

The decade ahead
Preparing for an
unpredictable future
in the global chemical
industry



1 Executive summary

As the global economy emerges from the Great Recession of 2007–2009, the chemical industry finds itself passing through a period of profound transformation. Profit margins have been shrinking; return on capital has been in steady decline. The recent recession has only exacerbated the problems. The commodity side of the business has been investing in large-scale advantaged capacity in developing markets and is now struggling with overcapacity. Among the fragmented specialty producers in developed markets, competition is growing more fierce, end markets are in chaos, and rationalization continues. Integrated players, wary of declining profits on the commodities side, are searching for ways to shift their portfolios to include more specialized products.

To gain deeper insights into the performance of the chemical industry, the Deloitte Touche Tohmatsu (DTT) Chemical Group analyzed the financial and operational performance of 231 global public chemical companies between 1998 and 2008, including specialty, commodity, and integrated players. This analysis shows that profitability has suffered in both the commodity and specialty sectors. Profits will continue to decline unless steps are taken to reverse the trend. In the coming decade, established strategies will be an inadequate foundation for success and may not ensure survival. New approaches are required as prerequisites for competitive viability. Naturally, the specifics of these approaches vary by sector.

For commodity chemical companies, the priority remains to preserve cash and increase free cash flow but in many cases that is quite a challenge. Excess capacity will be a major theme in the years ahead, prices will come under further pressure, margins will be further squeezed, and any cash that is wasted will be missed.

The specialty chemicals sector faces several challenges independent of the competitive pressures in the commodity sector. Companies in this sector will need to find better ways to focus on customer behavior and tailor their operations to offer only the most profitable products and services.

For integrated chemical companies, it is reasonable to assume that both commodity and specialty challenges will apply. Additional acquisitions will be a prime objective in the years ahead, particularly as a means of moving farther downstream into the specialty chemical sector.

The industry is further delineated by geography. Commodity chemical companies are shifting to lower cost, higher future demand centers in the developing world and today, the Asia-Pacific region holds the market share lead. The Middle East has a smaller but growing share but demand is quite unlikely to match supply. Meanwhile, the chemical industry continues to play a key role in the economies of the United States (U.S.) and the European Union (EU). That said, even specialty producers are fighting to keep market share and are facing new competition, including from companies located elsewhere.

For the suggested changes, there are common themes, including adopting a more disciplined and focused approach that responds to new challenges. Underlining these measures is the pursuit of strategies based on clear and distinctive value propositions that are themselves based on an in-depth understanding of customer needs and preferences.

Yet the reality is that the more a strategy focuses on differentiation and competitive advantage, the more success depends upon correctly predicting market behavior. But choosing the formulas for success is difficult given uncertainties about the future shape of the business environment. Over the next decade, chemical industry executives could face competitive dynamics that differ from today's conventional wisdom and expectations.

When the way forward is unclear, keeping a range of alternative possibilities in view is crucial to effective planning. Studying scenarios is effective for defining and working with multiple perspectives on the future. Scenarios relevant to the chemical industry can be constructed from discussion and debate currently underway in the public and private sectors, in academia, and in the media.

Reviewing the predictions, analyses, and commentaries from these sources reveals differing points of view concerning the outlook for the economy, regulation, and technology, which we have woven into the following three scenarios of how the global business environment could unfold between now and 2020:

- **Transition.** Western economies suffer inflationary spells followed by hard landings, while the developing world focuses on domestic consumption and enjoys steadier growth. Economic and energy supply issues are higher priorities than emissions control.
- **Resilience.** In both developed and developing nations, growth rebounds as governments play an active role in managing their economies, directing investment, and promoting national competitiveness. Renewable energy and nanotechnology are among the top areas targeted for support.
- **Dislocation.** Difficult challenges and heavy-handed government policies keep growth subdued in the West. In Asia and the Middle East, the falloff in foreign export demand causes an economic slowdown that leads to social and political unrest.

Implications

Given these divergent ideas as to how the next decade may play out, it is clear that chemical companies need to consider bold strategies. However, they need to be able to adjust their approach as unexpected obstacles and opportunities present themselves. Strategic options can furnish this flexibility. They reside in assets that contribute to the existing strategy, but which can be combined with other assets to enable a shift in strategic direction. The assets may be wholly owned or accessible through mechanisms, such as a minority stake, joint venture, or an alliance.

In summary, becoming more disciplined and focused allows chemical companies to function effectively in a global industry that is increasingly competitive, cyclical, and commoditized. Pursuing strategies that involve greater differentiation allows business units a better shot at creating sustainable value. Paying attention to alternative versions of the future allows chemical industry leaders to anticipate what may lie over the horizon and establish the strategic options needed to deal with developments that could require changes in course. The overall effect of these measures is to equip companies to meet the uncertainties of the new decade.

2 Overview of the global chemical industry

Economic growth in modern societies has been strongly connected to advances in chemistry and the development of the chemical industry. It is no different today. Humanity's biggest challenges demand solutions. Many of them will only be realized through new materials and compounds provided by the chemical industry.¹

The global chemical industry, which consists of petrochemicals, inorganic compounds, and specialty applications and gases, generated around US\$3 trillion in sales in 2008. Of this, specialty chemicals represented US\$1.8 trillion with commodity chemicals accounting for the remaining US\$1.2 trillion.² The specialty chemicals sector is currently concentrated in developed economies, whereas for commodities, developing countries have become increasingly prominent.

The U.S. is the number one producer of chemical products in the world, generating over US\$664 billion in sales a year in 2008. The American Chemistry Council estimates that in 2008, the chemical industry employed 850,000 individuals in the U.S. or four percent of the country's workforce.³ Chemical products were components of 96 percent of U.S.-manufactured goods. The industry's exports more than doubled between 1998 and 2008, and now represent 10 percent of the United States' total exports.⁴

The industry plays a similarly key role in the competitiveness of the EU manufacturing industry. In the EU, the chemical industry employs 1.26 million people. The EU accounted for 30 percent of global chemical sales in 2007, a 2.7 percent reduction from 1997.⁵ Sales actually grew during this period, but because of stronger sales in the rest of the world the EU lost market share. That said, the European chemical industry has been, and remains, a strong and successful player in the world market.

As with many other industries, the Asia-Pacific region has a significant and growing role in the chemicals sector. The region is the largest in revenues for commodity chemicals, accounting for 38 percent of global share.⁶ The influence of China, its booming economy and robust industrial sector, is certainly a major factor. The overall chemicals sector grew at 8.1 percent between 2002 and 2007⁷ and currently employs 1.2 million people.⁸ The Middle East is a significant emerging player on the production side. While still a smaller participant, the Latin America's chemical industry experienced average growth rates of 4.9 percent for the same period.⁹

¹ High Level Group on the Competitiveness of the European Chemicals Industry, *European Chemicals Industry: Enabler of a Sustainable Future*, February 19, 2009.

² DataMonitor 2009 report, "Global Chemical Commodities: Industry Profile." Estimated as 60% of total, "2006 Fine Chemicals: The Industry and the Business" by Peter Pollak, PhD.

³ American Chemistry, *Business of Chemistry Summary*, AmericanChemistry.com, 2009.

⁴ American Chemistry, *Chemistry Industry Facts*, AmericanChemistry.com, June 2009.

⁵ CEFIC, *Growth of the Chemical Industry, Facts and Figures*.

⁶ Datamonitor *Global Commodity Chemicals Profile*, April 2009.

⁷ CEFIC, *Growth of the Chemical Industry, Facts and Figures*.

⁸ Bloomberg Equity Screening by Sector and Region.

⁹ CEFIC, *Growth of the Chemical Industry, Facts and Figures*.

Figure 1: Global chemical industry revenue growth



Sources

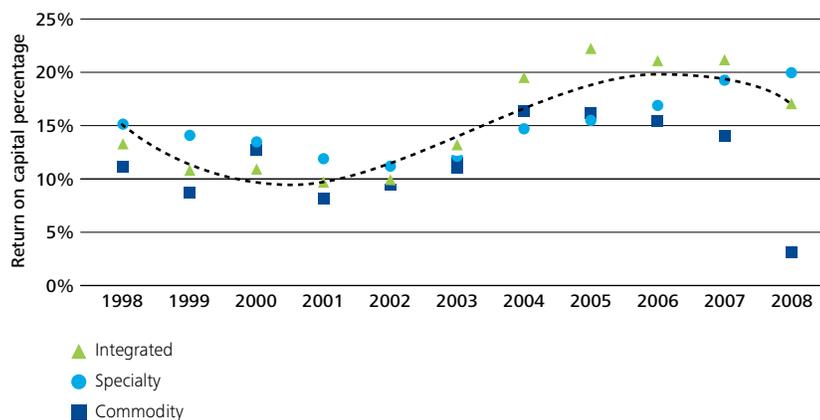
1. DataMonitor 2009 report, "Global Chemical Commodities: Industry Profile."
2. Estimated as 60% of total, "2006 Fine Chemicals: The Industry and the Business" by Peter Pollak, PhD.
3. Interview with Mukesh Ambani, Chairman, Reliance Petrochemicals.

But the overall size and strength of the industry has not been enough to counter challenges to growth and profitability in recent years. Customer demand has matured in critical segments of established geographies, leaving companies with less room to maneuver. The global industry has doubled in size since 1999 but in the last five years, the compound annual growth rate (CAGR) of industry sales has slowed considerably (see Figure 1).

A new global competitive dynamic has emerged. Consumer demand is now global. Local demand in the emerging economies of China, India, and the Middle East has increased. And in the Middle East, feedstock is getting cheaper. The industry is no stranger to increasingly stringent legislation and regulation, but greater governmental involvement through stimulus and mandates presents a different landscape.



Figure 2: Return on capital percentage (1998 to 2008)



Note

ROC: Operating return on profit before interest, special charges, and taxes / (net working capital + net fixed assets).

Source

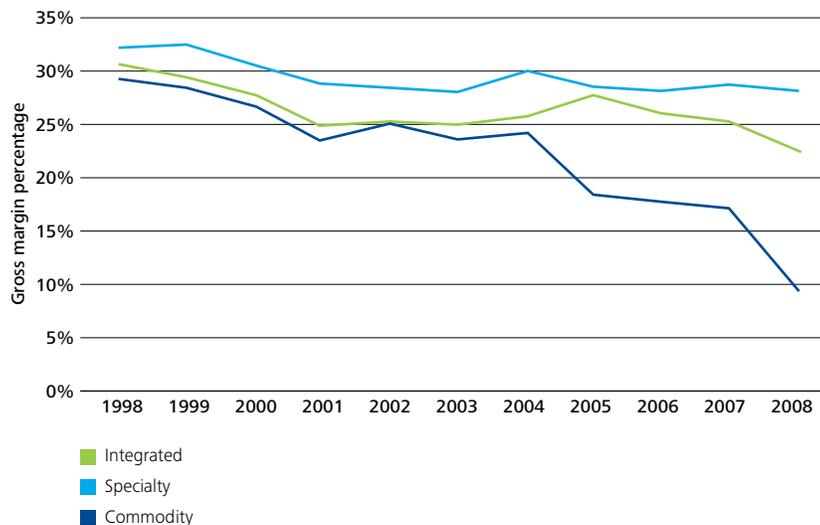
Capital IQ and DTT Chemical Group analysis.

Mature markets challenged by stagnating growth and volatile returns

To gain deeper insights into the performance of the chemical industry, DTT analyzed the financial and operational performance of 231 global public chemical companies for the years between 1998 and 2008. Of these, 164 were specialty chemical companies, 47 were commodity chemical companies, and the remaining 20 were integrated players.

The analysis shows that despite its pervasiveness, the industry has experienced volatile return on investments, (see Figure 2) and has shown evidence of further commoditization across all sectors. Research by the DTT Chemical Group and Devon Value Advisers shows that public company operating return on capital has a high correlation with shareholder value, in chemicals and 70 other industries.¹⁰ Falling margins across sectors are a contributing factor, with the commodity chemicals sector experiencing the sharpest decline — 19 percent between 1998 and 2008. Gross margin in the specialty chemicals sector fell 4.8 percent between 1998 and 2008 (see Figure 3).

Figure 3: Gross margin percentage (1998 to 2008)

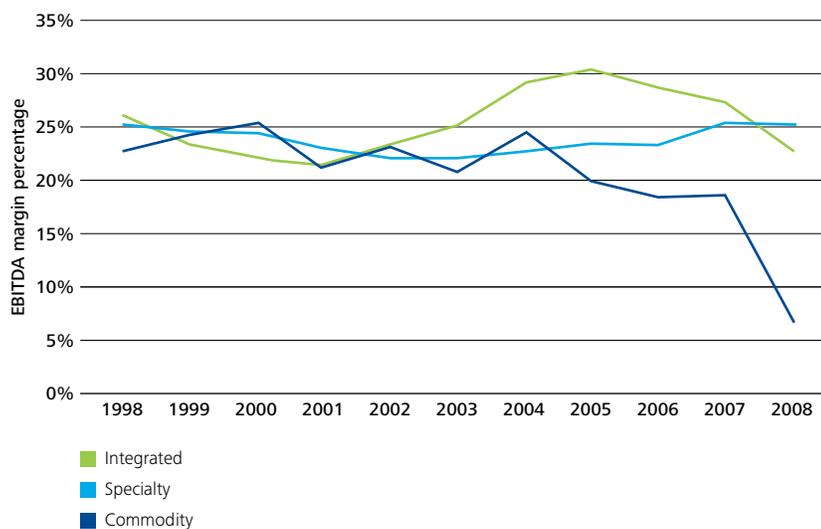


Source

Capital IQ and DTT Chemical Group analysis.

¹⁰ Operating return on capital = Operating profit before interest, special charges, and taxes (EBIT), divided by the capital required to operate the business (Net working capital plus net fixed assets).

Figure 4: EBITDA margin percentage (1998 to 2008)



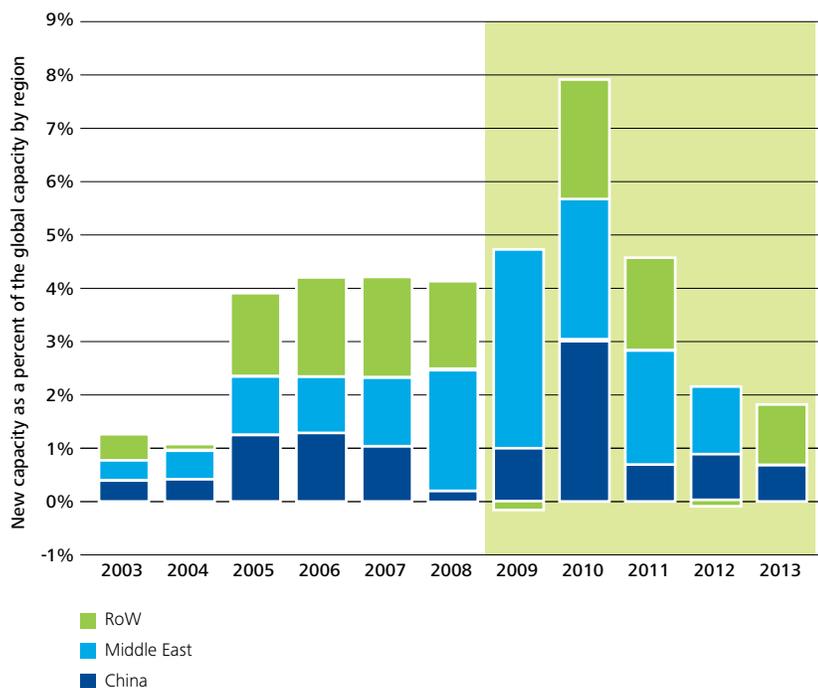
Source
Capital IQ and DTT Chemical Group analysis.

