Toward a smarter enterprise

Disaggregation and dispersion for innovation and excellence

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Abstract

Purpose – The purpose of this paper is to trace the emergence of knowledge-centric innovative enterprises that function in a disaggregated and dispersed form and further contemplate the economic and managerial rationale behind this strategy. A constant challenge to large organizations as well as those pursuing the intent to grow bigger is how to sustain the innovative dynamism.

Design/methodology/approach – The authors review the evolution of disaggregated and dispersed enterprises and discuss the changing cost structures for transactions, integration and coordination in the global knowledge economy. They elaborate the benefits of scale reduction and dispersed operations with examples.

Findings – Their review of the extant practices suggests that managers are finding value in disaggregating the firm operations. Disaggregation enhances the firm agility and responsiveness and helps the firm exploit the fleeting opportunities without incurring the opportunity cost or risking high investment.

Practical implications – Corporations need to become nimble, and their structure should be networked and permeable with significant industry actors. Integration would be imprudent if there is huge sunk cost due to uncertainty in business. Scale reduction and disaggregation, and operating in a dispersed mode – like a shoaling form – would help the companies exploit the fleeting opportunities without incurring the opportunity cost and risking high investment.

Originality/value – In addition to reviewing the rise of disaggregated enterprises, we explore the economic and managerial rationale of the disaggregation strategy, and discuss the learning and innovation, investment and cost-related advantages that stem from the disaggregated form of organization.

Keywords Knowledge economy, Transaction cost, Bureaucratic cost, Disaggregation/dispersion, Network firm, Shoaling strategy

Paper type Conceptual paper

Introduction

A constant challenge to large organizations as well as those pursuing the intent to grow bigger is how to sustain the innovative dynamism that ensured the success during their primary years. Over the recent decades, managers and organizational theorists have been advocating an array of management solutions such as matrix structures, autonomous divisions, cross-functional teams and self-managing teams to foster the nimbleness and innovativeness. But sustaining the entrepreneurial dynamism and

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giving the managers and employees more autonomy, a sense of ownership and self-determination has been a major challenge in many companies.

In the 1970s, Schumacher (1973) proposed an economic future that accentuated "small is beautiful", promoting an aesthetic and humanistic view of economic and production systems. In recent years, the concept of smaller scale has emerged into a new economic reality offering an alternative paradigm to the business world for building organizations that are efficient, innovative, eco-friendly and dynamic. There is an emergence of knowledge-centered global enterprises operating as "dispersed network of smaller units" across many markets and industries. This phenomenon is increasingly referred to as "organizational disaggregation" or "scale reduction", meaning the size of the subunit and the entire organization is decreasing (Birch, 1987; Contractor *et al.*, 2010; Rossi-Hansberg and Wright, 2007). Contractor and associates (2010), observing this trend, suggest that "the boundaries of many firms have simultaneously shrunk organizationally and expanded geographically, while also becoming more permeable". This new business paradigm concurs with the gradual transformation of industrialized world into post-industrial or post-bureaucratic societies in which information and knowledge drive economic growth, and the rise of postmodern firms that generate value more from intellectual capabilities than from physical inputs (Benkler, 2006; Boisot, 1999; Kogut and Zander, 1996; Nahapiet and Ghoshal, 1998; Teece, 2003). We explore the significance of building knowledge-centric firm that functions as a corpus of disaggregated structures, and in particular to the organization of manufacturing, research and development (R&D), marketing and service delivery systems to implement business and corporate strategies.

From the days of industrial revolution, efficiency and cost have been the major parameters in designing organization and production systems. Large-scale mass production, integration and colocation of business processes were considered the most suitable mechanisms to meet the demands of large markets with efficiency and lower cost. Until the late 1980s, integration of business functions and consolidation of value chain with mass production technologies were deemed effective strategies for achieving higher market share and superior returns (Carroll, 1984; Casson, 1984; Perry, 1989; Teece, 1976). In recent decades, as the focus is steadily shifting toward agility and quality, disaggregation and dispersion have emerged into a preferable organization form. Benefits of disaggregation and dispersion include modularization, mass customization, achieving zero defect and total quality, job enrichment, employee empowerment, safety and quality of work life and proximity to customers or critical raw material sources (Liker, 2004; Spear and Bowen, 1999). The economic, investment and cost-related advantages that stem from the scale reduction and dispersion are phenomenal, and this strategy has vast implications for employee learning, customer responsiveness, innovation and enhancing dynamic capabilities (Andersson and Pedersen, 2010; Contractor *et al.*, 2010). At the industry level, firms pursuing disaggregation strategy will augment consumer utility and value creation, spur more technological innovations and will enhance opportunities for growth (Andersson and Pedersen, 2010; Contractor *et al.*, 2010; Zenger and Hesterly, 1997).

The paper proceeds as follows. First, we contemplate the significance of disaggregation and dispersion in the context of progresses in manufacturing technologies, ever-changing customer preferences and organizational problems that arise due to integration, abrupt discontinuities in product and technology life cycles and

the need for product customization. Second, we discuss the shift from scale economy to knowledge economy, and the changing cost structures for transactions, integration and coordination in the post-modern global economy. Finally, we elaborate the benefits of scale reduction and dispersed operations to businesses and address the impact of disaggregated design on managerial economics of the firm.

Evolution of manufacturing systems: a review

Right from the days of Adam Smith through industrial revolution to modern times, the division of labor, specialization and sequencing of all tasks in a centralized large production or integrated organization are considered central to achieving greater productivity, economies of scale and building intellectual capital and firm capabilities (Adler, 1995; Chandler, 1962, 1990; Dunning and Lundan, 2009; Lawrence and Lorsch, 1967). Although such large-scale production systems emphasizing specialization have been the source of economic and competitive advantage in several industrial sectors until the recent past decades, these large-scale systems are associated with several social and economic problems. Some have observed that the high degree of specialization practiced in large-scale production systems results in monotony, weakening of the employees' skills and morale and alienation of employees from the task, organization and the coworkers (Chandler, 1977, 1990; Miller, 1994). Others have argued that large integrated organizational systems are less agile, lack responsiveness to market dynamics and provide limited incentives for entrepreneurial initiatives and innovation, besides having complex governance structure and organizational inertia (Miller, 1994).

