

## M&As in the Evolution of the Global Chemical Industry

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*Merger and restructuring activities are responses to strong change forces, notably the increased pace of technological change and the globalization of markets. These processes have been magnified in the global chemical industry. The higher growth of the service industries which are not chemical use intensive has been an adverse secular development. The R&D intensive chemical industry has produced a high rate of innovation and made significant contributions to the economy. Yet, the rapid rate of diffusion of important new discoveries has dampened the returns from the high risk R&D investments. In adapting and adjusting to these challenges chemical firms have made continuing use of the many forms of mergers, divestitures, joint ventures, restructuring, spin-offs, share repurchases, as well as internal efforts to renew strategic visions, improve efficiency, and reduce costs.*

M&As have performed a significant role in the adjustment processes of the chemical industry. The chemical industry illustrates patterns of restructuring and M&As similar to those in industries generally (Weston, Chung, and Siu, 1998; Filippello, 1999; Weston and Chiu, 1996; Weston and Jawien, 1999; Siu and Weston, 1996). This paper will illustrate how these patterns have evolved in the chemical industry under the following topics: 1. Change forces. 2. Characteristics of the chemical industries. 3. M&As in the chemical industries. 4. Concentration trends. 5. Conclusions.

### CHANGE FORCES

Total M&A activity in the United States in 1998 reached \$1.3 trillion, double the level of the previous year and accelerating the trend of earlier years. It is estimated that in the rest of the world M&As totaled \$1.2 trillion for a worldwide total of \$2.5 trillion in

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1998. M&A activity also is an index of restructuring, joint ventures, split-ups and spin-offs, share repurchases, etc. in the increased pace of the adjustment processes of firms and industries in the economy.

The major change forces that have propelled the increased pace of economic adjustment processes are: technological change, the globalization of markets, and favorable financial and economic environments. The new technologies include advances in computers and related products transforming industrial processes, product proliferation, and new ways of doing business, illustrated by the internet and “the Walmart way.” Improvements and cost reductions in communication and transportation have created a global economy. Industry boundaries have become blurred with new competitive impacts coming from diverse and changing sources. These growing forces of competition have been reflected in deregulation in major industries such as financial services, medical services, airlines, and other forms of transportation. Strong economic growth, relatively favorable interest rate and financing environments, and rising equity and asset prices have facilitated the adjustment processes described.

#### CHARACTERISTICS OF THE CHEMICAL INDUSTRIES

While the adjustment processes have followed the same general patterns exhibited by other segments of the economy, distinctive characteristics have influenced how the change forces have operated in the chemical industry. A rich literature is available on the characteristics of the chemical industries (see References).

“M&As” as a short-hand for adjustment and adaptive processes in firms are related to the economic characteristics of their industries. The U.S. chemical industry

produces almost 2% of U.S. gross domestic product, making it the largest contributor to GDP among U.S. manufacturing industries (Arora, et al, 1998, p. 6). The chemical industry is a high tech, R&D oriented industry that receives about 12% of patents granted annually. It produces over 70,000 different products. Few industries exhibit the diversity and complexity of the chemical industry.

The industry characteristics we judge to be significant for an understanding of M&A processes within the chemical industries are: The industry has many distinctive segments, a number of which overlap with the oil and other energy industries as well as with pharmaceuticals and life science products. Two major types of firms have been identified. "All-around" companies operate in many areas. "Focused" firms operate in downstream specialized segments.

R&D performs a key role in the long term viability of chemical firms. Because new R&D discoveries often are not in the firm's core businesses, new products may require time to fit into organization effectiveness and may fail to achieve significant economies of scope. A series of R&D efforts that result in "dry holes" will negatively impact sales and profitability causing vulnerability to takeovers. In the chemical industries innovations are imitated relatively rapidly by large competitors. The commoditization of products may occur relatively soon after innovations. This results in the familiar economic pattern of cobweb responses. Favorable profit margins induce large additions to capacity from existing and new entrant firms, resulting in downward pressures on prices and returns. This problem has been aggravated in those segments of the chemical industry in which the process development of new products is performed by specialized engineering firms (SEFs), capable of installing turnkey chemical production

plants. This speeds the diffusion of process information, making it more difficult for innovators to maintain a competitive advantage. These market processes take place in a global setting and can affect even niche segments of the industry.