Earnings before interest, taxes, depreciation, and amortization (EBITDA) margin and return on capital trends show the cyclical nature of the overall industry during the period studied (see Figures 2 and 4). What the industry has been slow to realize — but now understands — is that the specialty chemicals sector is no longer immune to cyclicality. There is more variability in specialty company performance and less differentiation in the specialty chemical products in terms of unique properties or usage. As a result, there are fewer true specialty companies. Of those that remain devoted to specialty products, some have segments that are exposed to cyclical or distressed end markets.



Figure 5: Capacity investments

In 2010, the new capacity will constitute approximately 8% of the existing global capacity.



Note

Rest of World (RoW).

Source

CMAI, Deutsche Bank, and DTT Chemical Group analysis.

Between now and 2013,
78% of new capacity will
be installed in China and
the Middle East

Capacity investments in basic commodities in developing nations have tipped the scale

Large investments in new capacity in the Middle East and China were announced between 2004 and 2007, and in some cases, enjoyed the encouragement and support of government subsidies and mandates. According to a forecast by the Gulf Petrochemicals and Chemicals Association, the Middle East has the potential to become the epicenter of global petrochemicals manufacturing, producing essential materials for packaging, health care, pipes, electronic goods, personal care, construction, and many other industrial or consumer requirements.¹¹ It remains to be seen how the Middle East will address the issue of proximity to customers as this has been a hallmark of success in the specialty sector. Analysis of current announcements suggests that the region's ethylene capacity could more than double in the next five years, rising from more than 13 million metric tons in 2007 to more than 29 million metric tons in 2012 (see Figure 5). This represents nearly half of global capacity growth.¹²

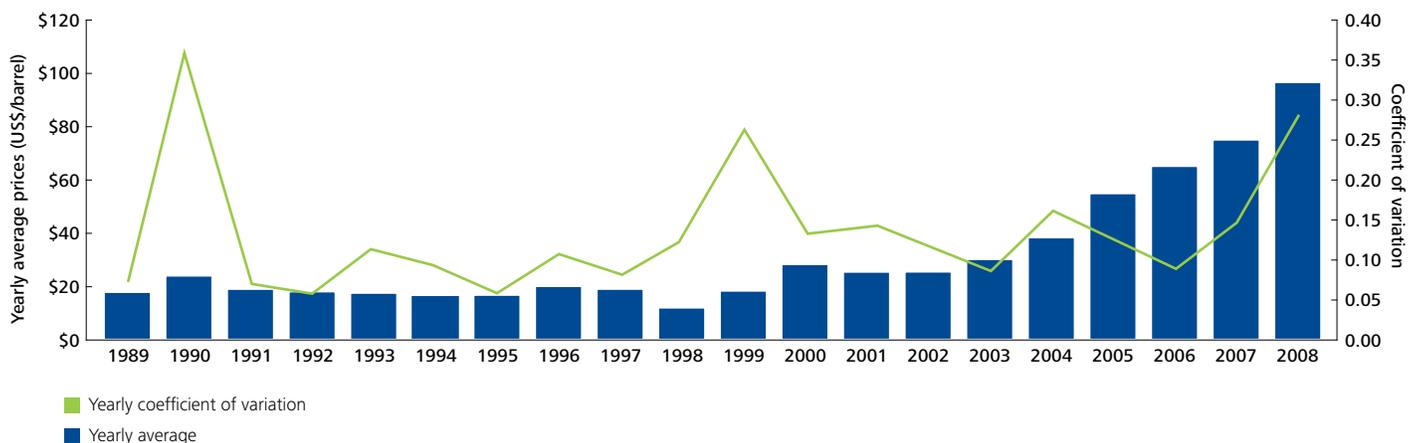
The impact is being felt. The combination of new, low-cost capacity in the developing world and the recent slowdown in demand growth has accelerated efforts in the developed world to sell or shut down capacity. Companies in the industry are facing a more severe strategic reality.

The global demand-supply situation could be further upset by planned capacity additions in combination with stagnating growth. As a counterbalance, the economic downturn, some technical glitches, and rising construction costs have led to announcements of delays in some projects, particularly in the Middle East. So there is still uncertainty around the extent to which capacity additions will affect the global demand-supply balance, complicating the task of forecasting the ultimate changes.

¹¹ EnergyAsia.com, December 1, 2007.

¹² EnergyAsia.com, December 1, 2007.

Figure 6: Yearly average and volatility of oil prices



Source

Bloomberg data and DTT Chemical Group analysis.

Higher and volatile feedstock prices are an ongoing problem

Crude oil prices have increased from a yearly average of US\$18.35 per barrel in 1989 to US\$66.03 in 2006 to US\$96.70 in 2008. Moreover, the price has become more volatile. The coefficient of variation, measuring price volatility (yearly standard deviation divided by the yearly average), has increased from 0.07 in 1989 to 0.31 in 2008, with the highest volatility occurring in 1990 at 0.35 (see Figure 6).¹³ And in 2008, with too much capacity and the subsequent drop in demand, oil prices have also seen unprecedented volatility, reaching a high of US\$145 per barrel. From an average of US\$139 in June 2008, the price dropped to US\$41 in December 2008.¹⁴

The International Energy Agency (IEA) predicts that the world’s primary energy needs will increase 45 percent by 2030. Rising demand from China and India could

have a lasting impact on the global feedstock and energy situation. The IEA expects China to overtake the U.S. as the world’s largest energy consumer early in the new decade. At the same time, new crude oil production is likely to come from difficult-to-drill areas such as ultra-deep water. Arctic regions, and increasingly complex reservoirs, such as oil sands, will be expensive to exploit.¹⁵

Unlike crude oil prices, natural gas prices vary from one production location to another. While commercial natural gas prices shot up in the U.S. from US\$8.4 per 1,000 cubic feet in 2003 to US\$11.99 in 2008,¹⁶ the Middle East and Russia are favored with vast reserves of affordable natural gas.¹⁷ Historically, commodity chemical operations have valued flexibility in feedstocks and this will still represent an advantage going forward. However, depending on certain demand scenarios, the larger issue is the availability of hydrocarbons and the pace of change to renewable energy and other alternative fuels.

¹³ Bloomberg data and DTT Chemical Group analysis.

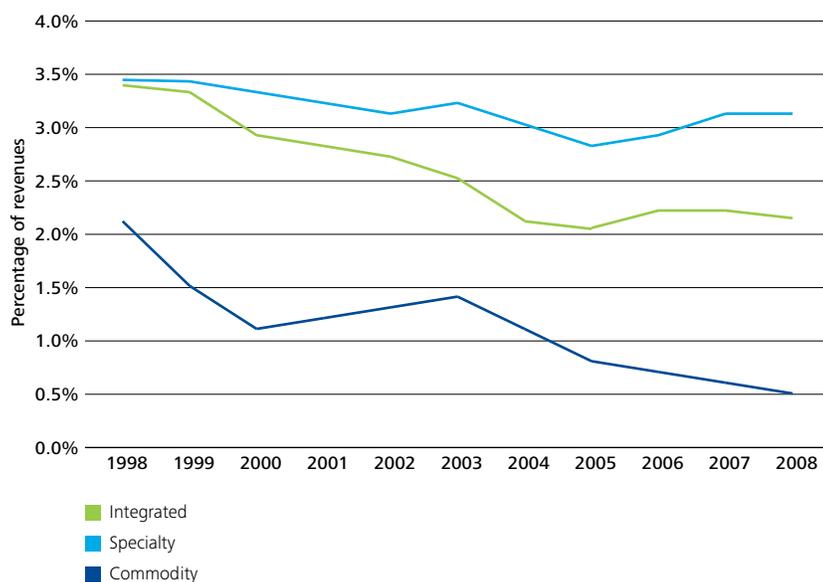
¹⁴ Bloomberg data and DTT Chemical Group analysis.

¹⁵ International Energy Agency, World Energy Outlook, 2009.

¹⁶ Energy Information Administration data, Natural gas prices (2003 to 2008).

¹⁷ Energy Information Administration data, International Energy Outlook 2009, Country analysis briefs, Chapter 3, Natural gas.

Figure 7: R&D as a percentage of revenues (1998 to 2008)



Source
Bloomberg data and DTT Chemical Group analysis.

Innovation down to a trickle

Chemical industry research and development (R&D) spending and its output have declined over the past two-to-three decades (see Figure 7). The result has been more matured and commoditization. Given the ongoing difficulties the industry faces, this trend could very well continue. This is unfortunate and yet is endemic to many industries. Although R&D is an expensive and often long commitment, there is a fertile set of issues that could be addressed. The issues on the list include:

- Alternative energy
- Scarcity and quality of water
- Greenhouse gas emissions and pollution
- Need to improve agricultural yield to feed growing regional populations
- Increasing need for safe and efficient infrastructure
- Need for lightweight products with superior properties.

In addition to these issues, there is a growing demand for “green chemistry” to design chemical products and processes that reduce or eliminate the use or generation of toxic substances across the life cycle of the product, from its design to manufacture and use.

Finding and delivering breakthroughs will likely require contrarian behavior. While most companies continue to cut R&D spend either to protect margins or maintain R&D yield, few companies stand to gain through longer term commitment and focus on solutions critical to society. Efficiency in commercialization and plugging into a global innovation network will hold the key to innovation efforts in the coming decade.

Figure 8: Global and U.S. end markets

Global end markets	Outlook	2007	2008	2009	2007 to 2009 growth	2014	2007 to 2014 growth
Energy and petroleum (E&P)	■	\$2,606	\$3,356	\$2,036	-22%	\$2,985	15%
Automotive	■	\$2,022	\$1,909	\$1,705	-16%	\$2,252	11%
Electronics	■	\$219	\$220	\$199	-9%	\$257	17%
Printing	■	\$430	\$446	\$411	-4%	\$466	8%
Aerospace and defense	■	\$143	\$148	\$140	-2%	\$156	9%
Personal care	■	\$179	\$186	\$190	6%	\$234	31%
Pharmaceuticals	■	\$810	\$850	\$875	8%	\$1,075	33%

U.S. end markets	Outlook	2007	2008	2009	2007 to 2009 growth	2014	2007 to 2014 growth
Housing	■	\$335	\$232	\$178	-47%	\$254	-24%
Automotive	■	\$253	\$216	\$163	-36%	\$227	-10%
E&P	■	\$294	\$394	\$211	-28%	\$359	22%
Electronics	■	\$11	\$10	\$9	-19%	\$9	-12%
Paper mills	■	\$39	\$40	\$34	-13%	\$34	-14%
Packaging	■	\$63	\$62	\$59	-6%	\$61	-3%
Personal care	■	\$51	\$51	\$51	-1%	\$58	13%
Pharmaceuticals	■	\$205	\$210	\$214	4%	\$246	20%
Heavy construction	■	\$57	\$61	\$60	5%	\$70	22%
Municipal water	■	\$90	\$92	\$95	5%	\$109	21%

Note

Industry revenues in US\$ billions.

Source

IBIS estimates — revenues at constant prices using 2009 as base year.

Disruption in developed economy end-markets

In the aftermath of the recent recession, demand for chemicals in certain developed world end markets dropped 40 percent in a matter of mere months. Some companies found themselves on bankruptcy watch, with share prices sinking to single digits.

Some of the biggest consumers of chemical industry products in developed markets — the giant automotive and construction industries — have suffered during this recession due to slackening consumer demand and collapse of the housing industry (see Figure 8). The importance of the automotive sector to both employment and the economy at large prompted governments in major economies to provide financial assistance to certain manufacturers. But there remains significant uncertainty about the timing of the recovery of demand for automobiles, and in other key end markets, as well as about the impact on chemical industry companies that are suppliers to these sectors.

Although the effects of stimulus programs are subject to debate, optimistic forecasters expect that government spending on infrastructure will lead to more activity in 2010, creating growth in demand for construction chemicals, paints, and coatings. Increased demand for chemicals might also come from spending on paint and coatings used in infrastructure construction and repair projects, including highways, mass transit facilities, and other public works.¹⁸ On the other hand, the rebound may be masked by stimulus actions. What we could be seeing now as a rebound, is more of a reset. If this is the case, some key end-markets in certain geographies may take half the decade or longer to retest 2007 levels and business models will have to be adjusted accordingly.

Environmental safety will no longer be a cost of doing business but a way of doing business

Although it cannot be anticipated which specific dimensions of environmental regulation will play, there is a preview of items included in the registration, evaluation, authorization, and restriction of chemicals (REACH) agreement formalized in the EU in 2007. While the tactics of developing nations to stall measures for addressing growing climate concerns may work in the short term, over the next few years, decisive measures may come into place. Additionally, during the second half of the decade, it will be the developing nations reaching a suitable level of economic prosperity and driving measures to protect scarce resources including water.

¹⁸ U.S. Congressional Budget Office, *Estimated Impact of the American Recovery and Reinvestment Act on Employment and Economic Output as of September 2009*, November 2009; International Monetary Fund, *World Economic Outlook*, October 2009; "President's Stimulus Bill: Will it Help the Chemical Industry?" ICIS.com, March 3, 2009.



3 New prerequisites for competitive viability

As highlighted earlier, the list of issues faced by the global chemical industry is long. Executives face slowing growth rates, volatile returns on investment, falling gross margins, excess capacity, reduced R&D budgets, high and volatile feedstock prices, and weakened end markets. However, the issues confronting the industry as a whole play out differently at the sector level. Unique challenges confront commodity, specialty, and integrated chemical companies. An analysis of the circumstances in these sectors indicates that old ways of doing business must be changed. In the coming decade, established strategies will be an inadequate foundation for success and may not ensure survival. New imperatives apply. This section reviews the record in the commodity, specialty, and integrated sectors and identifies the approaches that constitute the new prerequisites for competitive viability.

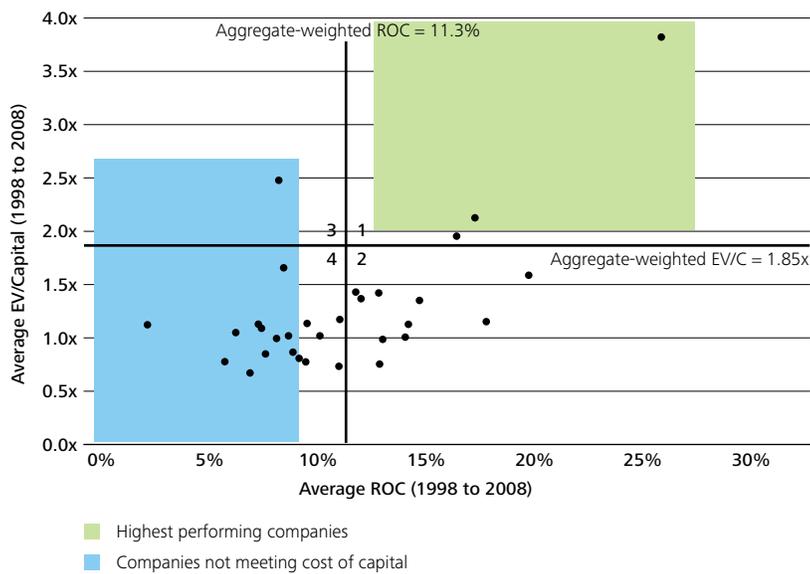
Commodity chemicals

Through an analysis of how the 35 commodity chemical companies (excluding 12 pure inorganic companies from the dataset of 47) in the study performed from 1998 to 2008, we can see some potential implications and further challenges for the road to 2020 following (see Figure 9):

- **Gross margins have been falling in the commodity chemicals sector from 28 percent in 1998 to 16.5 percent in 2007.** Over the five years between 1998 and 2003, the average gross margin was 23 percent, but fell to just 18 percent between 2003 and 2008.
- **Operating margins before interest, taxes, and restructuring charges for the period between 1998 and 2008 averaged 7.2 percent.**
- **Over the last decade, the commodity industry has returned an 11.4 percent pretax return on capital.** On a return on equity basis over 10 years, the commodity sector has barely returned the long-term cost of equity.
- **With operating return on capital close to the cost of capital, commodity chemical companies have returned to higher levels of debt leverage.** After some years of taking debt off their balance sheets, the debt-to-equity ratio across commodity chemical companies has again increased from US\$0.98 of debt for every dollar of equity in 2003 to US\$1.06 in 2007 and US\$1.19 in 2008.
- **Some commodity chemical companies with falling revenues and cash flows were unable to de-lever enough to withstand the challenges brought on by the recent recession.** Some companies with large fixed interest charges are finding themselves with few options available as they try to weather the storm.

