use of biofuels will change the relationship between commodity groups with a significant impact on prices and demand
Finding	Biofuels have yet to demonstrate a significant and lasting impact on prices or demand – but that potential is clearly real

The commodities price spike in 2007 and early 2008 was caused by a confluence of several factors, some of which were common to all commodities. Chief among these were an extended period of economic growth, particularly in India and China, driving demand for commodities, and depreciation of the dollar. Relatively poor crops in Australia, EU, and Ukraine in 2006 and 2007, and trade restrictions imposed by many grain producing countries in 2006-2008 were casual factors in agriculture. Two newer factors were the speculation in the commodities markets by financial players and the increased grain demand due to an expanded biofuels industry, although the historical impact of either of these is less clear.

Biofuels are positioned to have a particularly interesting impact on commodity markets and on the price dynamics across commodity groups. They were never previously present in supply or demand side volumes, and they establish an entirely new linkage between food and fuel markets. Fuel and fertilizers are clearly components of the cost structure of most grains, but the corn price is also a major component of ethanol cost. Now, for the first time, not only does fuel affect grains, but grains also affect fuel. Thus, it is incumbent on any company operating in the food/fuel space to have an understanding and view on the role biofuels are likely to play in the relationships between these key commodities.

Biofuels are here to stay, thanks to several characteristics that make them an appealing alternative to petroleum fuels – such as reduced emissions, decreased dependency on foreign oil and a smaller environmental impact – and to strong political support for biofuels in the US, EU, and Brazil, among other markets. The dynamics of the industry is heavily affected by the "blend wall," or the maximum percentage of biofuels that can be blended with a core fuel without modifications to engines and infrastructure. At volumes below the blend wall, a total of 10-12 billion gallons of ethanol annually (8-10% of total gasoline consumption), the industry is effectively mature. Price competition is a key consequence of such a mature industry and margins tend to accrue to blenders rather than corn producers.

However, if the volume of ethanol demanded exceeded the levels defined by the blend wall, the impact on the commodity markets would be highly uncertain. Feedstock availability would be called into question if corn harvests could not meet this higher demand, yet this might have little impact on food product prices. As noted above, there is a low correlation between meat and feedstock prices, and there is no precedent for the relationships at such a high volumes.

Other scenarios include the emergence of alternative biofuels (e.g., biodiesel) which would reduce the net demand for ethanol. Technologically, the biofuels industry is still advancing; cellulosic ethanol is promising but economically untested, and algae-based technologies are appealing but also unproven. The economics of both are likely to be highly location-specific. Furthermore, consumer acceptance of ethanol is not a given as it is inherently inferior to petroleum gasoline in terms of several performance measures. The future of biofuels is also dependent on infrastructure investments and regulatory support, which will undoubtedly be impacted by national and international policy and the level of enforcement of those mandates. This diverse range of possible scenarios that describe how the biofuel market might evolve, serves to highlight the uncertainties in both the near and longer term.

Conclusion

In summary, this study reveals that:

- Recent price spike notwithstanding, long-term agricultural commodity and fuel price trends have been largely consistent over the past 50-plus years
- Price correlations are higher within commodity groups, and the correlation between commodity groups is unexpectedly low
- There is a low level of substitution among animal proteins
- There is low correlation between meat and feedstock prices
- Rising energy prices have had a greater impact on biofuel prices and demand than rising feedstock or food prices
- If fuel prices rapidly increase again or if ethanol mandates are enforced, ethanol prices can be expected to rise, and could put pressure on corn prices

Together, these observations support a view of food/energy price dynamics in which grain prices are typically only loosely related to fuel prices. But the observations also reveal that that price linkage could become quite strong under a number of plausible scenarios (i.e., increased ethanol demand). In addition, the volatilities, levels and relationships among the prices of these commodities are quite idiosyncratic, requiring detailed analysis of the precise commodities of interest before robust conclusions can be drawn.

Even though predicting short-term volatility or correlations is anything but accurate, in the medium-term, a risk manager or strategist thinking about the relative market dynamics of specific food and fuel commodities can use a disciplined framework to address each commodity's inherent properties. The most salient of these include:

- Production cycle
- Storability
- Transportability
- Fungibility
- Strategic importance

All of these play roles in the supply and demand dynamic identified in the decision support framework. Ultimately that framework must address the supply side and demand side of each relevant market, and assess the extent to which these may be related. Several energy and food markets were examined in this study, and one key finding is that each specific market is quite different. If crucial strategic or investment decisions are to be guided by any analyses of these markets, the analysis must be thorough, robust, and specific.

The historical escalation of food prices around 2007 was the result of numerous factors, and detailed analyses show that ethanol demand appears to have played a very minor role, if any at all. That said, corn is currently the key feedstock in ethanol, whose demand is expected to grow exponentially in the near future. Envisioned demand for ethanol will create the potential for dramatic corn price escalation. Mitigating the explosive growth in biofuel demand are political, technical, and infrastructure barriers, and a good deal of uncertainty. While the current link between food and fuel prices is weak at best, these unknowns may continue to drive volatility until they are resolved.

Methodology

This paper is the result of a joint study by Oliver Wyman and The Center for Emerging Market Enterprises, Tufts University. The goal of the study was to examine the implications of the dual use of commodities for both food and energy and to draw together the key facts required to guide multinational corporations through an increasingly complex decision-making environment.

This study began with statistical analysis of the price levels and correlations of five fuels (crude, gasoline, diesel, natural gas, and ethanol), three grains (rice, wheat, and corn), and three proteins (beef, pork, chicken). That was followed by economic analysis of the fuel and food value chains, including technology, cost structure, industry supply curves, bottlenecks, availability of feedstock, infrastructure, retail, demand analysis, and consumer preferences. Also included in the analysis was an assessment of relevant public policy issues, including regulations and trade patterns.

The quantitative analysis was followed by interviews with leading participants along the value chains. Companies interviewed in the food sector specialized in agricultural inputs, production and commodity markets, as well as food processors and companies in the retail food sector. Fuel sector interviewees included biofuel production and retail fuel companies.

Oliver Wyman is an international management consulting firm that combines deep industry knowledge with specialized expertise in strategy, operations, risk management, organizational transformation, and leadership development.

The Center for Emerging Market Enterprises at The Fletcher School, Tufts University is global hub for enterprise-based research, study, and networking. Core research topics, including enterprise strategy, local capital markets, energy and commodity markets, and inclusive commerce, address critical issues for businesses operating in emerging markets. For more information, please visit http://fletcher.tufts.edu/ceme.

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