Chemical industries interact with other industries. As petrochemicals became a high percentage of chemical company production, oil refining and the chemical industry converged. Large oil companies were able to expand into the chemical industry more easily than the chemical companies could expand into oil refining. The switch from coal to oil allowed the development of many organic chemicals which revolutionized the industry with new products. Recently, some firms have been shifting from oil to life science products. Synergies between the chemical business and life science activities have not been well established.

Chemicals is a “keystone” industry. Many products are related to chemicals. As an R&D intensive industry, the chemical industry has been a source of new technologies which have diffused over many other industries. Chemicals are building blocks at every level of production in major economic segments of agriculture, construction, manufacturing, and the service industries (Arora, et al, 1998). Chemical industry technological innovations have been important in individual industries, specifically textiles, petroleum refining, agriculture, rubber, autos, metals, health services, and construction.

The international competitiveness of other U.S. industries depends upon a strong U.S. chemical industry that can supply critical products at high quality and competitive prices. For a number of chemical products, competition in foreign markets requires

operations in foreign countries. Acquisitions are often a least cost method of establishing operations abroad and/or a method of acquiring new capabilities and new product lines.

One of the adverse economic trends affecting the chemical industry stems from the changing structure of the economy. The increase in the service industries relative to manufacturing, construction, basic industries, and other major users of chemicals has caused a decline in the growth of chemical shipments in response to changes in GDP growth (U.S. Industry & Trade Outlook '99). In the 1960s, a 1% change in GDP growth was associated with a 2.9% change in growth of chemical shipments. By 1998, the 2.9% ratio had declined to 0.9%. Chemical shipments are not keeping up with the growth in the economy. Thus, secular trends represent a retardation factor for chemical industry growth. This is a massive influence, difficult to overcome. This negative secular influence is aggravated further by the relative rapidity of commoditization of new products.

Entry into the chemical industries has been relatively easy. As noted, oil & gas companies have made substantial expansion into important segments of the chemical industry. The boundaries between pharmaceutical and chemical firms is blurred. Many important pharmaceutical firms started life as chemical companies. An important source of entry into individual chemical industries is from established firms in other chemical, oil, and pharmaceutical firms. Thus, although some individual chemical firms may have a large market share in individual product segments of the chemical industry, their price and production policies are severely constrained by active and potential entrants. An important economic implication is that the relevant market for measuring the economic position of individual companies is the global chemical industry, not individual product

segments in individual national markets. Especially important are foreign firms, many of which can make rapid entry by acquisitions of domestic firms, whose capabilities provide an immediate market position with potentials for powerful expansion by combining strengths.

In many cases new entrants into a segment have purchased activities divested by an established chemical firm. This is an empirical pattern for which the explanations are complex. Differences in bundles of capabilities and environments cause some activities to shrivel and fade in one firm and yet expand and thrive in another. Thus, substantial evidence supports the conclusion that entry into chemical industries is relatively easy, and mobility between segments is continuously taking place.

#### M&As IN THE CHEMICAL INDUSTRIES

M&As have historically performed a significant role in the evolution of the chemical industry. In Germany in 1926, the largest producers of organic chemicals consolidated into IG Farben. Apparently this was the response of large dye makers to increasing competition from American companies (Da Rin, in Arora, et al, 1998, p. 320). After World War Two, the Allied powers restructured German industry. IG Farben was broken into its major constituent firms: Bayer, BASF, and Hoechst.