Deeper analysis reveals that the highest performing companies in the first quadrant have typically developed innovative business models and strategies that are worth studying closely. The least performing companies in the fourth quadrant have been challenged with issues around product portfolios, as well as strategic and competitive positioning. Finally, the undervalued and overvalued companies that placed in the second and third quadrants had highly variable performance, including very well in some years and challenged in others, resulting in their placement thereof.

Figure 9: Commodity chemicals average return on capital and enterprise value to capital multiple



Notes

ROC: Operating return before interest, special charges, and taxes / (net working capital + net fixed assets).

EV/C: (Market cap + total debt – cash) / (net working capital + net fixed assets).

Quadrants

- 1 Highest performing companies
- 2 Undervalued companies
- 3 Overvalued companies
- 4 Least performing companies

Source

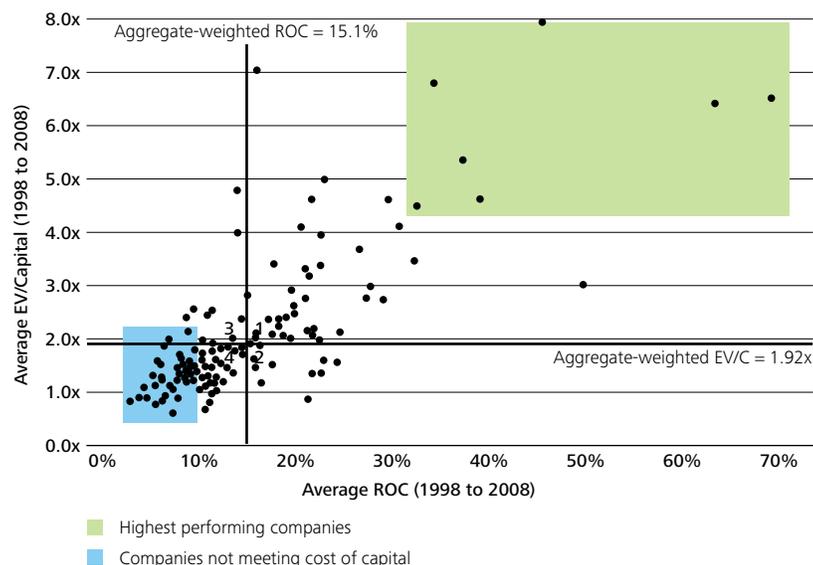
DTT Chemical Group analysis.

In summary, for companies that focus on commodity and high-volume intermediate chemicals, and especially those with significant assets in developed countries, the next decade begins with little or no margin for error. Hopefully, companies in this segment of the industry have learned that with the current outlook for excess capacity, this is not simply a matter of growing out of problems as has been the case in the past. The prerequisite for competitive viability is to preserve cash and increase free cash flow in order to counter the effects of slimmer margins. Commodity chemical companies need to focus on the following:

- **Manage existing assets for cash flow over reported profit.** View capital expenditures with the greatest skepticism and seek creative approaches (such as minority investments) to secure supply.
- **Shut down or sell capacity ahead of changes in the supply curve:** Understand the magnitude of capital employed as well as the profitability of all units and facilities. Consider a range of options in selling capacity that may also include the sale of a low-cost facility for more money if return on capital could eventually be compromised by location or the magnitude of capital employed.
- **Invest cautiously in new capacity.** In developing markets, where competitive advantage can be achieved and sustained, use creative financial structures to secure access to supply. Beware of cumulative investment traps resulting in overcapacity.
- **Use cash flow to pay down debt and de-lever the balance sheet.** As cash flow and balance sheets strengthen, use debt judiciously to lower the average cost of capital, but take care to avoid the risk of returning to liquidity problems that have been prevalent in the recent recession.

Figure 10: Specialty chemicals average return on capital and enterprise value to capital multiple

The market rewards for improved ROC are fairly linear as seen from the EV/Capital ratios.



Notes

ROC: Operating return before interest, special charges, and taxes / (net working capital + net fixed assets).

EV/C: (Market cap + total debt – cash) / (net working capital + net fixed assets).

Quadrants

- 1 Highest performing companies
- 2 Undervalued companies
- 3 Overvalued companies
- 4 Least performing companies

Source

DTT Chemical Group analysis.

Specialty chemicals

The very notion of “specialty” chemicals is coming under challenge as we head into the new decade. The data indicate that among companies who currently fall under that banner, there is variation in both company performance and business model definition. This suggests that, given recent changes in end markets, even the top-tier “true specialties” have unaddressed portfolio issues.

In the past, classic specialties were a combination of unique chemistry or materials applications, differentiated service, and depth in specific end-market niches. This combination rewarded the sector with a value premium and profitable growth for addressing unmet needs. Today, the number of hallmark specialties has diminished, yet the category has expanded. The definition of the specialty segment has not been updated, and as a result, the sector now encompasses a more diverse combination of business models — products that are now mature and some markets that are overserved. This is not surprising as the name “specialty” suggests that products and services required to address unmet needs will mature and change over time.

Substitutes will emerge and previous growth markets will become commoditized. In the set of 158¹⁹ specialty companies, return on capital (ROC),²⁰ enterprise value (EV) over capital, and other key metrics from 1998 to 2008 were evaluated. Based on the metrics, a calculation of weighted-average mean thresholds to segment performance. The results show large differences in performance between the players both year-over-year and on average for the full period (see Figure 10).

¹⁹ Out of a 164 specialty companies in the dataset, six industrial gas companies were removed.

²⁰ Devon Value Advisers defines: “ROC = Operating Return Before Interest, Special Charges and Taxes / (Net Working Capital + Net Fixed Assets) and EV/C= (Market Cap + Total Debt – Cash) / (Net Working Capital + Net Fixed Assets).

Of the 51 top performers, most have either focused on niche markets that have grown profitably, migrated to new niche markets as existing markets have matured, or become commoditized. Moreover, at one or more times over the past 10 years, almost all have focused on new applications and innovation. They have looked to provide exceptional customer service and have restructured their operating model to be more in tune with market realities. At least 10 companies have thereby continued to achieve superior market performance and valuation for all 10 years.

Of the 68 companies with the poorest performance, there are about 40 that, on average, failed to make their cost of capital for the 10 years analyzed. Many also failed to make the cost of capital in most individual years. As would be expected, the top-performing companies have by and large been rewarded with high multiples and the lowest return companies have had commensurately low valuations.

Going forward, profitability and growth will be driven by making the right choices about new applications and services, geographic markets, and core technologies. These choices will need to be supported by a flexible business model that addresses the requirements of being capital-efficient and differentiated while still remaining flexible in responding to market changes. This is in addition to the critical need to refocus the core business on profitable and growing segments and rationalizing commoditized elements of the portfolio.

In the future, specialty companies will be better off if overcapacity in the upstream sector materializes consistent with consensus forecasts. This could ensure minimum supply disruptions for the companies in the sector. Assuming the supply of commodity and intermediate chemicals used by specialty chemical manufacturers continues to be available over the next decade, with only normal shortages and price movements, the specialty chemicals sector would treat volatility as a tactical problem to be managed, rather than a strategic one requiring long-term investments in upstream supply protection. Problems with upstream supply would seem among the more minor worries facing the specialty chemicals sector over the next decade.

The specialty chemicals sector faces several challenges independent of the competitive pressures in the commodity sector. Actions the sector must consider include:

- **Redesign customer innovation and service models.** From 1998 to 2008, specialty chemical producers experienced a larger reduction in gross margins than they were able to offset through reduced overhead.
- **Confront continuing decline in unit volume growth.** End-market unit growth has declined steadily over the last 40 years and will likely continue to decline, especially in the developed countries. Based on five-year global gross domestic product (GDP) growth projections, it would be realistic to expect that unit growth in this industry for the next decade will slightly exceed global GDP. Recognize that in every specialty portfolio that was analyzed, there are growth and profit challenged segments.



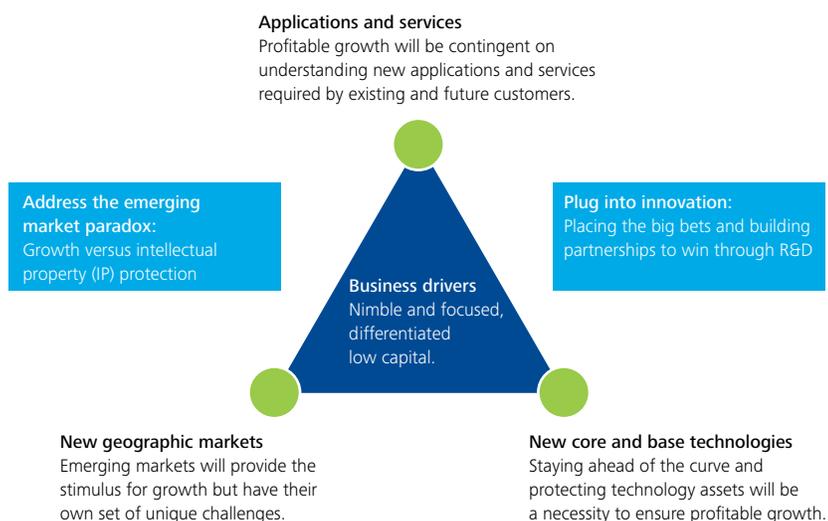
- **Understand and address excess complexity.** According to the American Chemical Council, 96 percent of manufactured goods have chemical content.²¹ The complexity of specialty operations has been steadily increasing in small amounts over thousands of plants and customers for several years. Despite efforts to rationalize, this nagging operational and marketing problem has been a detractor of profitability. SKU proliferation, thought to be a necessary by-product of differentiation, is masking current excess capacity and will be unsustainable going forward.
- **Choose between dominant or niche roles.** The 158 companies profiled in this study are the largest publicly held specialty companies, yet they have less than 35 percent of the US\$1.9 trillion specialty chemicals market. In many product categories, there are five to 10 competitors providing the same solutions. They lack a granular knowledge of customer preferences, product profitability, and total cost to serve. Increasingly, the options will be reduced to either being dominant in the category or a niche competitor with a differentiated product.
- **Stop gross margin erosion.** On a sector-wide basis, gross margins compressed by 4.2 percent from 1998 to 2007 and have declined further in 2008 and 2009. Customers, aided by the Internet and better information technology and more sophisticated methods of procurement, continue to relentlessly seek price reductions and other concessions from specialty competitors. While certain product and service areas have managed to resist the pressure better than others, the DTT Chemical Group expects margins to continue to shrink through the next decade as a result of these factors.
- **Fight cyclical and restore the value-added premium.** Average operating margin in the period between 1998 and 2008 was 8.6 percent for the 158 companies in the specialty chemical group. Specialties enjoyed peak margins of 10 percent in 2007 and 2008, and 9.7 percent in 1998. They were in a trough in 2002 and 2003, when their operating margins were seven percent. As the industry has matured, cyclical has become more pronounced and the variability of performance due to input costs and economic cycles has become a fact of life. In the next decade, specialty companies will need to take a full-cycle view of investments and economic trends. They will also want to take a long look at how they could restore their value-added premium.

Specialty companies will need to dramatically alter their business model to succeed in the coming decade. Three critical factors for success will be developing new applications and services, building new core and base technologies, and addressing new geographic markets. New business models will need to get all the three dimensions right in order to survive.

²¹ American Chemistry, Industry Facts Sheet, June 2009.

Figure 11: Specialty growth drivers

Specialty companies that successfully navigated the three dimensions tended to outperform the market.



Source

DTT Chemical Group analysis.

Given these actions (see Figure 11), strategic and tactical considerations for specialty chemical companies would include the following:

Strategic

- **Focus on customer behavior.** Knowing enough about customer behavior to ruthlessly remove or recost products or services that will not fetch profitable prices will be an essential focus of the coming decade. The specialty chemical industry will have the opportunity to use advanced tools, such as customer relationship management, pricing optimization, and Test & Learn (see APT's Test & Learn solution) software, that has been used successfully in other industries for more than a decade. Competitors who ignore this challenge and load up on unprofitable businesses to gain market share may destroy value.
- **Return to growth with an educated eye.** Use focus and simplicity as guides to transform the business. Determine the best way to innovate and commit to outcomes. Develop the capability to scan the external environment for the optimal acquisition and divestiture opportunities. Be realistic about the need to divest businesses that would have greater value-creation potential under a different owner.

Tactical

- **Eliminate the concept of marginal contribution from all but short-term decisions.** Shorten the time executives have to fix products that fall short on a full cost basis, raise the discount rate on venture activities to the 30 percent to 50 percent levels that professional venture capitalists apply to their portfolio investments, and ruthlessly restructure or eliminate activities that cannot credibly achieve cost of capital returns or higher.
- **Learn to manage supply like a value-added distributor.** This means owning or controlling what is competitively advantageous but restricting to distribution those products that customers need but will not pay a fair price to obtain.

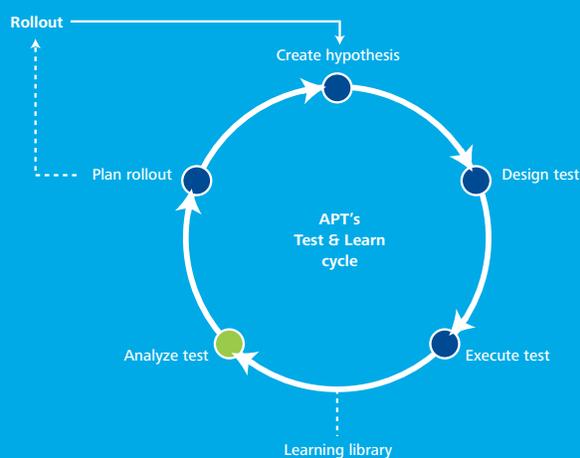
APT's Test & Learn solution

The chemical industry has long, successful experience in applying the principles of Design of Experiments in production facilities, but the "signal-to-noise" problem has made this idea impractical in much less controlled sales and marketing environments. Applied Predictive Technologies (APT) has pioneered the extension of the experimental method to market-facing activities.

A Test & Learn capability helps companies to answer key questions that drive shareholder value, such as:

- Should we change or unbundle pricing by account or ship-to? How far can we raise price before we put account retention at risk?
- Should we extend payment terms to 45 days? Should we add 100 basis points in the penalty period?
- Should we increase or decrease account service levels? For which accounts?
- Should we introduce this new piece of account servicing technology? For which accounts?
- Should we introduce this new product? How much of its sales will be cannibalized, versus true new-to-system sales? How should we price it?
- Should we introduce this new sales representative incentive plan? Should we move to a true franchise model?