As large-scale manufacturing systems require high degree of asset integration and involve high fixed costs, there is an increase in investment risk. While placing all manufacturing and operational assets (integrated) in one or a few locations would help streamline the production process, achieve specialization efficiencies and economies of scale, but the resulting concentration of assets and facilities increases the organizational complexity and bureaucratic cost (Chandler, 1977; Williamson, 2002). Researchers have observed that, in uncertain and turbulent market environments with customers expecting variations in product or technology, the large-scale organizations are less responsive (Adler, 2001; Canbäck, 2004; Tushman and Anderson, 1986). The major reasons are as follows:

- The change has to involve the whole system because of extensive integration of the entire value chain, and such large-scale changes naturally invoke resistance, as they are entrenched in high specialization.
- As there is heavy capital investment due to asset concentration, the cost of change or exit is very high, and there is less incentive for management or owners to initiate major changes.
- As the temporal and spatial distance between the operations and managers increases, errors in information processing accrue due to high level of bureaucracy, and often the organizational responses to changes are delayed or even flawed (Williamson, 1975).

On the human and social side, large-scale production systems are well known to cause adverse effects (Fullan, 1970; Susman, 1972). Because the large-scale production systems tend to primarily emphasize high speed and volume as the essential attributes of job design, they tend to weaken the interpersonal and social relations. As employees

are primarily rewarded for efficiency and productivity, the operational performance is given the primacy often neglecting the human and social dimensions. Several studies have observed that large manufacturing and business organizations have been the cause of many adverse social and environmental consequences (Fritz, 1961; Gephart, 1984; Kinghorn, 1985; Shrivastava *et al.*, 1988). These include environmental disasters, accidents costing human lives, worsening business–community relationships, unhealthy management–labor relationships, deskilling and dehumanization of work, incidents of social conflicts (e.g. intensive urbanization with class divisions) and physical and psychological disorders (Fritz, 1961; Fullan, 1970; Kinghorn, 1985; Susman, 1972). Managerial efforts and social policies aimed at reversing the damages and enhancing corporate social responsibility in large firms were once considered antithetical to corporate goals due to high cost of change involved. For instance, firms engaging in eco-friendly programs and bearing the cost of externalities were considered counter to the shareholders' interests and free market logic (Friedman, 1980).

In recent years, several innovations have occurred in manufacturing that moderate the adverse effects of production technologies on business economics and organization. Toyota's successful innovations in automobile manufacturing such as flexible manufacturing system, lean production and continuous improvement techniques had helped it emerge as a flagship company and transformed the entire automobile industry in the 1990s (Liker, 2004; Womack *et al.*, 1990). Flexible manufacturing involves a combination of machineries and automated systems to reduce setup time, increase use of individual machines through better scheduling, enhance the quality of work through job rotation and job enrichment and improve quality control at all stages of production (Liker, 2004). Flexible manufacturing systems also have enabled firms to achieve a high degree of product customization with the capability to offer more variety at low cost. *Kaizen*, or continuous improvement process, often is considered the "building block" of all lean production methods. *Kaizen* focuses on eliminating waste, improving productivity and achieving sustained continual improvement in targeted activities and processes of an organization (Liker, 2004; Morgan and Liker, 2006). Employee participation in all decisions pertaining to volume, variety, inspection and quality is an essential attribute of these systems. Continuous training and team-based rewards are said to enhance the safety, quality of work life and overall organizational climate (Liker, 2004).

Modular product design is another technique that has complemented the flexible manufacturing systems and enabled mass customization strategies not only among many manufacturers of consumer and industrial products but also in service industries. Product systems are considered "modular", when they can be decomposed into a number of components that may be mixed and matched in a variety of configurations enabling product variety. The components are designed to connect, interact or exchange resources and information in differing ways by adhering to a standardized interface. This modular approach to product development, manufacturing, organization structure and marketing has been a source of competitive advantage for many firms such as Honda, Hewlett-Packard, Toyota and Levi Strauss. Through modularization and sharing of critical components, production processes, end products and services, companies can achieve high differentiation and product variety as well as quality and cost savings. For instance, Levi's Jeans has successfully implemented mass customization strategy with the modularization technique – using computer-controlled

design and production methods, from six colors, three basic models and two types of fly – it can increase the number of choices from 130 pairs to 750 pairs in each store.

In the automobile industry, firms taking a modular approach enjoyed market share gains of around 5 per cent per year, while firms pursuing a single-model approach lost 1.1 per cent market share per year (Robertson and Ulrich, 1998). Toyota's production system, for a case in point, not only involved modular product design but also a nested modular organization structure. As Spear and Bowen (1999) observed, Toyota's nested modular organization structure enabled its engineers to make design changes in one part without upsetting other parts and allowed the company to delegate high responsibility to lower levels of the organization without experiencing chaos and disruptions. Modularization reduced the incremental cost of meeting individual or segment requirements, reduced setup and changeover time, reduced product development time and cost and enabled both economies of scale and scope (Robertson and Ulrich, 1998; Spear and Bowen, 1999). Modularization also facilitates organizations to undertake quantum change by enabling loose-coupling among various sub-systems (Miller and Friesen, 1984; Weick, 1979). Thus, large organizations such as W.L. Gore Associates and Virgin Group can act as entrepreneurial companies by dividing themselves into smaller units (Gladwell, 2002). Such organic structures (Brown and Eisenhardt, 1997) can help firms take advantage of flexibility and learning for creating new markets (Ghemawat and Ricart, 1993; Mikkola, 2003).

Miniaturization of production technologies and products is another major revolution reshaping the economies in several industrial sectors. With the help of miniaturization, nano-technologies and robotics, products and production equipment are scale-reduced without losing the functionality, aesthetics and cost-effectiveness. As materials and design approach the smaller scale, the conventional rules governing the behavior and properties of these components, devices and systems change significantly, and this creates value along the entire value chain, from the raw material stage through production to consumption in terms of innovation, differentiation, customization, utility and cost-related advantages. Miniaturization not only has resulted in the growth of computer, consumer electronics, medical electronics and toy industries worth a trillion dollars, but has also created new possibilities to develop much smaller and more flexible micro production systems, such as energy-efficient machine tools and portable factories. Such smaller systems have enabled simplicity, mobility, affinity, ownership, autonomy, changeability and energy efficiency, and in turn facilitated dispersed operation of production and service activities in such industries as manufacturing, aerospace, transportation, material handling, and health care (Burisch and Raatz, 2011; Hanna, 2012).