Also in 1926, the British government induced a merger to form Imperial Chemical Industries (ICI). Brunner, Mond was combined with another strong firm, Nobel, and joined with much weaker firms – United Alkali and the British Dye Corporation. This powerful aggregation had immediate access to the public equity markets. But ICI suffered declines in market shares over the years. A possible

explanation is underperforming management with a lack of effective corporate governance due to its widely diffused ownership (Da Rin, in Arora, et al, 1998, p. 320). In 1993, ICI spun-off Zeneca, its pharmaceutical division. In May of 1997, ICI bought four companies whose sales were 20% of ICI, but whose operating profits were 68%. The four companies were National Starch, Quest, Unichema, and Crosfields. Its planned sale of \$1 billion of chemical assets to DuPont and NL Industries in early 1999 was blocked by the U.S. Federal Trade Commission.

At the end of World War One, DuPont had substantial liquid assets from the wartime profits of its explosives division. This strong financial position and effective management led to both innovation and diversification. This history is set forth in a detailed study covering the history of DuPont from 1902-1980 (Hounshell and Smith, 1988).

During the 1980s, DuPont was involved in over 50 acquisitions and joint ventures, investing more than \$10 billion. A major part of this investment was the purchase of Conoco and Consolidation Coal. In 1998, DuPont began spinning off Conoco. In 1999, it spent \$7.7 billion to buy the 80% of Pioneer Hi-bred International it did not already own. Fortune Magazine (4/26/99, p.154) called this “trading oil for corn,” saying that DuPont “hopes to use the corn grown with Pioneer seeds as the feedstocks for its bio-engineered chemicals.” A DuPont release of July 7, 1999 announced plans to consolidate its coatings manufacturing facilities and to reorganize “other business activities” over a period of nine months following the \$1.8 billion acquisition of Herberts, a European coatings supplier.

These brief capsule histories of three major firms in the chemical industry illustrate the full panoply of acquisitions, alliances, restructuring, divestitures, and spin-offs. In the Fortune list of the global 500 (8/3/98) DuPont was ranked number one in chemicals with sales of \$41.3 billion. The offspring of IG Farben were ranked in the next three positions, each of which with sales of about \$32 billion. Dow was fifth with sales of \$20 billion. ICI held the sixth position with sales of \$18 billion. It is interesting to note that ranks 7 through 12 were each from different countries with sales of \$15.4 billion for Rhone-Poulenc (France), \$14.1 billion for Mitsubishi Chemical (Japan), \$13.9 for Montedison (Italy), \$13.6 for Norsk Hydro (Norway), \$12.3 billion for Akzo Nobel (Netherlands), and \$11.6 billion for Henkel (Germany).

The size, complexity, dynamism and turbulence of the chemical industry would be expected to produce a high level of merger activity. Our studies demonstrate that in any given year in the U.S., five industries account for about 50% or more of total M&A activity by dollar value (Mergerstat, Annual Volumes). Yet, between 1981 and 1998, “Chemical, paints, and coatings” was in the top five in only one year, placing number five in 1986. Over the total period 1981-1998 chemicals, paints, and coatings ranked 17<sup>th</sup>, accounting for some \$83 billion of M&A activity in relation to a U.S. total for the 18 years of \$4.7 trillion. The top three industries were “Banking & finance” with \$641 billion, “Communications” with \$385 billion, “Oil & gas” with \$345 billion.

A partial resolution of the paradox between the size and complexity of chemicals and its relatively low ranking in M&A activity is provided by classification ambiguities. For example, a Chemical Manufacturer’s Association listing of thirty-one mergers and acquisitions of over \$500 million in 1998 includes pharmaceutical and other life sciences

firms as well as oil & gas industry combinations. The two major producers of M&A statistical compilations, Mergerstat and the Securities Data Corporation, would have separate categories for the latter two groups. Using the broader definition of chemical and related industries as a category establishes this area as one of the top ranking areas in M&A activity. Change forces have impacted industries generally but with greater effect in industries such as chemicals, characterized by a high rate of innovations in both processes and products as well as relatively easy entry conditions.