Test & Learn software is the foundation of an institutionalized capability:

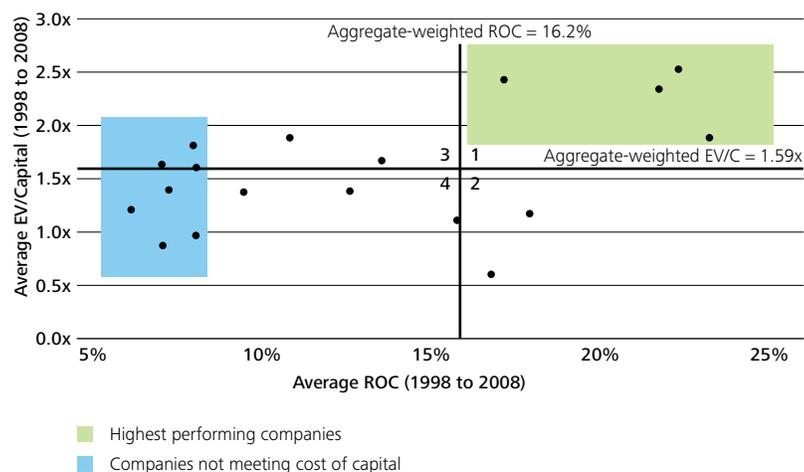


Source
Applied Predictive Technologies.

- **Provide services.** Charge the customers that truly need service or want it and eliminate services from those who will not pay for it. Determine appropriate service models and charge accordingly.
- **Segment total capacity.** Capture not only the variable costs but also the actual full expense and capital costs accrued when a product is sold to an end customer.
- **Manage assets.** Treat assets with the same importance commodity chemical producers treat their capacity. This is especially true for specialty chemical markets where integrated producers have significant market share. Specialty chemical companies that depend on supply from the merchant market, reliable availability, and competitively priced material will have to resist making investments in intermediate capacity to protect themselves in periods of shortage of critical supplies. These periods, which take place under each of the scenarios, will occur less than 20 percent of the time between now and 2020. It is important to balance the cost of supply shortages against the greater fixed costs of onerous contracts or ownership of upstream assets.

It is recognized that for many specialty chemical companies, the implied strategies discussed above signal the need for revised business models. Those that adopt this approach will create value by increasing profitability and cash flow but may also risk comparison to others gaining short-term market share through marginal pricing. Investors in successful and profitable specialty companies will likely support growth through acquisitions of less profitable companies. They will need to select specialty companies with track records of profitable management.

Figure 12: Integrated chemicals average return on capital and enterprise value to capital multiple



Notes

ROC: Operating return before interest, special charges, and taxes / (net working capital + net fixed assets).
 EV/C: (Market cap + total debt – cash) / (net working capital + net fixed assets).

Quadrants

- 1 Highest performing companies
- 2 Undervalued companies
- 3 Overvalued companies
- 4 Least performing companies

Source

DTT Chemical Group analysis.

Integrated chemicals

Companies that focus exclusively either on the upstream or downstream sectors of the chemical industry have good reason to watch the 20 global giants that play across the full industry. These companies represented 13 percent of the chemical industry revenues in 2008 and grew revenues at above 10 percent CAGR between 1998 and 2008, significantly higher than the chemical industry average. The integrated players have over the course of the last decade taken significant steps to move downstream to acquire assets with greater value-creation potential. This can be seen by the growth in ROC from 13 percent in 1998 to a high of 21 percent in 2007. This has also been supported by significant reduction in selling, general, and administrative expenses (SG&A) spend from 18 percent in 1998 to around 10 percent in 2008. However, with weakening gross margins from 30 percent in 1998 to 22 percent in 2008, there has been increasing cyclicality (see Figure 12).

Going forward, in addition to the actions mentioned for commodity and specialty companies, the integrated players should also consider the following:

- **Achieve the synergies from the existing acquisitions.** Overcapacity, weak pricing in the upstream commodity sector, and the far stronger performance of the specialty sector over the last decade appear to have attracted the notice of the large integrated industry competitors such as BASF, AkzoNobel, SABIC, and Dow Chemical Company.²² These companies have used their balance sheets to make substantial acquisitions in downstream specialty markets. Making the right acquisitions and divestitures is critical to a company’s success and they will have to focus on achieving the desired synergies from those deals.

²² Dow acquires Rohm and Haas, April 1, 2009, Bloomberg.com, “SABIC to buy GE Plastics for \$11 billion,” May 18, 2007, and Bloomberg.com, “BASF agrees to buy Ciba to expand specialty chemicals,” September 15, 2008.

- **Expand the specialty chemical business.** Integrated players with large balance sheets often enjoy better access to new capital and also generally earn profits that exceed the cost of capital. If the pressure on profits continues in the commodity end of the industry, it is reasonable to assume that the large integrated companies will seek further opportunities to expand their specialty chemical business, largely through acquisition. If the integrated companies have an Achilles heel, it is that the commodity chemical legacy, large investments for scale and market share, is not well-suited to the marketing skill set that is important for success in the specialty chemicals sector over the next decade.

Strategic clarity

Commodity, specialty, and integrated chemical companies must reinvent major elements of their established business models. The specific changes that are needed vary from one sector to the next, but what they have in common is adopting a more disciplined and focused approach that responds to new challenges.

Companies must improve their operational efficiency, limit expansion (except where carefully justified) and concentrate on products that customers value most. Underlying all of these measures is the pursuit of strategies that are based on clear and distinctive value propositions. This means having an in-depth understanding of customer needs and preferences.

However, the more a strategy focuses on differentiation and competitive advantage, the more success depends on correctly predicting future customer behavior and making strong commitments to the right markets, technologies, product designs, brands, processes, values, and standards.

But given the uncertainties about the business environment, making the predictions that will lead to success is difficult. The following section outlines three of the most likely scenarios.





4 Scenarios for future market dynamics

The uncertainties in the decade ahead

Chemical companies' strategic planning is complicated by uncertainties that obscure the view of the future business terrain. The industry is emerging from the downturn with a set of challenges that includes improving operational efficiency, limiting expansion, and increasing focus and differentiation. In determining how best to address these issues executives must be careful about the assumptions built into their strategies. Circumstances in the next decade could differ from today's conventional wisdom and expectations. When the way forward is unclear, keeping a range of alternative possibilities in view is crucial to effective planning.

The future business environment is receiving substantial attention. Discussions and debates about the future of the industry are taking place in a variety of arenas — political, private sector, academia, think tanks, research centers, the news media, and the Web. Reviewing the predictions, analyses, and commentaries from these sources reveals differing points of view pertinent to three broad areas that affect chemical industry markets — the economy, regulation, and technology. These divergent perspectives serve to highlight crucial uncertainties:

Economy. Will national economies pull out of the recession and register steady growth, falter and sputter, or experience boom-and-bust cycles? Are emerging markets going to be the world's growth engines, or will their acceleration be interrupted? Is the global economic system going to be more integrated or less?

Regulation. How strict will governments be with respect to environmental, health, and safety (EHS) regulation? What effect will developments involving energy and the environment have on regulatory policy? How will regulatory regimes differ from one country to the next?

Technology. How will developments involving energy supply, energy security, and climate change affect efforts to commercialize alternative energy and green technologies? Will energy prices remain high, favoring innovation, or will they moderate due to declining demand and new sources of supply? What role will resource nationalism and government planning play in influencing energy price behavior and setting research and development priorities?

Equally qualified observers give different answers to these questions. The causes of the divergent views range from political philosophy and geographic location to professional disciplines and schools of thought. In some cases, the disagreements boil down to different ways of interpreting the same data. Probing the significance of the different viewpoints is productive as a means of alerting chemical industry executives to factors that should be considered when setting strategy.

Scenarios provide an effective mechanism for defining and working with multiple perspectives on the future. DTT's analysis has organized the conflicting views on the economy, regulation, and technology into three scenarios for the period 2010 to 2020. A decade was selected as the time horizon both because a 10-year period is appropriate for the investment cycles in the chemical industry and because the beginning of the second decade of the century provides a convenient unit for framing an inquiry into future trends and developments.

The following sections summarize the main components of each scenario and highlight some of the main implications for the business environment in general, and the chemical industry in particular. Additional material on the scenarios and their sources can be found in the Scenario appendix, Section 7.

Scenario one: Transition

Overview: The West's global domination deteriorates as North America and Europe are unable to contain the inflation that erupts after the recent recession. Boom-and-bust cycles persist throughout the decade. Developing nations are more adept at managing growth and they decouple from the West in favor of a China-centered bloc. Concerns about energy reserves grow as it becomes more difficult and expensive to produce enough oil and gas to meet demand. Given the economic turmoil, efforts designed to raise EHS standards take a backseat to protecting jobs, finding new energy sources, and cutting energy use.

Global business conditions

Economy. Volatile conditions in the developed world lead to a reconfiguration of international links. When industrial nations are unable to put their economic houses in order, China and other developing nations focus on trade and investment with each other. This initiative gains increasing support not only from Russia but also from formerly western-oriented countries in the Asia-Pacific region, most notably Japan. Western political leaders resort to protectionist policies that further alienate the developing world and exacerbate their own economies' plight.

Regulation. Economic issues affect deliberations over regulatory policies. For developed nations, the priority is preserving existing jobs while in developing nations, it's creating new ones. Questions about the cost of new programs to promote environmental protection, health, and safety restrain policymakers and regulators both in introducing new measures and administering those already in force.

Technology. The pace of conventional oil and gas production falls behind demand. Champions of the peak oil theory declare victory — they say this validates their contention that world reserves are at the point where production from cheap, easy-to-access sources will move into decline. High costs and rapid depletion rates limit the usefulness of deep-water oil deposits and shale gas formations as substitutes for conventional energy supplies. Developed nations increase their efforts to develop energy-saving materials and processes as well as alternative energy sources that require limited energy inputs to produce. By contrast, the Asia-Pacific bloc focuses on gaining better access to remaining reserves, sparking geopolitical tensions.

Metrics. For developed nations, the decade is reminiscent of the mid-1960s to late 1970s. Inflation soars to eight percent to 10 percent at times, followed by hard landings. The more stable developing nations stay slightly above their 15-year average of 5.5 percent annual GDP growth. Oil prices are consistently high, in the US\$80 to US\$110 range. Ethylene prices rise slowly, peak, and oscillate around US\$880 per ton, well above the 15-year average of US\$660 per ton (see Figure 13).

Industry-level dynamics

In the West, the boom-and-bust patterns complicate the job of balancing capacity with demand. Chemical executives are forced to confront hard choices over the consequences of trying to maximize market share when there remains the risk of a new downdraft that could leave the company with excess capacity. Historically, many companies have had difficulty resisting the urge to retain or add capacity during upturns, only to regret their optimism when demand plummets.

Struggling western chemical companies are eager to increase their presence in the robust markets of the developing world, but restrictive policies on foreign trade and investment create impediments. As the developing-world bloc solidifies, domestic producers and companies based in developing nations receive preferential treatment.

New players in China, India, and the Middle East capitalize on strong growth at home and gain scale through both consolidation and organic growth. Closer ties with Japan give them access to IP and technology that boost their competitive clout. However, protectionist barriers limit their ability to move into and compete with global industry leaders in western markets. Although this constrains expansion, the issue is substantially offset by their favored status in growing developing-world markets.

Chemical companies based in the developing world are less affected by issues relating to feedstocks and energy than their western counterparts. For developing nations that are net energy consumers, concerns about energy supply are mitigated as national oil companies redouble their efforts to conclude acquisitions, investments, and contracts in Africa, Latin America, and the Middle East.

R&D on alternative energy sources is more intense in the West. Due to concerns about declining energy reserves, the emphasis is on substitutes that produce the maximum energy output for units of energy inputs, not only in the immediate production process but also in the steps before and after production, including manufacturing equipment, building facilities, growing crops, shipping, and storage. This affects the allocation of funding for work on renewables, oil sands, coal-to-liquids, and other alternatives. Debates on how to measure the true ROI of energy production are common.

Concerns about hindering economic growth trump strict environmental policies, but the specter of dwindling fossil fuel reserves provides ample motivation for cutting energy use both in industrial processes and in end products. This sparks R&D on lightweight materials that reduce fuel used in transportation and materials that have improved insulation qualities that decrease energy waste. More specialized products and increased chemical content in products raise the chemical industry's share in the total purchasing costs of buyers in industries, such as automotive and construction.

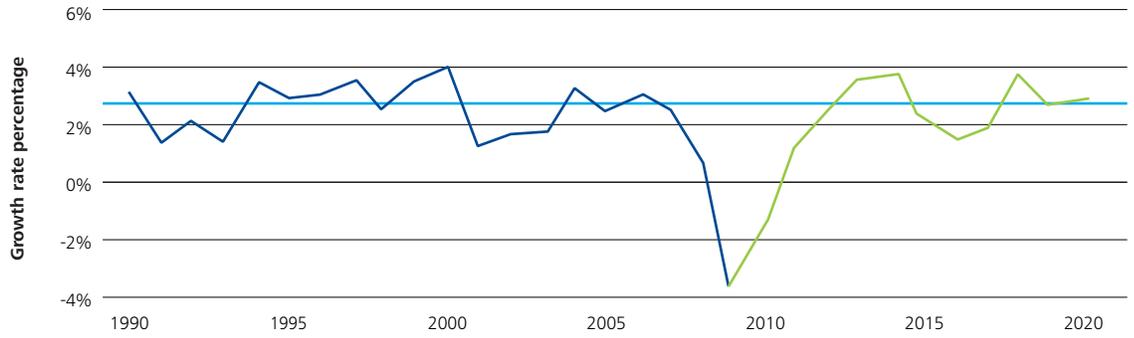
In the specialty chemicals sector, there are opportunities to improve profitability by addressing new and unmet needs in businesses, industries, and households. In both developed and developing markets, the energy-conservation priority creates openings to provide services that foster energy efficiency and to collaborate with industrial customers in developing products with new energy-conserving properties. In the developing world, customers are increasingly receptive to products that fit economies and societies with rising standards of living and that resonate with local cultures and preferences.

R&D efforts become more cooperative, with governments and universities assuming a greater role in partnerships with the cash-focused private sector. This arrangement results in longer time horizons for the development of new products. The developing world, although aided by links with the Japanese industry, focuses on expanding R&D infrastructure and chemical-engineering capabilities.

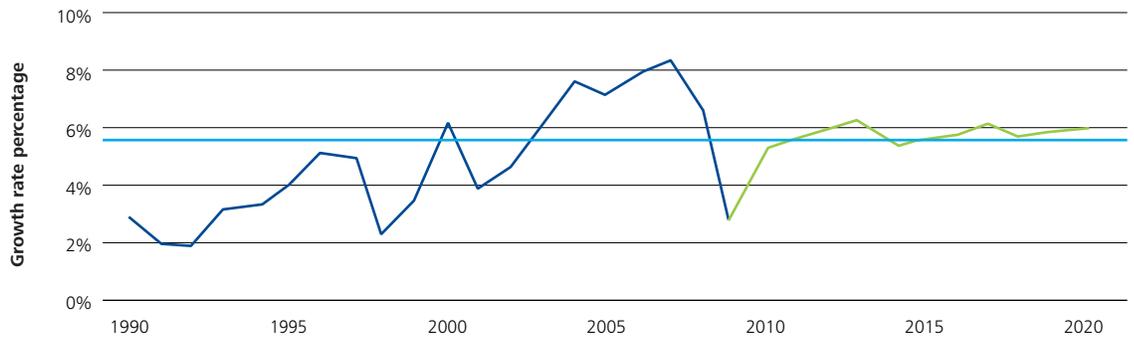
Chemical companies with a large proportion of revenues and assets in developed markets experience lower and potentially unsatisfactory returns and diluted growth. These companies also face a higher cost of capital, which creates further constraints. In this scenario, companies with upstream assets are negatively affected until supply-demand balance is achieved. Specialty companies must decide how aggressively to expand into developing markets and how to protect their proprietary advantages.