As Gene Frantz of Texas Instruments narrates the milestones of miniaturization,

> You can almost say that we are on the path to the vanishing product – where the product will be so small and insignificant in size but so significant in capability that we really don't know where we have it; we just know we have it (Wright, 2006, p. 172).

The advances in manufacturing suggest that these systems are becoming smaller and modular enabling scale reduction, more autonomy and flexibility to meet the organizational demands of innovation and customer responsiveness. The size of the global market for miniaturized products and production technologies is now estimated to reach around $ 2.5 trillion in 2015 (Invernizzi, 2011).

From scale economy to knowledge economy: a paradigm shift

In a scale economy, a firm's growth in terms of integration of assets, businesses and processes is primarily dictated by the principle of increasing gains in marginal revenues and cost savings as the volume of output increases. The economies of scale had been a dominant paradigm until the late 1980s, as market mechanisms such as arm's length contracts were said to carry high risk because of the uncertainties and asymmetric conditions that arose due to lack of information with regard to the motives and capabilities of the parties engaged in the transactions (Coase, 1937; Williamson, 1975). Owing to the paucity of adequate managerial and technical knowledge among suppliers and the trust chasm that was generally prevalent among owners, employees and suppliers (partly due to the concerns and attributions of opportunism between transacting parties), integration of assets was considered essential for achieving control in a scale economy.

Given the uncertainty and imperfect information, production and business transactions needed to be integrated into large hierarchical firms when the transaction cost of coordinating production through the market exchange is greater than the cost of organizing those transactions within the firm (Coase, 1937; Williamson, 1975). The integration of organization and production systems and annexing employees into large hierarchical firms was considered a better strategic response to achieve efficiency and quality, despite increases in investment and the risk associated with it (Coase, 1937; Williamson, 1975, 2002). Specialization and standardization were strongly encouraged to achieve optimization and increasing returns. As the size of the organization increased – as increasing returns to speed, revenues and cost savings had accrued – firms achieved high productivity and profitability. Also, integration and colocation of critical functions such as R&D, marketing and engineering are considered essential due to several contingent reasons, such as the locational availability of factors of production, the extent of intra-functional and cross-functional dependence, the reciprocal interdependence among functions and the complexity of products and processes (Adler, 1995; Dunning and Lundan, 2009; Ketokivi and Ali-Yrkkö, 2009; Lawrence and Lorsch, 1967; Powell *et al.*, 1996).

In addition, integration strategies are considered significant, owing to either contextual or firm-specific factors, across industries including knowledge-based firms. We would like to narrate a few circumstances why integration is still keenly pursued. If a firm is a trailblazer quite ahead of its competitors with its innovation, wants to safeguard the intellectual assets and if its industry is in the growth stage offering differentiation opportunities, integration rather than disaggregation is a preferred strategy. Even firms in the knowledge-driven global industries such as telecommunications, computers and software opt for vertical controls through mergers and acquisitions. Apple, for example, is pursuing the vertical model for more than three decades, which features integration of all hardware and software required for its products – iPhone and iPad – under one roof (Knowledge@Wharton, 2012). Google recently acquired mobile device maker Motorola Mobility with plans to manufacture its smartphones and TV set-top boxes rather than contracting out. And the enduring software titan Microsoft makes hardware for its Xbox gaming system.

Integration is also viewed advantageous from marketing and branding perspectives in several industries and markets. Large integrated firms enjoy economies of scope by gaining more shelf-space for products in distribution channels, lower advertising rates, better media

placements and lower churn rates or higher retention rates (Scherer and Ross, 1990; Sharp *et al.*, 2002). Insurance, banking, consumables and telecommunications are examples of such markets (Sharp *et al.*, 2002). The choice of integration is also determined by certain industrial and macro-economic conditions. Recent studies confirm that integration – either horizontal or vertical – augments firm survivability in new-born and declining industries (Khalid, 2006). In developing economies where many industries are in the early stages of industry life cycle and the product prices remain high due to factor costs, integration is still the most recommended option to benefit consumers and firms (Alfaro *et al.*, 2012; Herrigel and Zeitlin, 2009; Legros and Newman, 2013). Similarly, studies report that firms prefer integration if they need to exercise more control over quality, technology and critical raw materials, and such moves are frequently observed in industries facing decline. For example, Arcelor-Mittal helped revive several steel manufacturing units through a global consolidation strategy. Recent studies also suggest that challenges in managing disaggregated operations have caused some firms to revert to integration strategies (Aeppel, 2006; Kench *et al.*, 2012; Gross, 2006). For instance, with the rise of transportation costs, its inability to control product quality in outsourced production and due to difficulties in handling large volumes of service calls, Dell recently decided to bring several of its disaggregated operations back to full vertical control.

The integration and vertical control strategy, however, is increasingly considered less attractive due to demand fluctuations, fragmentations of consumer markets, inability to sustain innovation in large hierarchical structure and steep increases in bureaucratic cost. Of course there are limits to firm size and bureaucratic efficiency, which have been elaborately expounded by several scholars (Arrow, 1983; Blau and Meyer, 1987; Canbäck, 2004; Child, 1973; Riordan and Williamson, 1985; Williamson, 1975). As Williamson (1975) argued, the limits to firm size are bureaucratic in origin and can be explained by four main categories that offset returns to scale and cause the diseconomies:

(1) *atmospheric consequences* due to specialization such as resistance to change, alienation and low job satisfaction;

(2) *bureaucratic insularity* resulting in rigidity, manager–employee relations becoming perfunctory and dysfunctional and lapse of coordination and common purpose;

(3) *incentive limits* impeding R&D productivity, innovation and entrepreneurial drive; and

(4) *communication distortions* due to bounded rationality causing information delays, errors and bottlenecks.