M&As have performed a number of important roles in the chemical industry. Some may be listed: 1. To strengthen an existing product line by adding capabilities or extending geographic markets. 2. To add new product lines. 3. Foreign acquisitions to obtain new capabilities or a needed presence in local markets. 4. To obtain key scientists for development of particular R&D programs. 5. To reduce costs by eliminating duplicate activities and shrinking capacity to improve sales to capacity relationships. 6. To divest activities not performing well. 7. To harvest successful operations in advance of competitor programs to expand capacity and output. 8. To round out product lines. 9. To strengthen distribution systems. 10. To move the firm into new growth areas. 11. To expand to the critical mass required for effective utilization of large investment outlays. 12. To create broader technology platforms. 13. To achieve vertical integration.

In summary, M&As may enable firms to revisit and refresh their strategic visions. M&As may also reduce the time required to catch up to other firms that have developed new technologies, new processes, and new products. M&As enable a firm to make changes more rapidly. The cost of new projects is known at the time of purchase. By obtaining a going organization the delays in the learning process are reduced or avoided.

But M&As and internal new product programs are not mutually exclusive. One can reinforce the other. A disadvantage of internal programs is that the firm may lack the requisite experience, it does not have an effective operating organization in place, and the time required for achieving a profitable market position is uncertain.

Acquisitions have different kinds of disadvantages. Despite due diligence, it is impossible for the buyer to know as much about what is being acquired as the seller. Implementing two organizations is not easy. Considerable executive talent and time commitments are required. Implementation problems are magnified if organization cultures are different. This is often a serious challenge in cross-border transactions.

Joint ventures have widely been used in the chemical industries. Since the areas of expertise are so diverse, it is difficult for a firm to embrace all. Often the size of investments and the risks involved may be reduced by combining the different expertise and capabilities of different companies. Joint ventures, strategic alliances, and the joint use of facilities can minimize investment outlays and magnify capabilities. For every merger, there are many more joint venture-type activities. By alliances and joint ventures, outlays and risks are reduced, learning may be achieved, and returns can be attractive.

We emphasize that M&As represent a short-hand for a wide range of adjustments and adaptations to changing technologies, changing markets, and changing competitive thrusts. The many forms of restructuring include spin-offs and split-ups to realign organization systems. The goal is to group activities so that the benefits of relatedness, focus, and the development of distinctive and superior expertise in each area of activity can be achieved. Organization restructuring is also used to group related activities and to

better measure their performance. Thereby, compensation systems can more effectively be related to performance.

M&As and restructuring include changes in financial policies and effectiveness. One aspect is to review cost structures to improve the utilization of investments in receivables, inventories, and plant & equipment. The other side of this coin is effective utilization of financing sources. Dow Chemical is legendary for its innovative use of dividend policy, equity financing, and aggressive debt leverage to facilitate its growth.

The chemical industry has also made considerable use of highly leveraged restructuring such as leveraged buyouts (LBOs) and management buyouts (MBOs) (Lane, 1993). The key logic of LBOs can be summarized. A company is identified that has stable earnings or earnings growth potential from an improvement in strategy, operations, or management (a turnaround potential). High leverage is initially employed to finance investment requirements needed for the turnaround and to buy out previous owners. Management is given an opportunity to buy equity shares representing a significant fraction of the shrunken ownership base. The stable or augmented future cash flows are used to pay down debt and to increase the portion of cash flows available to equity holders. The aim is to increase equity prices so that in at least three years the company could be taken public again, realizing large gains to the organizers of the buyout and management.

In the early 1980s there were opportunities for buying segments or companies at low price-to-cash flow multiples, with opportunities for improving efficiency and financial performance. Early successes led to the expansion of large buyout funds leading to competition for the dwindling opportunities and the payment of higher price-

to-cash flow multiples. LBO activity revived in the 1990s with greater sophistication and more direct participation by financial investors. Cain Chemical and Vista Chemical were financial groups active in the chemical industry.