Figure 13: Transition scenario — Metrics

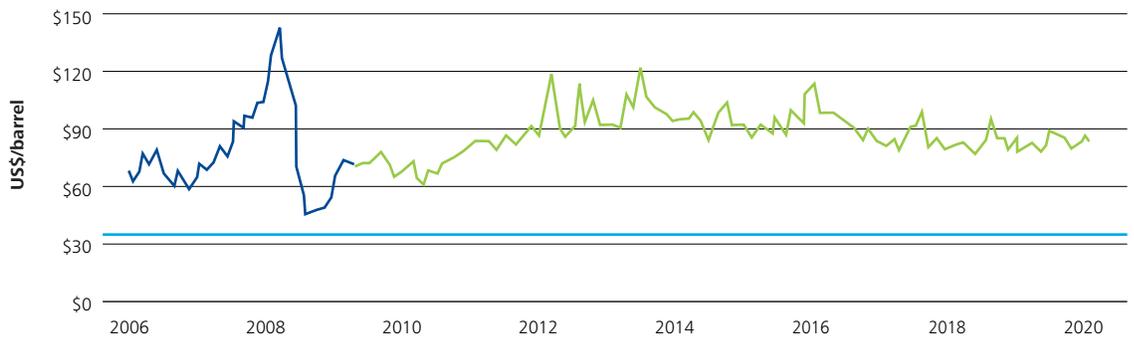
Developed nations' economic growth
Traditional industrial economies do not recover until 2011 and thereafter experience a series of inflationary growth spurts followed by sharp drops.



Developing nations' economic growth
China leads the formation of closer ties among developing nations, who work on shifting their economic focus to consumption rather than exports to the West.



Oil prices
Declining global production bolsters the case for the peak oil theory and shale gas wells prove to have a short, steep extraction curve in addition to other issues. The fall in the dollar's value keeps oil prices high as well.



Ethylene prices
Ethylene prices rise slowly, peak, and settle at higher levels as availability of local gas and energy does not improve.



- 15-year historical average
- Estimated 2010 to 2020
- Historical data

Source
International Monetary Fund, Bloomberg, and DTT Chemical Group analysis.

Scenario two: Resilience

Overview: A strong recovery is attributed to astute government management of national economies, and the policy pendulum swings away from reliance on market forces. China, Europe, and the U.S. become increasingly competitive but accept a set of uniform rules and mechanisms to deal with commercial disputes and limit geopolitical frictions. Public opinion favors more stringent global EHS standards. Renewables and nanotechnology benefit from various forms of government support.

Global business conditions

Economy. After a harrowing recession, the global economic picture improves with surprising speed. Support for free-market economics never revives in the face of strong evidence that government intervention and coordination are effective. Governments guide investment and promote national competitiveness. China, Europe, and the U.S. assemble rival networks of economic and diplomatic alliances. The architecture of international agencies and institutions is revised and strengthened to contain the struggles for global leadership.

Regulation. EHS regulation becomes more stringent due to rising public expectations associated with prosperous times, growing concerns over climate change, the strengthened role of government, and pressure to meet international obligations. Businesses collaborate with governments and labor to develop workable policies that apply uniformly across numerous national markets.

Technology. The quick return of economic growth makes it essential to invest in energy infrastructure after years of postponing maintenance, repair, and new construction. In an atmosphere of environmental sensitivity, there is also pressure to develop fossil fuel alternatives and improve energy efficiency. Mandates, prohibitions, and incentives proliferate as national governments intensify their efforts to cope with energy and environmental challenges, while competing for global leadership in advanced technology.

Metrics. In this scenario, the economic readings resume the favorable patterns of the quarter-century that began in the mid-1980s, conditions Bank of England governor Mervyn King has dubbed “NICE” — non-inflationary, consistently expansionary.²³ Indeed, both developed and

developing nations do better than their 15-year GDP growth averages. Oil prices are on the high side not due to resource issues but to curtailed investment in infrastructure that makes it hard to keep up with demand (see Figure 14).

Industry-level dynamics

Stronger global growth under this scenario means that companies can accept more risk. In the absence of economic volatility, capacity demands are more predictable, leading to more informed investment. In developed nations, there is less need for capacity cutbacks. Healthier cash flows give western companies more ability to expand in emerging markets, but with protectionism held in check, they face increasing competition in their home markets from rivals based in the developing world.

High oil and gas prices squeeze the profits of commodity chemical producers in developed nations. Vigorous competition prevents them from passing all of the high costs along to customers. There is ample incentive to invest in bio-based feedstocks and alternative sources of energy.

The chemical industry caters to buyers in the automotive, construction, and housing industries that are vying to develop products that respond to the priority consumers place on protecting the environment, countering climate change, and reducing fossil fuel consumption. Government regulatory policies prescribe limits and requirements that augment market-driven demand for offerings that incorporate sustainable technologies and are free from toxic substances. Likewise, chemical companies benefit from demand created by public-private cooperation to develop high-speed rail networks and other advanced infrastructure oriented toward energy efficiency and emissions reduction.

²³ Alistair MacDonald, “U.K. Growth Forecast Far from NICE,” *Financial Times*, May 20, 2008.

The industries served by chemical companies gain leverage through expansion and consolidation. The automotive industry, in particular, becomes more globalized as national governments permit cross-border mergers that result in fewer and larger automakers. Governments are anxious to free themselves from commitments to weak manufacturers and the strong recovery moderates concerns about the labor-market effects of post-merger rationalization.

As customers in the automotive sector begin procuring new types of materials, they shop around and choose suppliers based on quality, the ability to provide multiple products and services, and the expertise to participate in product development. The advantage goes to chemical companies proficient at commercializing processes for the mass manufacture of bio-based and nanotechnology products and that use more collaborative models for innovation. New entrants working on bio-based processes and nanotechnology applications pose stiff competition. Some ally with global players.

Increased globalization and the promulgation of uniform global standards create conditions that are conducive to consolidation within the chemical industry. Middle Eastern and Chinese suppliers aggressively forward-integrate and accelerate the creation of massive chemical complexes, challenging industry leaders by producing basic chemicals and certain types of specialty chemicals. Developing-world specialty chemical producers compete to create their own niches based on their understanding of customer behavior in specific geographic and product markets.

Asian companies focus on setting up their own R&D units with European and U.S. collaborators, or acquire boutique firms specializing in nanotechnology, biotechnology, and other emerging technologies. China and India strive to excel at strategic innovation. Both countries encourage the production and export of high value-added chemicals, invest heavily in innovation (green tech, clean tech, and nanotechnology), and R&D. Prominent in the race between these two developing powers are Chinese and Indian scientists who have been persuaded to return from top posts in the West.

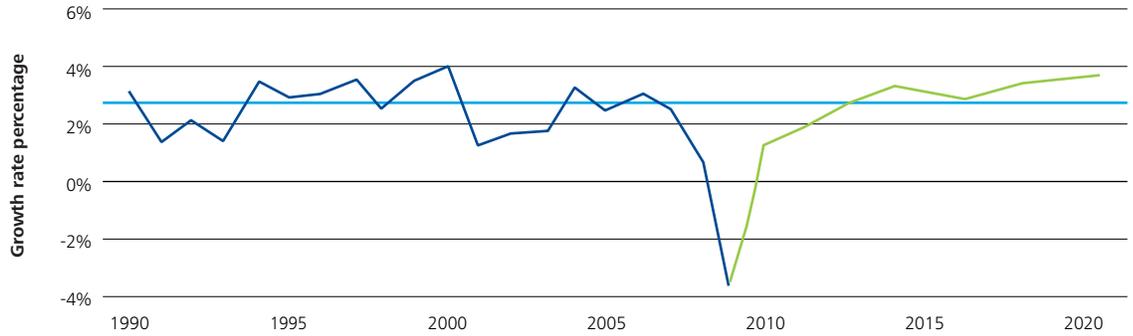
Middle Eastern companies continue to form joint ventures with western companies, seeking specialty chemicals technology and experience. But western players resist making investments in intermediate capacity as they try to balance the cost of supply shortages against more fixed costs of onerous contracts or ownership of upstream assets. Cash-rich Middle Eastern companies acquire stakes in some western companies to expand in these markets.

Companies have the opportunity to allocate their capital differently from past practices when conditions were fairly favorable. A repeat of spending patterns of the past, may lead to future challenges. By learning from past spending habits, companies have the opportunity to do things differently and create more value.

Figure 14: Resilience scenario — Metrics

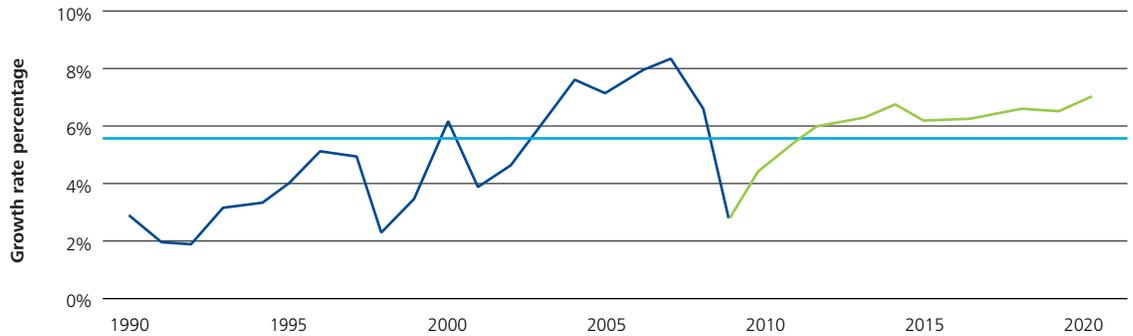
Developed nations' economic growth

Developed economies emerge from the recession early in the decade and enjoy steady expansion thanks to effective government cooperation with business and labor.



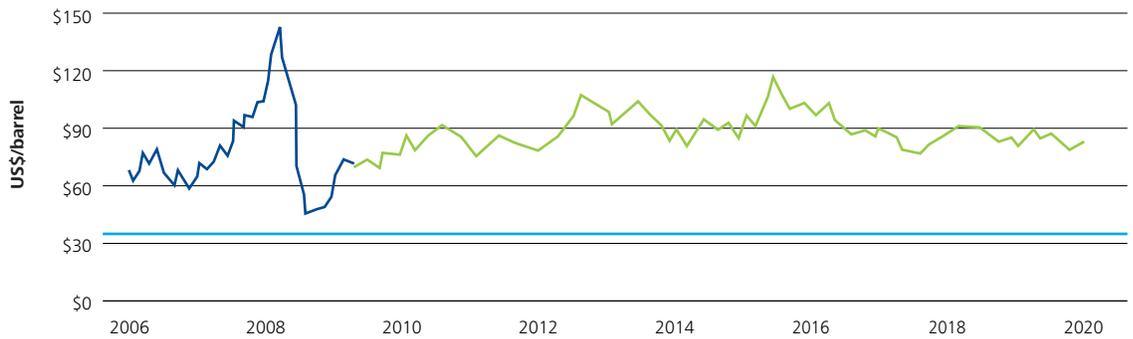
Developing nations' economic growth

China and other developing nations grow strongly, benefiting from government policies designed to improve international competitiveness and smooth the way to more consumption-based economic development.



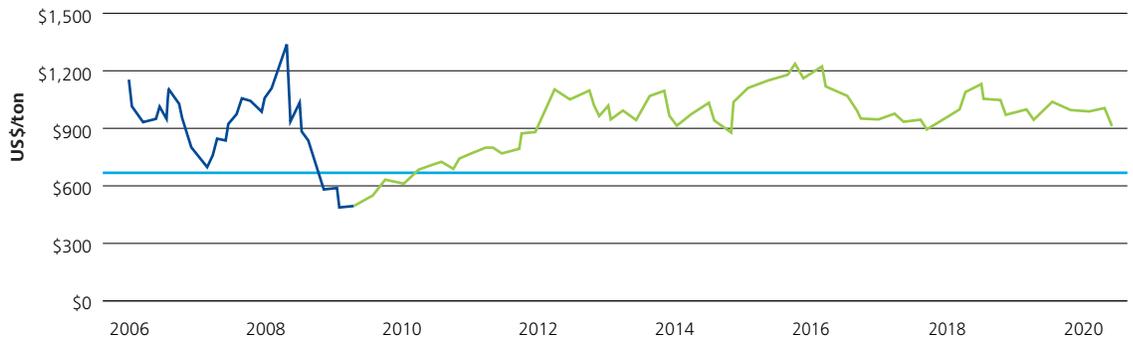
Oil prices

The strong recovery finally elicits overdue investments in energy infrastructure, but oil producers have difficulty meeting demand for much of the decade, which promotes the commercialization of renewables and other fossil-fuel substitutes.



Ethylene prices

Ethylene prices move up with rising global demand and drop from the peak level towards the end of the decade due to the development of alternatives.



- 15-year historical average
- Estimated 2010 to 2020
- Historical data

Source

International Monetary Fund, Bloomberg, and DTT Chemical Group analysis.

Scenario three: Dislocation

Overview: In developed nations, a decade of lackluster economic performance means coping with dispirited consumers, wary investors, and disgruntled voters. In Asia and the Middle East, the falloff in foreign export demand has even more adverse repercussions. With growth curtailed, domestic social and political unrest intensifies and international frictions flare into conflicts. Turmoil in some developing-world nations intermittently affects global oil markets, but generally resource prices are low due to reduced demand and excess capacity. Regulatory policy and R&D support during the decade are uneven thanks to the turbulence of the times.

Global business conditions

Economy. Conditions are chronically weak in developed economies. Credit markets malfunction, unemployment stays high, and the costs of caring for the elderly continue to mount. Reduced demand creates an imbalance for developing nations dependent on export markets, particularly those in Asia and the Middle East. Interest in trade and investment flows on the north-south axis increase as Europe expands relations with emerging economies in Africa, and the U.S. turns more attention to Latin America.

Regulation. Political leaders in the developed world persist in trying to cope with weak growth through failing-firm rescues, stimulus programs, and expensive efforts to reshape their economies. EHS regulation intensifies. Many of the solutions are counterproductive and the damage government does is compounded by rising tax burdens. The developing nations of Asia and the Middle East adopt policies to address environmental issues, but political instability hampers their implementation.

Technology. Despite moderate oil prices during the decade, promoting green technology is a high priority in developed nations given concerns about climate change and the hope of creating green jobs. With private sector R&D spending reduced by the stagnant economy, government priorities, and funding determine what areas receive support, a practice that meets with uneven success. In the developing world, technological progress is impeded by adverse economic, social, and political conditions.

Metrics. The 2010 to 2020 period is similar to Japan's "lost decade." GDP growth recovers from the depths of the recession, but limps along in the low single digits. Growth in developing economies stays several points below their

15-year average. Oil and ethylene prices register only slightly above their 15-year averages (see Figure 15).

Industry-level dynamics

With both developed and developing economies sluggish, the Dislocation scenario presents chemical companies with trying conditions. Capacity issues are exacerbated by the extended period of weak demand and investment is further stymied by political risks both within national markets and across borders.

Excess capacity in building-block chemicals, such as ethylene and aromatics, keeps the prices at moderate levels for specialty chemical companies. Excess capacity in building-block chemicals, such as ethylene and aromatics, keep prices at moderate levels for specialty chemical companies.