Conversely, the knowledge economy combined with digital revolution and global expansion has generated new strategic alternatives for business growth. Knowledge economy is drastically flattening the transaction cost in many technology-intensive industries. Through reducing the information asymmetry, knowledge economy is enhancing the power sharing and interdependence among parties engaged in the exchange of products, services and knowledge (Adler, 2001; Felin *et al.*, 2009). Given the extensive information sharing, importance of intellectual capital and demand for fair representation of all parties in the organizational governance, knowledge-centric firms enjoy high efficiency (Adler, 2001; Nahapiet and Ghoshal, 1998). Also, knowledge-driven enterprises help achieve both scale

economies and reductions in coordination costs by instituting lean organization and production systems. With the advent of modular arrangements, firms can now operate in a highly flexible and market responsive manner (Mikkola, 2003). As these modern systems enable highly decentralized and dispersed operations, firms can reduce both bureaucratic cost and transaction cost and the overall cost of their products and services. This possibility was envisioned by Coase himself in his seminal work on the theory of firm. As Coase (1937) states,

> When we are considering how large a firm will be the principle of marginalism works smoothly. The question always is, will it pay to bring an extra exchange transaction under the organising authority? At the margin, the costs of organising within the firm will be equal either to the costs of organising in another firm or to the costs involved in leaving the transaction to be organised by the price mechanism. Business men will be constantly experimenting, controlling more or less, and in this way, equilibrium will be maintained. This gives the position of equilibrium for static analysis. But, it is clear that the dynamic factors are also of considerable importance, and an investigation of the effect changes have on the cost of organising within the firm and on marketing costs generally will enable one to explain why firms get larger and smaller. We thus have a theory of moving equilibrium. (p. 404)

A general inference can be drawn that knowledge economy is gradually moving the cost equilibrium, in relation to the firm size, in the reverse direction in many industries. An illustration of the changing cost structures in relation to firm size is presented in Figure 1.

Economists observe this trend as "organizational disaggregation", meaning the size of the subunit and the entire organization is decreasing (Birch, 1987; Contractor *et al.*, 2010; Rossi-Hansberg and Wright, 2007). Organizational disaggregation is occurring whole economy-wide as well as within firms. Concurrently, there is an increase in entrepreneurial activity, and smaller organizations employ higher levels of the working population. For a case in point, the number of entrepreneurial firms – measured by new business filings – has radically increased (Baumol, 2002; Bhide, 2000). The industry

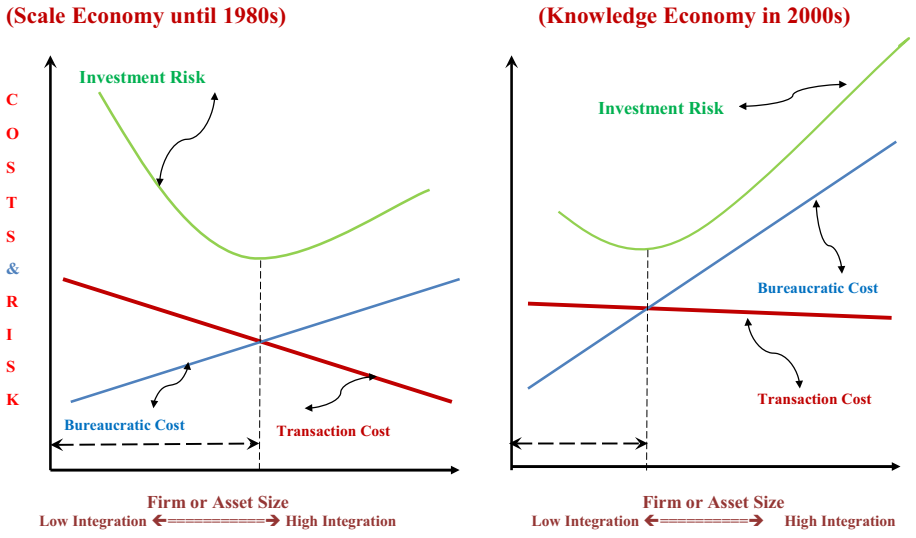

Figure 1.
Changing cost structures for production and organization

structure and performance of the manufacturing sector in the US economy also attest to the shift in economies and strategies of firms. Despite stable economic growth over the entire twentieth century, many large US firms in several manufacturing industries could sustain neither their market dominance nor their profitability. If there were no diseconomies of scale, as Panzar (1989) observed, we would presumably see much larger firms than we do today. On the contrary, large manufacturing firms in the USA employed 16 million people in 1979 versus 11 million in 1994, while employment in small- and medium-scale manufacturing businesses grew from 99 to 123 million people (Council of Economic Advisers, 1998; Fortune, 1995). Although disruptive technologies, outsourcing and globalization have contributed to this shift, failure due to a lack of responsiveness to market dynamics has been the major cause of decline in the number of large firms.

IBM's colossal failure in 1990s and its inability to sustain the leadership in the computer industry serve as testimony to the paradigm shift and provide an illustration of the problems of size and bureaucracy in the new economy. IBM lost $5 billion in 1992 and $8 billion in 1993. Its market share dropped 50 per cent and nearly 45,000 employees had to be laid off in one year. Industry observers offered several explanations for the IBM's debacle. In scale-based industries, size would always win because the economies of scale are so great. But not so in knowledge-based industries such as computers. The large firms such as IBM did not have any cost advantage over smaller rivals due to lower cost of components and intensive competition between suppliers in the industry. In fact, smaller PC manufacturers could undercut IBM with their much lower overheads. The competitors – then smaller companies such as Intel, Microsoft, Dell, Compaq and Hewlett-Packard – were nimble, whereas in IBM the bureaucracy was much heavier and quite slow to respond to the market dynamics with necessary product innovations. The smaller firms, on the other hand, were quite swift in responding to the emerging trends and deciding their strategic priorities.

In his book, Louis Gerstner – who was hired as the CEO to turnaround IBM – describes the company in such evocative metaphors as "*an elephant, the late Roman Empire, the Kremlin, the Titanic and an animal raised in captivity that is suddenly returned to the jungle*" (Gerstner, 2002). Although he was no stranger to big companies and bureaucracy, Gerstner witnessed an extraordinary insularity in IBM at that time and describes that it was suffering from a pathological focus on internal process rather than on customers and the marketplace. Despite the dominant position, in terms of brand recognition and technological leadership IBM enjoyed at that time, the predicaments and powerlessness it experienced serve as good testimony to the limits imposed by firm size and disorders that arise due to bureaucratic structure and culture (Williamson, 1975, 2002). IBM, of course, has freed itself from the bureaucratic shackles that constrained its innovation and profit potential, through a series of restructuring and reengineering moves involving disaggregation of business units, disintegration of value chain and divesting of some businesses, into a dynamic synchronized network structure knitting its hardware platforms, operating systems, software businesses, clients and application software businesses with special emphasis on service (The Economist, 1998). The synthesis of our argument is that scale reduction, disaggregation and dispersed operation have become "*de rigueur strategy*" to safeguard the large organization from inertia and bureaucratic cost.