A scaled down version of LBOs has been the use of share repurchases. The most prevalent form is open market repurchases of a firm's own shares. The announcement of share repurchases is taken as a signal of future improvements in cash flows. Such announcements on average have stimulated significant immediate share price increases as well as superior market performance in the ensuing three years. The subsequent improvement in cash flows makes the share repurchase announcements credible signals on average.

However, some manipulative financial engineering may also be involved. The reduction in the number of shares outstanding will increase reported earnings per share, even if total net income does not increase. For given net income levels, the ratio of net income to shareholders' equity is artificially increased when the market to book ratio exceeds one, since the reduction of book equity is magnified. For example, if book equity is \$10 per share and the market price is \$30 per share, the reduction in shareholders' equity from a share repurchase will be \$30 per share, per usual accounting practice, shrinking book equity per share by a factor of three. For the share repurchase practice to remain a credible signal of improved future cash flows, this mechanical aspect must be supported by substance – superior operating performance and good cash flows. One positive is that returning funds to shareholders may create confidence that management is responsibly giving shareholders the opportunity to invest the funds in alternatives that may provide higher returns. Another positive impact is that share

repurchases may be regarded as a signal of broader management efforts to improve the efficiency and profitability of the firm.

We find evidence that M&As and restructuring in their broadest meaning have been important in the chemical industries. One sample we utilized was to analyze the chemical companies followed by Value Line in the three groups of basic chemicals, diversified chemicals, and specialty chemicals. We found that every firm in their listings had engaged in one or more of the forms of restructuring – M&As with the broad sense as described above. The results are summarized in Table 1.

**Table 1**  
**M&A Adjustments in the Value Line Chemical Industries**

<b>Company</b>	<b>Restructuring Activity</b>
<u>Basic Chemical Cos.</u>	
Dow Chemical	Acquired Mycogen
DuPont	Divestiture of Conoco
Union Carbide	Share repurchase
Diversified Cos.	
Air Products	Share repurchase
Eastman Chemical	Deal to acquire Lawter International
W. R. Grace	Purchased Sealed Air
Imperial Chemical (ICI)	Sale of commodity chemical divisions
Minnesota Mining and Manufacturing	Share repurchase
Norsk Hydro	Made tender offer for Saga Petroleum
Novo-Nordisk	Various joint ventures
PPG Industries	Has made or announced 15 acquisitions since 1997
Pall Corp.	Share repurchase
Rhone-Poulenc	Planned merger with Hoechst
<u>Specialty Cos.</u>	
Airgas	Acquisition of Oxygen Sales & Service
Crompton & Knowles	Merger agreement with Witco Corp.
Engelhard	Share repurchase
Great Lakes Chemical	Purchased NSC Technologies
Hercules	Purchased BetzDearborn
International Flavors and Fragrance	Divesting aroma chemicals
Morton International	Purchased by Rohm & Haas
Nalco Chemical	Purchased by Suez Lyonnaise
Praxair	Acquired division of GP Industries
RPM	Share repurchase
Rohm & Haas	Purchased Morton International
Sherwin-Williams	Purchased Marson Chilena
Sigma-Aldrich	Purchased Genosys
Valspar	Acquired Dexter

It is clear that each of these firms from this Value Line sample has engaged in some form of acquisition, divestiture, joint venture, share repurchase, etc. These many forms of M&A and restructuring in the chemical industry parallel similar activities in other industries. The nature of the adjustment processes can be made more specific.

Table 2 briefly describes the reasons for M&A activities listed in Table 1, augmented by

a Chemical Manufacturers Association(CMA) list of 31 M&A deals of over \$500 million that took place in 1998.