Stringent regulation and high taxes add to costs, offsetting some of the savings that come with relatively low oil prices. Low oil prices make most alternative feedstocks uncompetitive with existing technologies. Energy efficiency is a priority.

Developed nations have an advantage in that despite their economic woes they are more politically stable than major countries in Asia and the Middle East. The fact that Africa and Latin America generally avoid such turmoil provides alternatives for chemical companies seeking markets with growth potential. Political reforms, expanding middle classes and improving infrastructure, and in some cases oil and gas deposits draw attention to places like Botswana, Brazil, Chile, Colombia, Egypt, Libya, and South Africa.

The agrichemicals segment is attractive in some of the more stable developing nations. With their populations growing, crop yields need to be improved.

In the Middle East, integrated refineries with downstream operations materialize in more stable countries. However, their ability to pursue specialty chemical production with western joint ventures is curtailed by political pressures and demand uncertainty.

Companies investing in bio-based processes and nanotechnology applications face hurdles in commercializing the technologies at the desired costs and still meeting stringent regulatory requirements. Nevertheless, government policies and programs addressing climate issues stimulate some opportunities for developing new products, particularly in developed nations. New standards and mandates oblige customers in the automotive, construction, and housing industries to become more energy-efficient and eco-friendly. In some cases, government funding, financing, and tax preferences are available to support pertinent R&D.

Although Dislocation may seem to be a low-probability scenario, it is profoundly important to understand it. In this scenario, China is able to meet its own demand for commodity chemicals, thereby creating significant oversupply in countries lacking indigenous demand, including the Middle East. This single factor will have far-reaching financial and geo-political ramifications, not only for the chemical industry but also for the global economy at large.

Perspective on the scenarios

The Transition, Resilience, and Dislocation scenarios capture different opinions and predictions regarding the next decade's global business environment. An actual corporate scenario-based planning exercise typically requires more detail than what is presented here and orients the scenario content to the specific topics and issues that are most pertinent to the company's businesses. However, these alternative futures illustrate the possibilities chemical companies need to consider when making strategic decisions. As this decade has demonstrated, the track events take can depart from what may seem preordained.

Figure 15: Dislocation scenario — Metrics

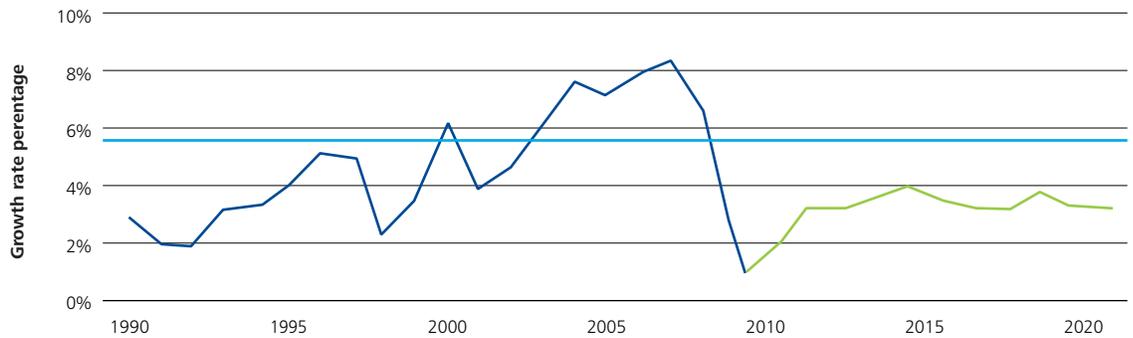
Developed nations' economic growth

Troubles in the financial sector, curtailed by consumer spending and new costs linked to the baby boomer retirements, are among the factors responsible for anemic growth.



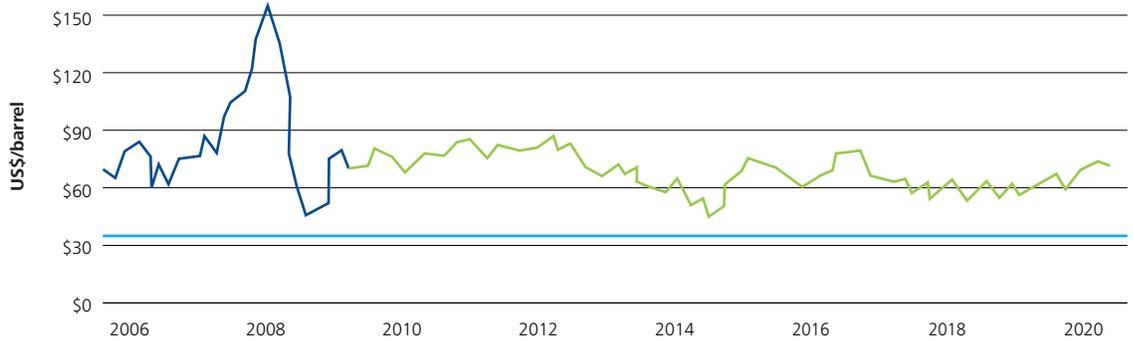
Developing nations' economic growth

Deprived of strong export markets, China and other developing nations find it difficult to cope with social and political pressures, and their economies sputter.



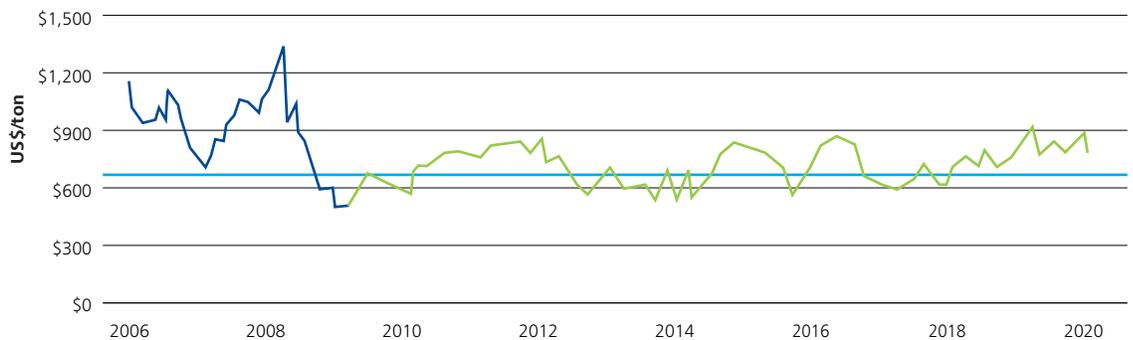
Oil prices

Low global demand, expanded capacity, and production from new sources push oil prices down, offsetting concerns about security of supply generated by the instability of oil-producing countries.



Ethylene prices

Prices increase initially due to anticipation of demand but settles down to historical levels due to the prolonged period of low demand and the availability of local gas.



- 15-year historical average
- Estimated 2010 to 2020
- Historical data

Source

International Monetary Fund, Bloomberg, and DTT Chemical Group analysis.

5 Scenario implications for industry sectors

Specialty chemicals implications (see Figure 16)

The specialty chemicals sector will face a series of issues through the course of the next decade. Specialty chemical executives will need to understand what led to the erosion of the value premium and understand how it will be revived going forward, if at all. Returns will be important. Higher returns will provide options for growth, including capital for investment in innovation. As new, developing market demand builds, there will be a trade-off between IP protection and growth that will need to be resolved over the course of the next decade. The trade-off will depend on the nature of demand rebound in the developed markets. If returns bounce back, the need to place IP at risk is reduced.

Specialty chemicals in Transition

The first half of the new decade will see growth rates among developing-market assets hold steady at around seven percent, while developed market assets fall to below GDP growth. Developed-market players will be frustrated at the difficulty of gaining access to markets in developing Asia and elsewhere in the developing world. Those who do gain access will be concerned about protecting their IP.

Profitability levels among developed-market players will rise towards the end of the decade. Developing-market players will experience a decline from the highs of the mid-2000s but will maintain stable performance over the decade. Operating margin will run from six percent in the middle of the decade to about nine percent towards the end of the decade. Greater coupling of commodity and crude prices will impact the specialty chemical industry as the companies struggle to solve the problem of value erosion, partly because of rising demand in low-cost markets.

The impact on players will vary from significant in the more commoditized specialty segments to moderate for the more specialty segments. With improving market conditions over the last half of the decade, there will be opportunities for innovation as returns pick up and support better capital acquisition programs.

Specialty chemicals in Resilience

Resilience presents opportunities for developed and developing-market assets as growth above GDP occurs across the board. The developed-world players will more carefully evaluate the IP to growth trade-off given that they will be able to sustain growth in their own markets. Generally the next decade will not see a wholesale shift of technology from the developed to the developing world.

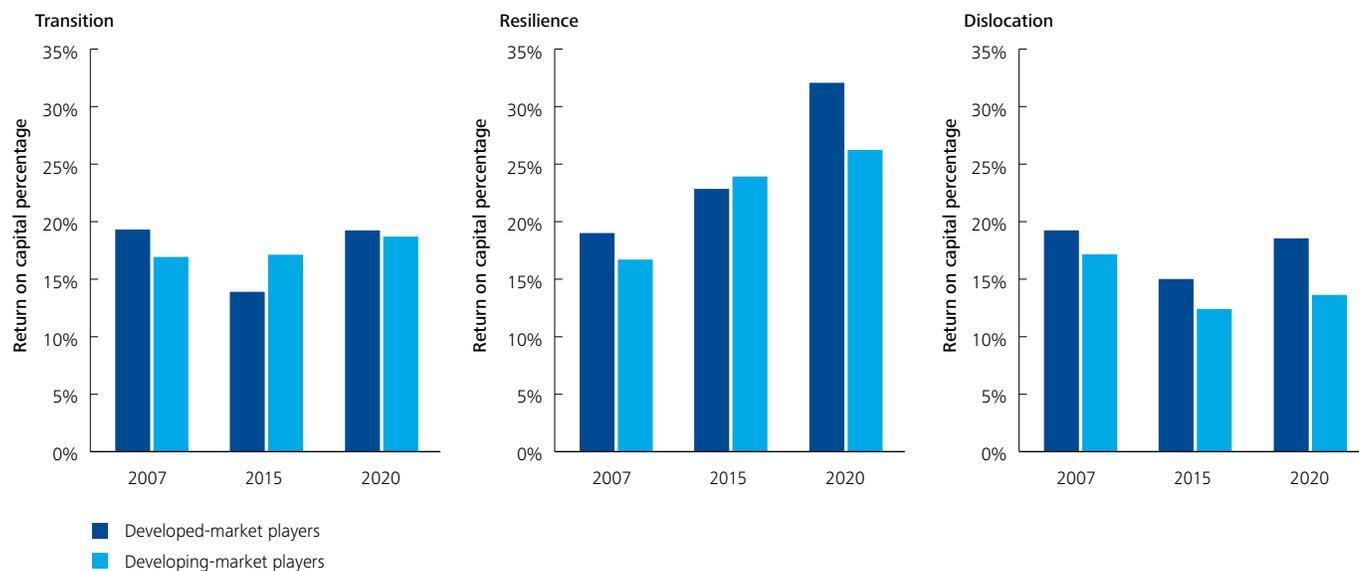
With returns on an upward swing, reaching levels not seen in the specialty chemical industry in the past, access to capital will become easier and impediments to innovation will be reduced. This will create opportunities throughout the developed and developing worlds for innovation and newer materials. Earnings before interest and taxes (EBIT) margins will hold up to the 2007 levels of 10 percent in the developed markets and 14 percent in the developing markets. With strong growth and innovation, the problem of value premium will also be solved by the players during the course of the next decade.

Specialty chemicals in Dislocation

Dislocation is a scenario that paints a bleak picture for the chemical industry at large. However, the specialty chemical players, especially those from the developed markets, will be able to hold onto their positions due to the especially difficult challenges confronting commodity-oriented developing-market players. Developed-market specialty chemical companies will be significantly more protective of their IP.

EBIT levels will be eroded by up to five percent across both developed and developing markets since the coupling with crude prices and commodity prices is higher. SG&A and R&D reductions are insufficient to negate the impact of raw material prices. Investments in innovation suffer through the course of the next decade as the players are forced to aggressively reduce SG&A and R&D to counter increases in cost of goods sold. This scenario sees significant erosion of returns in the case of some developing-market players, forcing them to fall under cost of capital.

Figure 16: Specialty chemicals projections



Note

ROC: Operating return on profit before interest, special charges, and taxes / (net working capital + net fixed assets).

Source

Capital IQ and DTT Chemical Group analysis.

Commodity chemicals implications (see Figure 17)

The primary concern for the commodity chemical players during the next decade will be their attempt to shore up returns that have at times fallen below the market-based cost of capital, a problem that has been exacerbated by the recent recession. Improved returns and growth are essential to create efficient commodity chemical players; otherwise excess capacity issues will worsen. The commodity players will also need to identify mechanisms that will help them hedge against the volatility of feedstock, through alternative feedstocks or gaining access to advantaged feedstock.

Commodity chemicals in Transition

Commodity companies in developed markets will experience a fall in operating profit through the first half of the decade without major structural change. In the second half, they will achieve a marginal rise in operating profit as the result of corrective measures they take to address challenges in the first five years. The developing-market players will invest in efficient new capacity and other infrastructure. That and their proximity to feedstock will enhance profitable revenue growth, thus supporting EBIT and significantly improving returns to levels higher than the specialty players in developed markets. Some developed-world companies will suffer returns falling below their cost of capital. For them increased capacity rationalization will be required for survival. Rationalization will continue through the decade with some payoffs registering towards the end of the decade.

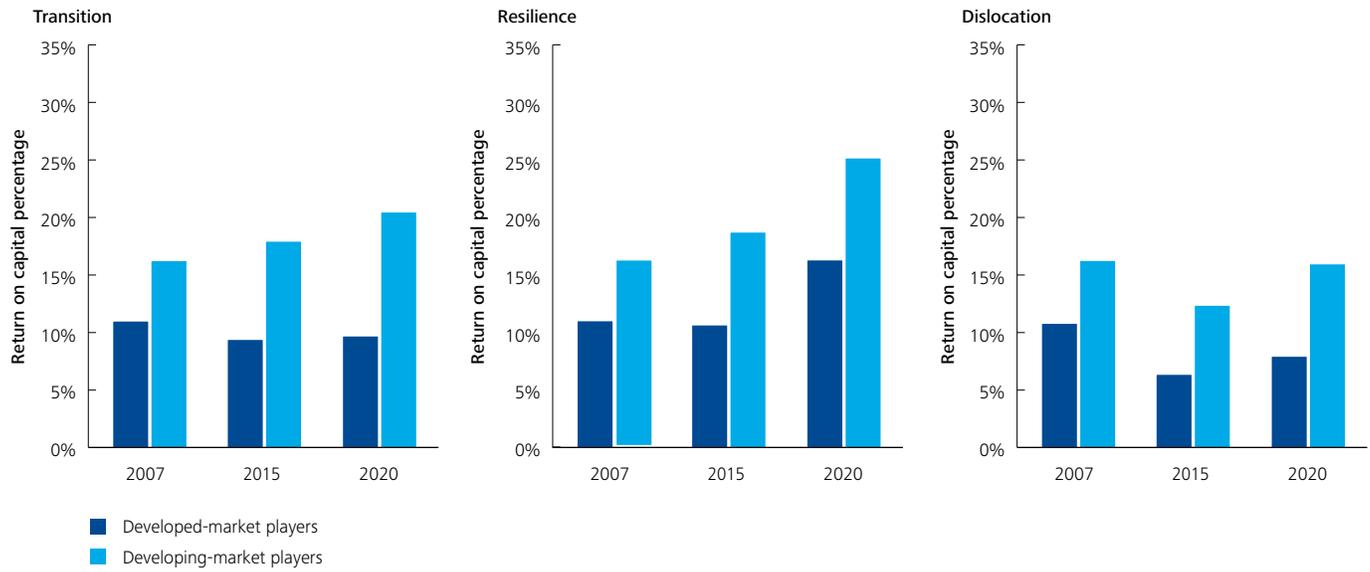
Commodity chemicals in Resilience

The commodity chemicals sector will experience a revival owing to robust demand growth. Commodity companies in developed markets will achieve a significant operating-profit improvement in the second half of the decade primarily on account of price growth from continued demand growth. Capacity utilization will improve, halting the current trend of asset rationalization in the developed world and leading to improved profitability. Developing-nation players will, apart from significantly improving returns and improving profitability, expand to almost twice their present size, and may as a result, marginalize some developed-market commodity players.