The Ford Motor Company is another major industrial-era firm that has gone through several organizational and strategic changes in the past two decades to survive the global competition, innovation challenges of Japanese rivals and the troubles of mature automotive industry. In its early years, Ford was a highly centralized and vertically integrated company. The whole organization was divided into functional silos, and all major decisions were taken centrally at the top of the organization. Until the 1970s, Ford owned and controlled most of the production and distribution of all materials and parts needed to manufacture cars. Ford owned steelworks, glassworks and rubber plantations, and even owned railways to transport the supplies and finished cars (Womack *et al.*, 1990). With its mass production system and knowledge of efficient production, Ford gained vast economies of scale and technology-based advantage. Ford was the symbol of modern industrial-era, bureaucratic, rational and vertically integrated enterprise of the time, and many companies in the automotive and other industries followed its strategy and structure.

Ford enjoyed high profitability and growth until Japanese automakers flooded the world markets with their small and reliable low-priced cars in the 1980s. Ford's organization structure lacked the responsiveness to design and produce small fuel-efficient cars. From 1990s onward, Ford has been engaged in a massive restructuring and reengineering efforts involving a series of changes to its structure and strategy. Ford first attempted to build a global matrix-structure to enhance collaboration across its divisions and functions. As Ford had confronted challenges in building a collaborative mindset among US, European and Asia/Pacific divisions to implement its new strategy of making a profitable "World Car for customers around the globe", during early 2000s Ford went through another round of reorganization to build what it called a "World Structure". Then in the mid-2000s, Ford revamped its organization with a "Way Forward Plan", which involved closing 16 manufacturing units and reinforcing some of its major brands such as Ford trucks, Mercury and Lincoln with new investments. The company removed several layers of management and flattened its hierarchy and designed a "Global Network Structure" with emphasis on teamwork and cross-functional collaboration and synchronization of international nodes and corporate functions to implement customization strategies. In 2008, despite recession, Ford did not take any financial assistance from the US Government. Its new global organizational structure appeared to be effectively offering Ford the advantages to become a strong global competitor. Through a series of changes spanning two decades, Ford has evolved from a monolithic vertically integrated hierarchy into a disaggregated, but synchronized, global network structure (Koenig, 2006; Sturgeon *et al.*, 2009; www.ford.com).

The small manufacturing plant commissioned by Toyota in 2011 (Ohira, Japan) and the Smart car (brand name) automobile plant built in 2001 (Smart-Ville, France) as a joint venture between Daimler autos and Swatch wrist watches are excellent examples of the scale reduction pursued by some of the world's largest automobile companies as a strategic response to the market dynamics. These small car plants are in stark contrast to the typical automotive plants built by Toyota and Daimler in the past; these new plants are smaller in production capacity and the size of workforce, consist of smaller production equipment, less automated but have high flexibility and are designed for extensive modularization and mass customization with very high supplier contribution in design, development and production. These plants are considered green and

harmonious in design with lower maintenance expenses, are easier to move and their production lines can be shortened or lengthened with products moving sideways. These smaller plants are designed for emerging markets, can be installed closer to transportation facilities or critical resources and can even be moved into existing buildings. A comparison of automotive plants built in the past and present times is presented in Table I.

Disaggregation of production and organizational systems

Standardization, task specialization, sequential coordination and economies of scale through asset integration in a concentrated manner were the sources of advantage in the industrial age (Womack *et al.*, 1990). Knowledge economy, however, has helped emerge an alternative paradigm that advocates disaggregation and dispersion of operations across a wider spatial domain without compromising the efficiency and production volume. With the advent of flexible manufacturing systems, modularization in manufacturing, product design and organization structure, scale reduction and spatial dispersion of manufacturing operations have become economically feasible. With the diffusion of management knowledge and availability of technological expertise on a global scale, dispersed production systems are ensuring both economic returns and reduction in social and environmental costs. Although dispersion may augment the coordination complexity, the organizational intricacies that affect the cost and productivity, however, are being minimized with the help of new-age technologies such as the Internet, electronic data interchange (EDI) , teleconferencing, telecommuting and decision support systems. Locating certain aspects of value creation either closer to raw materials or to markets and designing the entire value chain operations to match and correspond to the patterns of market size and distribution provide additional benefits.

Developments in global coordination of production, outsourcing and off-shoring combined with the Internet and communication technologies have enabled the firms to match the production systems with their multi-market-strategy choices. Knowledge and information-era digital technologies are enabling seamless zero-time information processing from the markets as well as the dispersed operational centers to decision makers. Recent studies, for example, have revealed that global supply chain management supported by information technology (IT) has achieved dramatic improvements in cost and time (Clemons *et al.*, 1993; Motwani *et al.*, 2000). IT reduces the coordination cost without increasing the transaction risks involved in dealing with external suppliers. Because IT has better monitoring capability and low asset specificity, firms have found it safer to invest in IT than in explicit coordination involving collocated facilities or specialized human resources (Clemons and Row, 1992; Clemons *et al.*, 1993). The cooperation between Procter and Gamble and Walmart enabled by the IT (such as scanner data, EDI, logistics and executive information system) is another good example of how firms can achieve global coordination of production, inventory, warehousing, delivery, sales, merchandizing and promotion efforts to improve the sales and profit performance. Also, the companies that provide IT services have built software and communication platforms to execute every business process needed in many industries such as health care, automotive, electronics, telecommunication and insurance. For instance, an India-based IT firm, Tata Information Technologies can handle all the information processing required within the entire value chain of an automotive firm (Engardio *et al.*, 2006).