**Table 2**  
**Chemical Industry – Reasons for Merging or Divesting**

<b>Companies</b>	<b>Reasons</b>	<b>Type</b>
Dow Chemical/Mycogen	Leverage Mycogen's biotech capabilities throughout Dow and merge agriculture and medicine operations	A, C, F, H,
DuPont/Conoco (Spin-off)	To avoid the volatility of the oil and gas industry	F, J
Eastman/Lawter	Pursuing growth opportunities in specialty chemicals, which are characterized by higher earnings and lower cyclicity	A, C, F, I
W.R. Grace/ Sealed Air	Combines specialty chemical business for synergies, expanded global reach, ability to compete in changing marketplace	F, I
Imperial Chemical (Divestitures)	Strategic shift toward specialty products and paints	B, I
Norsk Hydro/Saga Petroleum	Greater activity, lower cost and increased expertise in the oil and gas industry	F
PPG Industries (15 acquisitions)	Wants to sustain growth with profitable acquisitions in higher margin businesses	A, B, C, I
Rhone-Poulenc/Hoechst	Focus on life sciences and divest all remaining chemical businesses	A, B, I, J
Airgas/Oxygen Sales and Service	Investments in core distribution segment	D, F
Crompton&Knowles/Witco	Consolidating industry, size increases strategic options and lowers cost of capital	C, F
Hercules/BetxDearborn	Combined company will be able to meet paper manufacturers' growing demand for integrated services	K
Rohm&Haas/Morton	Expanded product lines, greater technical depth and broader geographic reach	C, K
Suez Lyonnaise/Nalco	Will be better able to provide customers with range of services they desire; will take advantage of cross-selling opportunities.	F, K
Praxair/GP Industries	Strategic acquisition that is part of the company's focus on health care as a key growth area	B, C, I
Sherwin-Williams/Marson Chilena	Acquisition is part of the companies continued interest in Chile and South America	D
Sigma-Aldrich/Genosys	Acquisition is part of Sigma's strategy to move into the molecular biology field	A, B, I
Lyondell/Arco Chemical	Gains preeminent, global market position in propylene oxide. Goal is to reduce cyclicity of earnings by broadening the product mix. Provides a platform for future domestic and international growth	D, F
Equistar II (Combination)	Diversify product line, Improve distribution network	F, K

The diverse reasons for the merger activities described in Table 2 are summarized in Table 3. They reflect general change forces as well as the particular characteristics of the chemical industry. The central influences are technology, broadening capabilities, adjusting to industry structure change, responding to the pressures of commoditization of products. These examples illustrate the multiple roles that M&As have performed in the adjustment processes in the chemical industry.

**Table 3**  
**Reasons for Mergers**

A.	Technologically dynamic industries to seize opportunities in industries with developing technologies
B.	To develop a new strategic vision
C.	To apply a broad range of capabilities and managerial skills in new areas
D.	International competition – to establish presence in foreign markets and to strengthen position in domestic market
E.	Deregulation – relaxation of government barriers
F.	Industry excess capacity and need to cut costs
G.	Industry roll-ups – consolidation of fragmented industries
H.	Change in strategic scientific segment of the industry
I.	Shift from overcapacity area to area with more favorable sales/capacity ratios
J.	Exit a product area that has become commoditized to area of specialty
K.	Combined company can better meet customers demands for a wide range of services; strengthen distribution systems

#### EFFECTS ON CONCENTRATION

Concern has been expressed that the rising tide of M&A activity might have undesirable impacts on industry structures. Specifically, the issue has been raised of whether increases in industry concentration will have adverse effects on competition. Considerable evidence has demonstrated that the degree of concentration does not predict the nature or intensity of competition in an industry (See Weston, 1978). Nevertheless, some still believe in this numbers game, so it will be addressed.

In our description of the nature of the chemical industry, it was established that the relevant market for analysis would be the world industry. We will begin with the U.S. market because of the availability of reliable data. We will then make estimates for the world market.