Commodity chemicals in Dislocation

Developed-nation commodity companies will see operating profit fall under four percent and remain at that level despite the fact that crude prices will be low as the result of dwindling demand. In a Transition or Resilience scenario, ROC will improve significantly owing to ongoing capacity rationalization. This trend will accelerate over the next few years. The full benefit of this rationalization on ROC will be seen in the second half of the decade. In a Dislocation scenario, ROC will fall significantly from current levels. While there will be a marginal improvement in the second half of the forecast period, ROC levels will not even come close to the current level of 11 percent. Even developing-market players will struggle in the first half of the decade and see lower returns as a result of the excess capacity investment and an absence of demand growth. However, with across the board capacity rationalization, these players will continue to be compelled to improve their profitability and will strengthen their market position somewhat.

Figure 17: Commodity chemicals projections



Note

ROC: Operating return on profit before interest, special charges, and taxes / (net working capital + net fixed assets).

Source

Capital IQ and DTT Chemical Group analysis.

Integrated chemicals implications (see Figure 18)

Integrated players across the world own significant commodity assets as well as specialty assets, and therefore, the issues they are dealing with are a subset of the issues of specialty and commodity chemical companies. They will face additional challenges unique to players of their scale and breadth. The integrated companies will need to watch profitability considering their commodity portfolio has the ability to bring down profitability. They also need to pay attention to valuation multiples in the specialty sector since they will actively consider purchasing assets over the course of the next decade given their need to improve returns.

Integrated chemicals in Transition

The developed-market players will be impacted by the coupling of their margins with crude and feedstock prices. However, some degree of mitigation will be possible thanks to their vertically integrated structures. Profitability levels for the developed-market players will fall slightly but hold steady through the course of the next decade. Due to investments in both capacity and acquisition, returns, despite a decline from 2007 levels, will hold stable as the developed-market players look for targets to hedge the weakness on the commodity side of their business. The developing-market players will see marginal improvements in returns by about one percent driven by governmental support. The developed-market integrated players in return for access to developing-world markets will open up some of their specialty assets to developing-world companies.

Integrated chemicals in Resilience

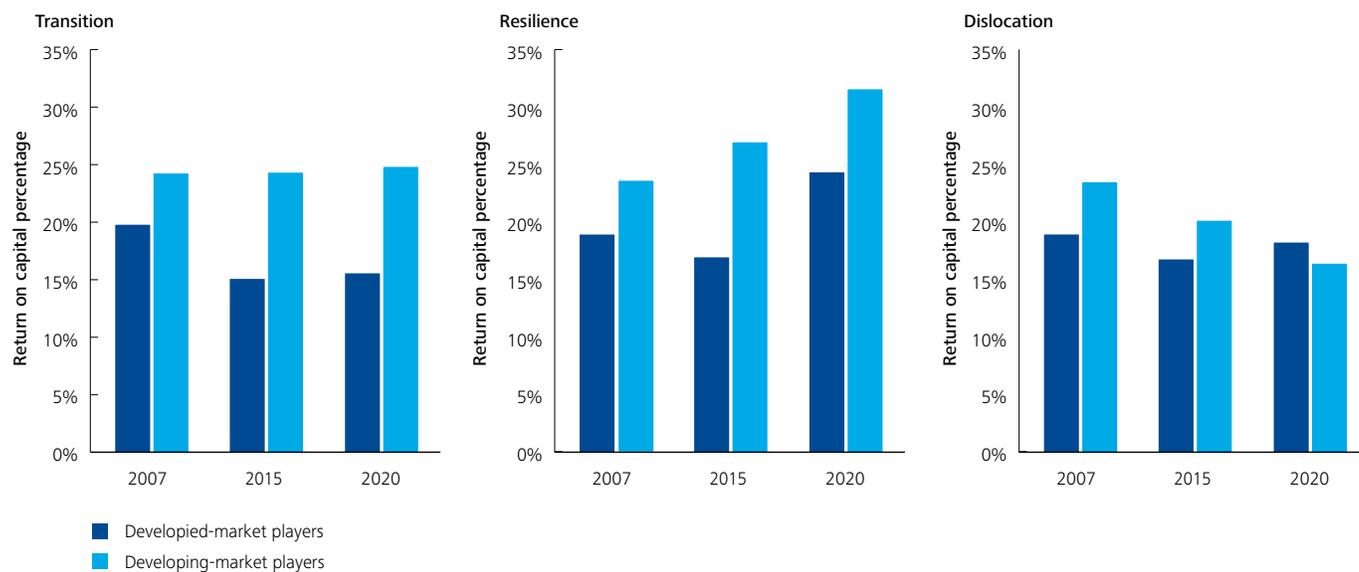
With demand growth of around four percent in developed markets and eight percent in developing markets, integrated chemical companies will be able to gain significant efficiencies driven by vertical integration. This growth also will likewise support profitability levels and improved returns for the developed- and developing-market players. In this scenario, the multiples for targets in the specialty chemicals sector remain high. However, improved cash flow will still provide opportunities for acquisitions. This will weaken returns in the case of the developed-market integrated players during the first half of the decade. Towards the end of the decade, the market will reward profitability and return performance of the developed-market integrated players. The integrated players based in developing nations will see growth opportunities as developing markets expand at eight percent. This expansion will attract investment into the market, reducing EBIT by one percent to two percent over the first half of the decade, returning to higher levels towards the end of the decade.

Integrated chemicals in Dislocation

Integrated chemical companies from the developed world will use their scale of operations to hold profitability and returns stable. EBIT will fall by about one percent during the decade — this coupled with asset rationalization in the developed markets will help remedy return levels that fell during the recent recession. In this scenario, specialty chemical assets are prime acquisition targets for integrated players, especially the ones with stronger balance sheets and improved access to capital. Commoditization will be a problem for integrated companies in the developing world, as is the case with specialty players. With demand shrinking, China will become chemically self-sufficient. This limits

its need for imported products which leads to even more capacity problems in the Middle East, where fortunes have been invested in expanding capacity. At the same time, China will not have investment capital to attract the higher technology and materials they need to develop the industry. Returns and margins in both China and the rest of the developing world will erode through the decade. This scenario will also see integrated chemical companies undertake significant capacity rationalization in developed and developing markets to ensure liquidity and reduce excess supply.

Figure 18: Integrated chemicals projections



Note

ROC: Operating return on profit before interest, special charges, and taxes / (net working capital + net fixed assets).

Source

Capital IQ and DTT Chemical Group analysis.

6 Conclusion: Preparing for an uncertain future

The next decade will test the global chemical industry. Currently the industry is struggling to make headway against a variety of issues that have been intensified by the recent economic downturn. New challenges lie ahead. With dwindling gross margins, excess capacity, high and volatile input costs, and markets that are weak and overserved, companies must shed legacy practices.

Essential elements of the solution are to reduce overcapacity, extract the maximum value from existing assets, and evaluate new initiatives more conservatively. Remaining a viable player in the commodities sector requires managing in a tighter, more selective manner.

However, companies aspiring to stand out must do more. To do so, they must maximize efficiencies to free up resources. They can then commit these resources decisively to a specific growth strategy rather than pursue a generic, middle-of-the-road approach. Companies that are disciplined and focused have the ability to galvanize their people, attract customers, and interest investors.

Being bold does increase strategic risk. A finely-tuned strategy involves adopting specific assumptions about customer preferences and other factors, such as technology developments, regulatory policies, and competitor moves. Success depends upon conditions playing out as assumed, but of course there is no guarantee this will happen.

Indeed, the point of the scenarios is that fundamental aspects of the business environment could unfold in dramatically different ways in the decade ahead:

- A strategy that assumes a growing economy in China will be aimed properly if developing markets expand as depicted in the Transition or Resilience scenarios. It will be much less suitable if the future brings turbulence of the type that occurs in the Dislocation scenario.
- A strategy that is based on projected demand for eco-friendly products will be aligned with marketplace needs under the Resilience scenario. It will be less effective in the Transition scenario, where economic concerns trump environmental stewardship.
- A strategy that banks on high demand for new insulating materials to promote energy efficiency will have promise if energy prices are high as in the Transition and Resilience scenarios. It could falter if energy prices are relatively low as in the Dislocation scenario.

Companies thus need a framework for strategy that allows business units to be aggressive while providing them with the means to alter their approach if obstacles or openings appear that are other than what they have planned for.

Strategic options can furnish this flexibility. Strategic options reside in assets that contribute to the existing strategy, but which can be combined with other assets to enable a shift in strategic direction. The assets may be wholly owned or accessible through mechanisms such as a minority stake, a joint venture, or an alliance.²⁴

An example of the latter is a minority position in a venture aimed at commercializing a highly energy-efficient green technology. In a future that resembles the Transition scenario, energy efficiency would be especially important and would raise the technology's value compared to alternatives that require more energy inputs. Under those conditions, it would be advantageous to shift emphasis to products incorporating this technology and buying out the partner in order to do so, in essence exercising the option.

Ensuring that business units have access to strategic options is a job of corporate-level management. Senior executives have the overall perspective required to assess the commitments business units are making as they pursue their strategies and, with the aid of scenarios such as Transition, Resilience, and Dislocation, to identify the assets that would be required to adjust to market conditions that diverge from the assumptions built into their plans.

In summary, becoming more disciplined and focused allows chemical companies to function effectively in a global industry that is increasingly commoditized, cyclical, and competitive. Pursuing strategies that involve greater differentiation allows business units a better shot at creating sustainable value. Paying attention to alternative versions of the future allows corporate leaders to anticipate what may lie over the horizon and establish the strategic options needed to deal with developments that could require changes in course. The overall effect of these measures is to equip companies to meet the challenges of the new decade. Acting now to become more competitive is important. As onetime professor of chemistry Louis Pasteur said, "Luck favors the prepared."

²⁴ Michael Raynor, *The Strategy Paradox: Why Committing to Success Leads to Failure (and What to Do About It)*, 2007.

7 Scenario appendix

This section contains additional information about the scenarios featured in the main text. The descriptions are organized by the three primary variables — economy, regulation, and technology — and are further segmented between developed and developing nations. Also included are representative examples of pertinent views and predictions from a variety of sources, including economists, pundits, and government entities. These provide support for the plausibility of developments depicted in each scenario.

Scenario one: Transition

Economy

Developed nations: Weak

Developed nations bounce back quickly from the Great Recession of 2007–2009, but governments and central bankers are unable to prevent an inflationary overshoot. Trying to avert a relapse into recession, they take their economies back to the volatile 1970s.

A surge of borrowing and spending ensues once the U.S. housing market stabilizes, credit markets mend, and joblessness abates. In the absence of stringent new regulatory controls, risk taking, and asset bubbles return. Meanwhile, government stimulus spending is difficult to curtail. Additionally, several trends that have kept prices down for decades weaken or reverse: productivity gains slow, taxes rise, commodity prices move up, and foreign purchases of U.S. debt decline.

When inflation flares, countermeasures are stymied by fears of hard landings, shrinking margins, and tough times. Central bankers trying to raise interest rates encounter opposition from political leaders concerned about unemployment and servicing public debts. Boom-and-bust cycles follow as policy swings from loose to tight and back again. The U.S. dollar and other developed-nation currencies fall in value. Protectionist policies curtail international trade and investment.

Developing nations: Strong

China and other Asian developing nations rebound after slowing through the recent recession. A clear divide opens between the vigorous economies of the East and the disorderly uncertain West.

China leads a move away from reliance on the West and the U.S. dollar. The plan is to expand mutually beneficial trade and investment flows among developing nations while building the consumer segment of domestic economies. Participants in the initiative include not only developing nations of the Asia-Pacific region but also Russia and many countries in Africa, Latin America, the Middle East, and central Europe. The decoupling process is not without costs and friction, but on the whole it succeeds. By late in the decade, the coalition is working so well that Japan has moved into its orbit and western powers are concerned about their loosening ties with Australia, India, South Africa, and South Korea.

Regulation

Developed nations: Moderate

In the developed world, support for aggressive regulatory policies sags. The unsettled economic situation saps enthusiasm for pursuing ambitious programs to protect the environment, health, and safety. Debate blocks measures that would impose new compliance costs on businesses and forces changes in industrial processes. Action on greenhouse gases is slowed by a backlash against claims that climate change is human caused and/or a serious threat. There is a pattern of avoiding or buffering legislative and regulatory provisions that would have a material adverse effect on jobs, prices, or tax burdens.

Developing nations: Moderate

Countries in the developing world were already dubious about accepting restrictions on greenhouse gas emissions to address issues they attribute to the earlier self-indulgence of rich nations. As it becomes apparent that what seemed like a solid consensus on climate-change science is dissipating, political leaders back away from serious action. Measures designed to improve safety and health gain ground in many developing nations, but always accompanied by concern about maintaining economic growth. Overall, the story is the same as among developed nations: There is a good deal of activity and discussion, but in reality, economic considerations trump social and environmental sensitivities.

Technology

Developed nations: Hot

Middle Eastern oil production is flat or increasing only slightly, which means trouble given the ongoing downward trend in output elsewhere around the globe. Champions of the peak oil theory declare victory. Output from rapidly depleting deep-water wells only partly offsets the declines in conventional oil production. Natural gas production is also a worry. As with deep-water oil wells, production from shale gas wells follows a spiking pattern. Russia's output is increasingly routed eastward and international shipments of liquefied natural gas aren't yet sufficient to make a difference.

With oil and gas supplies sinking, the priority is on cutting energy use. There are no affordable substitutes ready to emerge in quantities that will solve the problem quickly.

This sparks R&D on lightweight materials that reduce fuel used in transportation and on materials with improved insulation qualities that decrease energy waste. There is also interest in improving the efficiency of industrial processes.

There is progress in commercializing new nanotechnology applications. However, the impact is incremental rather than revolutionary.

The prospect of sustained high energy prices facilitates R&D on alternative energy sources. However, the emphasis is on substitutes that produce the maximum energy output for units of energy inputs, not only in the immediate production process but also in the steps before and after production (e.g., manufacturing equipment, building facilities, growing crops, shipping, and storage). This affects the allocation of funding for work on renewables, oil sands, coal-to-liquids, and other alternatives — debate over the energy-in, energy-out metrics of different technologies surrounds investment decisions in both the private and public sectors.

The volatile economic setting has an unfortunate effect on R&D. With speculation and risk taking in the picture, there are many cases of pouring money into ventures that lead nowhere.

Developing nations: Cold

The energy crisis is mitigated in the developing world by agreements that grant China and other ascendant powers privileged access to oil and gas reserves. They redouble earlier efforts to conclude acquisitions, investments, and contracts in Africa, Latin America, and the Middle East. Moreover, the switch to developing domestic markets helps to reduce energy demand somewhat; there is a slow decline in the need for commodities required to build up the infrastructure required for vast export industries. This is not to say there is no interest in developing alternative energy and energy-saving technologies; programs for this purpose are promoted by governments across the developing world. However, the urgency is less than in developed nations.