Table I.
A comparison of automotive plants: past and present

Ford plant in River Rouge, Michigan, USA	Toyota plant in Georgetown, Kentucky, USA	Smart car plant in Smartville, France	Toyota small plant in Ohira, Japan
Built in 1920s 16 million sq. ft of factory floor Assets: USD12 billion (time adjusted value) Employed 100,000 workers in 1930s and at least 6,000 workers in 1990s.	Built in 1986 7.5 million sq. ft of factory floor Assets: USD5 billion Employs about 6,800 workers	Built in 2001 1.5 million sq. ft factory floor Assets: USD500 million Employs about 1,800 workers	Built in 2011 1.5 million sq. ft of factory floor Assets: USD600 million Employs about 900-1,900 workers.
Capacity: 300,000 vehicles/year Layers of management: 12 levels (not including corporate office) Prime example of entire value chain integration from raw material to final product manufacturing, unitary assembly line system, plant included steel production, tire manufacturing, engine casting, manufacturing, major parts production and complete final assembly	Capacity: 400,000 vehicles/year Layers of management: six levels (not including corporate office) Moderately integrated plant; plant included manufacturing of engines and critical parts, Toyota Production System, just-in-time inventory, continuous improvement and total quality management, flexible manufacturing systems	Capacity: 200,000 vehicles/year Layers of management: five levels (not including corporate office) Environment-friendly (nearly 100 per cent recyclable) and mass-customized product, integration of supply chain to the maximum with modular assembly design and suppliers contributing about 85 per cent of the final value, suppliers are involved in design and final assembly through co-ownership of the site, codesign and some major share in the manufacturing activities	Capacity: 120,000 vehicles/year Layers of management: four levels (not including corporate office) Scale-reduced machine tools and lean production system, green and harmonious plant design with high energy saving equipment, modularization of critical components supplied by select affiliates and suppliers

Nike shoes offers an excellent illustration of a global strategy that involves the coordination of disaggregated, dispersed and decentralized units and processes, and that has helped build a multibillion-dollar dynamic firm competing in multiple markets/regions, with distinct strategies serving a variety of market segments. Nike's products are manufactured in > 700 factories, employing > 500,000 workers in 51 countries, offering > 1,000 styles and competing in several industries – footwear, apparel, sporting equipment, entertainment and leisure. Almost all its factories and operations are outsourced and managed through long-term relations. Nike designers create and then communicate via satellite new designs and styles for upcoming seasons to suppliers, who in turn, develop the prototypes. Once the prototypes are approved, the lead suppliers fax the product specifications to their plants throughout the world for immediate production. Nike's operation is a manifestation of a virtual network organization with high level of trust among the network participants. Ideas, designs, strategies, resources and facilities are leveraged, cross-subsidized and cross-fertilized for the benefit of the entire network (Heneman and Greenberger, 2002; Kaplinsky, 2000; Levy and Dunning, 1993).

There are several ways advantages emerge from disaggregating and dispersing the value chain of an organization (Audia *et al.*, 2001). First, dispersed operations may allow for placing certain value-adding operations closer to customers, and thus would enhance market responsiveness as well as would lower transportation costs. Second, dispersed operations allow for more variations and experimentation with process or product design. The learning capability is thus enhanced in a dispersed system helping the firm accrue diverse skills, experience and competencies. Due to enhanced learning facilitated by modern production and information technologies, the transaction cost of dispersed operations of the entire value chain is lower than the bureaucratic cost incurred in a typical integrated operation. Modularization of organization structure and product design, miniaturization of equipment, flexible manufacturing systems and seamless data and information connectivity have augmented the disaggregation and dispersion in knowledge-intensive firms without causing disruptions or increasing the transaction costs. Thus, notwithstanding the enormous reciprocal interdependence and complexity due to knowledge exchanges between value chain functions, the transactional costs and the associated risks have steadily declined. Disaggregated and dispersed organization – a shoaling form of organization – reflects a distributed form of organizational intelligence and information processing enabling dynamic capabilities and meeting the challenges of market complexities (Adler, 2001; Galbraith, 1973; Garud and Kotha, 1994).

The organizational design of Kyocera (Kyoto Ceramic Company), Japan, offers an interesting example of how a large global corporation of the size of 70,000 people with $14.5 billion revenue can be organized as a collection of small, customer-focused business units. Kyocera's organization structure is known as Amoeba management system (or Inamori way), developed by its founder Kazuo Inamori; it has > 3,000 amoebas (small units), with each unit empowered to operate independently, and at the same time is encouraged to collaborate with other amoebas to achieve synergy and profitable growth (Adler and Hiromoto, 2012; Inamori, 1999). Kyocera's executives believe that this style of management spurs market agility, enhances customer service and entrepreneurial drive and has helped the company to effectively manage the dynamic technological environment. W. L. Gore Associates is another knowledge-era

firm that illustrates how to organize a large firm with small company thinking. Gore Associates is a flat lattice (prism-like mesh) organization comprising hundreds of decentralized but networked small teams. This organization boasts of having no traditional organizational charts, no chains of command and nor does it have programmed channels of communication. Team units are organized around business opportunities and projects with complete autonomy. Employees are treated as "Associates" and Bosses are considered "Sponsors". With $3 billion in sales revenue and 9,500 associates worldwide, Gore Associates, Inc., is known as one of the best 100 companies to work for in the USA, Germany, the UK and Italy. It claims > 2,000 innovative patents in the fields of electronics, medical devices and polymer processing (Collins, 2001; Deutschman, 2004). A comparison of characteristics of firms during the industrial age (the scale economy) and the postindustrial knowledge economy is presented in Table II.

Although asset concentration and integration of value chain initially reduces the transaction cost, we propose that a high degree of asset concentration beyond a certain level is likely to increase the bureaucratic cost and thus overall coordination cost and investment risk (refer to Figure 1). As asset concentration increases, the number of bureaucratic layers increases, delays and errors in information processing accrue and salary and power differential between various organization levels increases. Furthermore, large organizations suffer from power conflicts, political coalitions, cost of high managerial ego and empire-building attitude – that is attempting to increase the scope of power and influence, as managers often become more concerned with acquiring greater resource control than with optimally allocating resources.

We further propose that the cost structures in the scale and knowledge economies exhibit different patterns. Organizational complexity, dynamism of markets and environmental uncertainty faced by firms in knowledge economy are much higher than that were countered by firms in scale economy (Adler, 2001; Felin *et al.*, 2009). Inability of hierarchical structures to respond to the dynamic and turbulent conditions accelerates the bureaucratic cost more so in new economy industries than the scale-driven industries. Whereas in new economy, notwithstanding the assumptions of opportunism being upheld, the transaction costs associated with external exchanges have drastically declined or flattened due to diffusion of knowledge, use of relational strategies such as alliances, joint ventures and collaborative networks, and participatory management approaches such as co-optation, codetermination, self-management teams and stakeholder-driven corporate governance (Adler, 2001; Herrigel and Zeitlin, 2009; Shin *et al.*, 2012).