Concentration will be measured by the HHI, named after the economists who developed it. This is the measure adopted in the anti-trust guidelines first issued by the Federal Trade Commission and Department of Justice in 1982 and retained in subsequent modifications. The HHI is measured by the sum of the squares of the market shares of all firms in an industry. For example, if there were 20 firms in an industry, each with a market share of 5%, the HHI would be  $20(25)$  which would equal 500. If only ten firms, each with a market share of 10%, the HHI would be  $10(100)$  which equals 1,000. With 50 firms with a market share of 2% each, the HHI would be  $50(4)$  which equals 200. This illustrates that more concentration results in a higher index and conversely. Of course, assigning equal market shares is artificial, but simplifies the arithmetic.

The guidelines have specified critical levels for the HHI. Below 1,000, concentration is considered sufficiently low, so that no further investigation is required to determine possible effects of a merger or joint venture on competition. If a pre-merger HHI is between 1,000 and 1,800 and the index had been increased by 100 or more, the merger would be investigated. If the industry HHI is more than 1,800 and it had been increased by at least 50, the merger would be challenged. Thus, if the industry consisted of one firm with 40% and six firms each with 10% of industry revenues, and one of the six was acquired by the largest firm, the new HHI would be  $50^2$  plus 500,

resulting in an industry measure of 3,000. It would clearly violate the anti-trust guidelines since the HHI exceeded 1,800 to begin with and was increased by 800 points.

Based on data of annual chemical sales in the United States by firm presented in Chemical & Engineering News (C&EN), we have calculated HHIs for the U.S. chemical industry. The HHI in 1980 was 178, declining to 148 in 1990, and to 102 in 1998. Obviously, the HHI for the U.S. chemical industry is far below the critical 1,000 specified in the guidelines. Furthermore, the trend has been strongly downward. How can the HHI decline when M&A activity is increasing? The answer is the intensity of competition – manifestations include: divestitures, spin-offs, carve-outs, downsizing, etc. Also, in the chemical industry, many new firms have come into being as a result of divestitures.

We have attempted estimates of the HHI for the world chemical industry. Compilations of chemical industry firms in the Fortune global list and other sources do not break out chemical sales as does C&EN for chemical sales in the U.S. Fortune and other compilers overstate chemical sales since the total company sales include products other than chemicals. These compilations may also not include in their chemical industry groupings petroleum and pharmaceutical companies with substantial sales in chemicals. Our best judgment of the HHI for the world chemical market is that it is significantly below the critical 1,000 level, and that it is probably declining for the same reasons that the HHI for the U.S. market has been declining over time – new entries and competitive forces which have reduced firm size inequalities.

We conclude that concentration in the chemical industries has been relatively low and decreasing over time. M&As and related activities in chemicals reflect the forces of

change and the dynamics of competitive actions and reactions. The pace of new product introductions has increased. Product life cycles have been shortened. The numbers of competitors have increased. Competitors from one industry segment are invading other industry segments. Industry boundaries continue to blur. Concentration has declined and competition has intensified in the evolution of the chemical industries.

## CONCLUSIONS

The high rate of M&A activity is being propelled by powerful change forces supported by favorable economic and financing environments. Rapid advances in technologies have led to the globalization of markets and increased intensity of competition. These forces have been magnified in the chemical industry, the most R&D intensive in the economy.

The innovation activities in the chemical industries are reflected in its high ranking in the annual number of patents granted. R&D efforts represent activities of high risk which should be associated with high returns – a basic principle of financial economics. But achieving such results has faced formidable challenges in the chemical industries. A secular problem has been that structural changes in the economy have produced relatively higher growth in the services industries (where chemicals are less important) than in the other major users of chemicals. This problem is compounded by the rapidity with which innovations by one chemical firm are diffused to competitors. Innovative products become commodities in relatively short periods of time. Thus, the impacts of the major change forces are even stronger in the chemical industries.

As a consequence, the chemical industries throughout their long histories have been characterized by adjustments and restructuring. The many forms of restructuring – mergers, joint ventures, cross border transactions, divestitures, spin-offs, share repurchase programs – are actively employed by chemical companies. They represent competitive responses to turbulent environments and vigorous competitive moves and countermoves.

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