Support for the Transition scenario

The next decade will almost certainly be characterized by a higher level of economic volatility and increased risk, clouding the certainty required for long-term planning and generating unpredictable movement in financial and economic indicators.

— Confederation of British Industry, *The Shape of Business: The Next 10 Years*, November 2009.

At the politico-military level, we remain a single-superpower world. But in every other dimension, financial, educational, social, and cultural, the distribution of power is shifting, moving away from American dominance.

— Fareed Zakaria, *Newsweek International* editor, *The Post-American World*, 2008.

The old-growth model, where we have to rely on consumption in the West for goods and services produced here, we feel will no longer serve us as we move to the future.

— Abhisit Vejjajiva, Thai prime minister, quoted in "Asian Nations Push Ideas for Trade — China and Japan Want to Reduce Reliance on Western Demand, Offer Vision for Creating an EU-Style Bloc," *Wall Street Journal*, October 29, 2009.

Of the 20 issues covered in the January national survey of top priorities for 2009, "protecting the environment" ranked number 16, down 15 percentage points from one year earlier. "Dealing with global warming" ranked last, down five percentage points from one year earlier.

— Pew Research Center for People and the Press, "Economy, Jobs, Trump All Other Policy Priorities in 2009," January 22, 2009.

Many disasters associated with warming are simply normal occurrences whose existence is falsely claimed to be evidence of warming. And all these examples involve phenomena that are dependent on the confluence of many factors.

— Richard Lindzen, MIT professor, "The Climate Science Isn't Settled: Confident Predictions of Catastrophe Are Unwarranted," *Wall Street Journal*, December 1, 2009.

Underwater fields, especially deepwater fields, deplete twice as rapidly as conventional oil fields on land ... New technology doesn't put any more oil in the ground. It just means we have a bigger straw to suck out what is already there.

— Jeff Rubin, economist, *Why Your World Is About to Get a Whole Lot Smaller: Oil and the End of Globalization*, 2009.

The harsh truths about shale gas: Enormous amounts of energy and water are needed to break open the impermeable rocks. Flows come out fast and then decline at record rates. Rig pumping service rates are enormous.

— Matthew Simmons, energy investment banker, "Have We 'Peaked'?" OTC 2009 Topical Luncheon, Houston, May 6, 2009.

The concept of net energy must also be applied to renewable sources of energy, such as windmills and photovoltaics. A two-megawatt windmill contains 260 tons of steel requiring 170 tons of coking coal and 300 tons of iron ore, all mined, transported, and produced using hydrocarbons.

— J. David Hughes, "The Energy Issue: A More Urgent Problem Than Climate Change?" in *Carbon Shift*, 2009, Thomas Homer-Dixon, editor.

One renewable energy resource is the cleanest, cheapest, and most abundant of them all. It doesn't induce deforestation or require elaborate security. It doesn't depend on the weather. And it won't take years to build or bring to market; it's already universally available. It's called "efficiency."

— Michael Grunwald, *Time Magazine* senior correspondent, "Seven Myths About Alternative Energy," *Foreign Policy*, September/October 2009.

Scenario two: Resilience

Economy

Developed nations: Strong

Throughout the developing world, confidence grows when major economies emerge from the downturn without serious missteps in shifting from emergency measures aimed at stimulus and rescue to policies geared to keeping inflation in check.

With the recovery comes growing international competition. The U.S. and Europe form globe-spanning networks of allies that compete in both the commercial and diplomatic realms — blocs that are based on mutual advantage rather than geographic proximity.

In the U.S., reforms in finance, health care, energy, and taxation produce a policy framework that seems better suited to the demands of a modern society. The process has its rough spots and takes time, but the results are well-received and the conviction takes hold that progress is possible even when dealing with longstanding problems.

In Europe, reforms that strengthen the EU have a similar effect. Legacy constraints weaken and there is more tolerance for surrendering sovereignty to permit collaborative action. The increasing cohesiveness within the EU makes it more effective in standing up for its interests.

Developing nations: Strong

The Chinese business environment improves thanks to reforms that promote the rule of law and more national uniformity under policies prescribed by Beijing. The swing away from investment and toward consumption proceeds at a steady pace. Democracy as it's known in the West doesn't emerge, but the Chinese Communist Party does become more technocratic than autocratic.

China competes with the U.S. and EU for the markets, resources, and diplomatic support of other developing nations. Resource suppliers, such as Indonesia, the Middle East, and Russia, play the three superpower blocs off against each other.

Agreement on global rules for trade and investment is facilitated by an overhaul of mechanisms for international cooperation. Sweeping changes replace the old architecture of the United Nations, World Bank, International Monetary Fund (IMF), and World Trade Organization (WTO) with a new, more unified structure. The changes nurture confidence that nations can maintain order while competing vigorously to promote their own interests and priorities.

Regulation

Developed nations: Stringent

Fears about the effects of climate change lend urgency to environmental protection and given the popularity of government solutions, efforts to protect the planet are increasingly led by the public sector. Industries have a voice in the government decisions that determine the pace at which they must adopt new technologies and processes, but labor unions are influential, too. Business leaders' cooperation is facilitated by government support for R&D projects that promote compliance with official plans and priorities.

The Toxic Substances Control Act and similar laws in many other countries are revised and strengthened to establish new and more stringent controls over the manufacture and use of chemicals. The EU's REACH code is the model widely copied in the West. Although the new rules significantly intensify regulatory intervention, the transition to the new system is smoothed by the careful design and effective administration that characterizes government performance in this era.

Developing nations: Moderate

As standards of living rise within the developing world, so do environmental sensitivity and concerns about health and safety. Governments collaborate to keep their policies on energy, the environment, and other topics from being undermined by competition from countries with lesser standards, or by businesses departing for more lenient jurisdictions.

Technology

Developed nations: Hot

As the new decade dawns, neither international oil majors nor national oil companies have invested sufficiently to meet the energy demand that grows when economies around the world start expanding again. Maintenance and repair work has been deferred for years and there are gaps in new infrastructure from drilling rigs and natural gas liquefaction plants to ports and pipelines. Energy prices rise. Natural gas is especially popular as a bridge fuel for both transportation and power generation, which affects industrial users. High energy prices attract investment into oil and gas infrastructure, but governments are determined to augment that investment with work on new alternatives. Government spending and public-private partnerships multiply.

Developing nations: Hot

China and other developing nations see green technology as a way to achieve an international competitive advantage while addressing concerns about energy security and climate change. Huge amounts of government money are poured into developing R&D programs and backing the commercialization of promising technologies. China and India are determined to lead the world in nanotechnology and their investments in that area will soon challenge the American and European blocs. Both China and India entreat expatriates to return home and apply their expertise on behalf of their native countries.

Support for the Resilience scenario

The U.S. and the rest of the world have embarked on recoveries that will gather strength in the second half of this year and proceed moderately vigorously through next year and into 2011. They will surpass almost all present forecasts on the upside and will once again illustrate the Zarnowitz rule: Deep recessions tend to be followed by steep recoveries.

— Michael Mussa, senior fellow, Peterson Institute for International Economics, “Global Prospects as of September 2009: Onward to Global Recovery,” September 17, 2009.

Second-world countries are the tipping-point states that will determine the 21st-century balance of power among the world’s three main empires including the U.S., EU, and China. The three superpower economies are so deeply intertwined that the costs of conflict have risen considerably.

— Parag Khanna, New America Foundation, *The Second World: Empires and Influence in the New World Order*, 2008.

The world does not need a multitude of institutions charged with dealing with different facets of the same problem. The IMF, World Bank, WTO, and Organization for Economic, Co-operation and Development (OECD) should be merged and radically streamlined.

— Stephen Roach, chairman, Morgan Stanley Asia, *The Next Asia*, 2009.

It is no cause for alarm that regulations have multiplied as the economy supplies so many more goods and services to the people. As economies change and grow more complex, it is only natural that more oversight is needed.

— Jeff Madrick, author, columnist; *The Case for Big Government*, 2008.

For our environment, this is a time unlike any I have seen in two decades of work on these issues. Our towering challenges are dwarfed by some of the greatest opportunities we have ever seen to protect our health and our environment. I hope it’s clear to you that I — and all of my colleagues at EPA — fully intend to seize those opportunities.

— Lisa Jackson, administrator, U.S. Environmental Protection Agency, remarks at the Conference on the Future of U.S. Chemicals Policy, October 6, 2009.

One can well envisage a scenario half a decade or so from now in which a period of strong demand growth again leads to a period of tight supply and higher prices as investment and capacity growth fail to keep up.

— Peter Jackson, senior director, IHS Cambridge Energy Research Associates, *The Future of Global Oil Supply: Understanding the Building Blocks*, 2009.

Chinese regulators have already taken many concrete steps to address environmental issues and support the development of greentech markets. In fact, when compared to other countries, both developing and developed, China appears to be on the path of becoming a global greentech leader.

— China Greentech Initiative, *The China Greentech Report 2009*, September 2009.

China and India are expected in 10 years to achieve near parity with the U.S. in two different areas: scientific and human capital (India) and government receptivity to business innovation (China). China and India will narrow significantly but not close the gap in all remaining factors.

— U.S. National Intelligence Council, *Global Trends 2025: A Transformed World*, 2008.

Scenario three: Dislocation

Economy

Developed nations: Weak

The recovery finally materializes, but there isn't much to celebrate. Growth in developed nations is feeble. Toxic assets are a stubborn problem. Unemployment is another bearish factor. The difficult job market causes consumers to cut back on their spending, which keeps corporate profits down and suppresses business investment. The rising costs of rescue programs, stimulus spending, entitlement programs, and debt service force governments to hike taxes even though this adds to the burdens borne by an already listless economy. The decade isn't as bad as the 1930s, but it's a long way from the stable growth of the prior quarter-century. Retiring baby boomers and younger generations alike are amazed at the failure to return to what had been considered normal, but there is little enthusiasm for reviving policies that rely on the operation of free markets.

Developing nations: Weak

China disappoints those who expected a return to stupendous growth. With demand down in export markets, China's economy is unable to regain momentum. Shifting to domestic consumption proves a complex and protracted proposition, which isn't helped by the instability that follows the bursting of real estate and stock market bubbles caused by the government's infusions of liquidity. The many foreign acquisitions made by Chinese firms with government encouragement are a mixed blessing at best, with so little growth at home and abroad, many acquisitions lose value. Discontent and dissent seethe and China becomes more militant abroad as its leaders try to deflect the pressure. Many developing nations that cater to China and the West experience turbulent times as well and export-oriented economies fail to deliver the growth required to placate populations seeking improved standards of living.

Multinational corporations search for alternatives to the turbulent Asian and Middle Eastern markets and find some areas of interest elsewhere in the developing world. For U.S. companies, the best options are in Latin America, while for Europe the focus is on Africa. The emphasis thus shifts from east-west opportunities to north-south.

Regulation

Developed nations: Stringent

The extended period of slow growth and high unemployment is accompanied by a divisive, contentious political environment. Unusual weather patterns create alarm about climate change and add to the atmosphere of despair. Politicians hounded by unhappy constituents promote rounds of legislation and rulemakings aimed at controlling climate change, pollution, and toxic chemicals. The result is a morass of expensive requirements that do more to undermine economic growth than to counter the ills they ostensibly target. Business lobbyists work to gain exceptions, exemptions, offsets, and other remedies that add to the complexity of the system.

Developing nations: Lenient

Political leaders in developing nations face essentially the same challenges as their counterparts in the developed world, but with even higher stakes. Social and political pressures reach the boiling point in many countries and measures that address grievances are hurriedly implemented in an effort to head off upheaval. Although sanctions against problems, such as harmful emissions, toxic substances, and unsafe working conditions, achieve some of their objectives, they are unsuited to dealing with the main source of resentment, which is the decline in economic growth.

Technology

Developed nations: Cold

Contrary to most expectations, energy prices stay relatively low throughout the decade. Political instability and conflicts in energy-producing regions interrupt the flow of oil and gas at times, but the impact of these events is muted by a number of factors: Lagging demand due to the weak economy; reductions in use that originated during the 2008 oil price spike; the completion of capacity expansions begun during the prior decade; the discovery of new deep-water oil deposits; and growing unconventional gas production. Nevertheless, government promotes renewables R&D both in response to concerns about climate change and as a means of reducing unemployment. In perspective, however, the scale of R&D activity is limited by budgetary constraints, and the results are curtailed by the political nature of the process for allocating support.

Developing nations: Cold

In the developing world, political leaders direct investment into green technology ventures that seem to have potential for alleviating climate concerns and providing employment, but they are unable to pick winners with any consistency. In many countries, science and technology suffer as programs are disrupted by adverse economic, social, and political conditions.

Support for the Dislocation scenario

The U.S. could very well stumble along for years, as Japan did during its lost decade, never summoning the courage to do what it needs to do and never really recovering.

— Simon Johnson, MIT professor and former IMF chief economist, "The Quiet Coup," *Atlantic*, May 2009.

The growth slowdown is amplified in world commodity markets, as many emerging markets face steep declines in their terms of trade. If historical patterns hold, the current lull in sovereign defaults or restructurings in emerging markets will likely come to an end, particularly if the recovery process in the world's largest economies is delayed.

— Carmen Reinhart, economics professor, University of Maryland, "The Economic and Fiscal Consequences of Financial Crises," *VoxEU.org*, January 26, 2009.

The current economic crisis will lead to huge overcapacity as Western demand evaporates. Asian companies, facing anemic consumer demand at home, will not be able to sell their products in the region. The Asian export-dependent model of development will either disappear or cease to be a viable engine of growth.

— Minxin Pei, senior associate in the China Program, Carnegie Endowment for International Peace, "Think Again: Asia's Rise," *Atlantic*, June 22, 2009.

Climate change is already resulting in an increase in the frequency, intensity and duration of floods, droughts and heat waves. Precipitation has increased significantly in eastern parts of North and South America, northern Europe, and northern and central Asia, whereas it declined in the Sahel, the Mediterranean, southern Africa, and parts of South Asia.

— R.K. Pachauri, chairman, Intergovernmental Panel on Climate Change, statement at U.N. Summit on Climate Change, September 22, 2009.

The more that "bells and whistles" are included in carbon market design, including strategic reserves, trigger prices, offsets, banking, borrowing, and free allocations, the more chances there are to game the system.

— Friends of the Earth, *Simpler, Smaller, and More Stable: Designing Carbon Markets for Environmental and Financial Integrity*, September 2009.

Projections of future demand will inevitably be cut further: one extraordinary lesson of the last 60 years is that after every spike in oil prices, demand growth flattens considerably.

— Edward Morse, managing director, Louis Capital Markets, "Low and Behold: Making the Most of Cheap Oil," *Foreign Affairs*, September/October 2009.

New technology, especially horizontal well-drilling combined with hydraulic fracturing, has increased productivity per well from unconventional sources notably shale gas and cut production costs ... The unexpected boom in North American unconventional gas production, together with the current recession's depressive impact on demand, is expected to contribute to an acute glut of gas supply in the next few years.

— International Energy Agency, *World Energy Outlook*, 2009.

Governments should not be in the game of using subsidies, taxes, regulation, mandates, loans, and investments to pick particular winners. It simply doesn't work, and, worse still, it crowds out or stifles potentially valuable competing technologies ... Industrial policy failed miserably in the 1970s and 1980s. Allowing governments to pick industrial winners and losers is just as bad an idea today.

— Michael Boskin, Stanford professor and former chairman of the U.S. Council of Economic Advisors, "Government Can't Pick the Winners," *Globe and Mail*, November 27, 2009.

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