At this juncture, it is significant to recollect Coase's (1960) argument that in a world of no transaction costs, the preferable form of governance, whether market or hierarchy is indeterminate: all governance forms would be of equal (i.e. perfect) efficiency. We offer a corollary to this proposition, instead of juxtaposing whether market mechanism or hierarchical integration, the relational mode of governance mechanisms that ensure transparency and procedural and distributive justice have come to effectively replace or substitute the hierarchical ownership on the one hand and reduce the cost of exchange transactions on the other (Rossi-Hansberg and Wright, 2007; Zenger and Hesterly, 1997). Thus, we argue, in the scale economy, the marginal increases in bureaucratic cost were smaller than the marginal decreases in transaction cost as the firm size increased. In the knowledge economy, on the contrary, the marginal rise in bureaucratic cost is much

Key organizational characteristics	Scale economy (until 1980s)	Knowledge economy (2000s)
Organizational population/landscape	Industrial, monopolies and corporate houses	Postindustrial, post-bureaucratic, postmodern, constellations of alliances
Corporate architecture	Capital-intensive asset integration	Knowledge-intensive alliances and networks
Spatial arrangement	High concentration and proximally located operations	Low concentration and highly dispersed operations
Relational dynamics	Hierarchical, top-down, supervisory and power-centered	Cooperative, trust-based and knowledge-sharing and mutual respect
Source of advantages	Firm size and economies of scale	Organizational intelligence and economies of learning
Coordination logic	Standardization and specialization	Agility, connectivity, compatibility and permeability (job enrichment and job enlargement)
Problems and challenges	High transaction costs due to information asymmetry, lack of trust, dearth of managerial and technical knowledge. high investment risk due to asset concentration	Steep increase in bureaucratic cost due to complexity, low value realization due to hyper dynamism in market trends, continual realignment of exchange relations, rapid erosion of proprietary rights
Strategic organization design	Functional structure, multi-divisional form built on functions, products or markets	Small scale, dynamic, collaborative communities of practice (knowledge form) built around competences and capabilities
Ownership	Individual appropriation and residual rights of control over the physical assets	Collective appropriation and controls over the information and knowledge

Table II.
A comparison of organizational forms in scale and knowledge economies

steeper than the fall in transaction cost as firm size increased (refer to Figure 1). Because of the strategic advantages due to the new cost structures, many firms are using dispersed organization form to production, marketing and distribution.

The evidence for this trend is corroborated in many industries. For example, PepsiCo India is planning to spread its manufacturing for many of its product lines on a wider spatial domain using franchise and contractual operators (*Business Standard*, 2012). The new model is a paradigm shift from the current PepsiCo system, in which the company's snack food "Kurkure" is distributed across the country from only eight manufacturing facilities. In the new model, Pepsi will setup at least two or three more new facilities in each state, and this will keep manufacturing close to consumption and thus would help cut the freight cost. Dispersed production will mostly involve contract manufacturers, and PepsiCo's long-term plan is to have each facility within 200-250 km from the retailers. The growth and success of microbreweries offers another interesting example of how small craft brewers such as Boston Beer Company (Brand: Samuel Adams) is breaking the industry barriers with their small dispersed operations and competing successfully in a mature beer industry dominated by large integrated beer companies.

Case summary 1: craft-beer-ship: breaking the barriers in the beer industry

The US beer industry sales account for $90 billion, selling about 200 million barrels, including the imported malt beverages about 27 million barrels (US Brewers Association Statistics, 2012). The beer industry employs directly and indirectly about 1.9 million people in the USA. The top three large-scale beer manufacturers (with production volume ranging from 6 million barrels to 125 million barrels), Anheuser-Busch-Inbev (ABI), SAB Miller and Coors, control close to 80 per cent of the US market share. The recent $52 billion merger between US Anheuser-Busch and Belgian-Brazilian Inbev helped to emerge the now global leader ABI, controlling > 50 per cent of the beer sales in the USA. This highly consolidated industry has been going through rough times in the past decade with overall sales volume steadily declining around 1 per cent per year. Large integrated beer companies are not able to effectively respond to the markets and segments demanding distinctiveness and quality. Surprisingly, in the same period, craft beer manufacturers have been growing at the rate of 10 per cent yearly, with increases in both sales revenue and consumption volume. In 2011, the craft brewers grew by 13 per cent in sales volume and by 15 per cent in dollar sales, with their market share steadily rising from 1 per cent to > 10 per cent of the beer market in the USA. Craft brewers sold an estimated 11.5 million barrels of beer in 2011, up from 10.13 million barrels in 2010 (US Brewers Association Statistics, 2012).

The decline in sales of large-scale breweries and the rise of craft brewers point toward not only a change in the behavior, tastes and attitudes of consumers but also a paradigm shift in the manufacturing and marketing of beers and the ensuing innovation in "*value creation*" in beer production and consumption. For nearly six decades, between the prohibition time in 1920s and until 1980s, American consumers' tastes and choices were geared toward mass-produced homogeneous beers designed for consistency, economies of scale and low-cost advantages with no exceptional taste or flavor. Until President Jimmy Carter signed the deregulation legislation in 1979, the beer industry witnessed a steady consolidation by large-scale mass-production beer companies. The deregulation reopened the market for small and micro craft brewers hosting innovations in beverage

flavors and enhancing quality of beers promoting "*beer connoisseurship*" in purchase and consumption similar to that in wine consumption (Bertsch, 1994; Carlson, 2011). The craft brewers include "small and micro brewers" with the production volume ranging from 15,000 to 1 million barrels per year. According to the brewers association of America, there are > 1,500 craft brewers in the USA.

Boston Beer Company – pioneering the micro-brewery revolution. The Boston Beer Company represents one of the most successful craft brewers in the USA, competing effectively against large mass-produced breweries. "Boston Beer" was founded by Jim Koch in 1985 with a family recipe and entered the market with a crafted beer brand "Samuel Adams Lager". This brand was initially brewed in small batches with an obsession for quality, freshness and flavor. Samuel Adams beers have won numerous international awards and are still brewed using the time-honored, traditional four-vessel brewing process and are market positioned in the "Better Beer Category". Samuel Adams is the only brewer practicing a cooperative program with its distributors to buy back its beer when it is past its peak freshness date. Samuel Adams brand boasts itself as high-quality hand-crafted beer made with world's finest all-natural ingredients purchased from Bavarian hops farmers. Instead of locking all the capital in production assets, Boston beer has grown primarily through microbrewery production methods and contracting with third-party packers and franchisees to produce all its brands. With this strategy of operating in a decentralized and dispersed manner using a chain of contract brewers, Boston Beer was able to market its specialty crafted beers nationally without incurring shipping expenses. From 500 barrels per year during its inception years to brewing close to 2 million barrels per year now, Samuel Adams has grown to be the largest craft brewer with 1 per cent of the total US beer market (www.bostonbeer.com). The success of Samuel Adams has become an inspiration and a catalyst to other small and microbrewers.

The exemplary performance of microbrewers and specifically specialty craft brewer like Boston Beer Company serves as a testament in support of the effectiveness of the business strategy of disaggregation and dispersion of manufacturing, marketing and distribution activities. The success of craft brewers like Boston Beer suggests that companies can operate profitably in a smaller scale disaggregating their core activities offering variety, quality, uniqueness and customization. And this strategy can be effectively replicated in a range of businesses and industries such as food processing, consumer durables and construction for achieving innovation and growth (Carlson, 2011).

In addition to the cost and marketing-related advantages, there are several socio-economic benefits of disaggregating a firm's value chain. Through disaggregation of operations, a firm can decentralize decision making and provide more autonomy, and thus, in turn, develop a sense of ownership control among employees and managers. Disaggregation allows for more product or design variations in manufacturing. Decentralized operation enables simple and lean organization structure, reducing the power and salary distance between management and employees. Dispersed value chain allows unit and functional level managers to search for new opportunities resulting in diversification and growth. With dispersed operation of the value chain, there is more opportunity for sharing or franchising the firm ownership with managers and employees, and thus reducing the cost of capital and investment risk. Dispersed arrangement helps firms to develop multi-pronged competitive strategies, that is,

enabling the firm to develop a unique or optimal strategy for each rival it encounters in the respective market or region. In addition to achieving cost reduction, quality and customer responsiveness, dispersed operations would help companies reduce the environmental cost and enhance the sustainability performance. Nucor's overall success in terms of cost savings, quality, innovation, employee learning and productivity, and overall effectiveness of financial and operational performance attest to the significance and consequence of scale reduction and dispersion of organization and production systems.

Case summary 2: Nucor steel – a mini and micro success story

To elaborate on the scale-reduction and dispersed operation of production and its impact on the firm performance and employee productivity, a brief on strategy, structure and culture of Nucor is presented here (www.nucor.com).

Nucor – a well-known steel producer and recycler in the USA – has a production capacity of $>$ 26 million tons. Nucor's philosophy matches with the maxim "small is beautiful" and believes they have gotten big by thinking small. While most of the steel manufacturers use large integrated steel mills, Nucor pioneered with mini- and micro-mills. These mills are far more efficient as compared to the integrated plants. They account for the majority of Nucor's steel production. Nucor also introduced a single-step process of producing steel slabs that dramatically reduced the time, space, manpower and energy needed to produce high-end steel. Its corporate headquarters are in Charlotte, North Carolina, and it runs approximately 200 operating facilities throughout North America. Most of these facilities are located in rural areas, capitalizing on the high work ethic of the residents there.

A multibillion-dollar firm, yet with $<$ 95 people working at its corporate headquarters and surprisingly few layers of management from the CEO to the frontline worker, provided rich rewards to its employees, including hourly workers. This company consists of 90 businesses that operate independently, but compete collectively. It resembles a family of small firms as compared to a large corporation. It has an unusually active and free exchange of ideas and solutions across its divisions and departments. Its managers have a high level of discretion to run its facilities and meet the needs of their customers. Research is an everyday activity in this company for every employee, which has made this company the innovation leader in its industry. Nucor believes employees, not managers, drive its success. At Nucor, there is a phrase "Push decision-making down to the lowest level" so its employees can feel ownership in the company.

Managers at Nucor believe that employees become more productive when they make most of the decisions. In this firm, "empowerment" has gone beyond a corporate buzzword. Nucor employees believe that if they have a suggestion, their ideas will not get buried in bureaucracy. Nucor allows for any employee to ask for a review of the complaint in an expeditious manner, if he or she has not received a fair hearing. The firm claims its unconventional thinking has yielded superb results, in terms of avoiding layoffs for lack of work, and over the past five years, 371 per cent return to shareholders, beating all other firms at Standard and Poor's 500 stock index.

Similarly, the success of Southwest Airlines demonstrates the significance of organizing the structure and operations in a dispersed manner even in a service-oriented high-tech airline industry. With one-fourth the size of Delta Airlines and one-half the size of American

Airlines in terms of the physical asset size, Southwest Airlines has been the most profitable airline company, beating all the carriers in terms of customer satisfaction, safety, destinations reached or connected, turnaround time, arrival time, costs/flight, operational performance and employee productivity. Although its fleet size is relatively smaller in number compared to that of large carriers, Southwest Airlines's > point-to-point operational strategy – which is akin to a dispersed operation mode – has turned out to be the most effective in cost savings, returns to investment and market penetration and passenger reach compared to the hub-and-spoke operational model (which is akin to concentrated operation) of other major carriers. Southwest Airlines, not surprisingly, has achieved the performance excellence primarily through instituting relational coordination of employees, that is designing and executing operations through facilitating shared goals, collective knowledge and mutual respect among employees across the entire organization rather than the hierarchical and supervisory system (Gittell, 2003).

Evidence for effectiveness of disaggregation or vertical disintegration is beginning to emerge in technology and knowledge-based industries. Outsourcing and offshoring of IT functions, leading the way for disintegration of firm value chain, offer the prime support for the economic benefits of disaggregation. Studies report that firms have gained not only cost advantages but also accomplished productivity gains, learning and knowledge transfers and innovations through decoupling and externalizing IT services from the core functions (Chang and Gurbaxani, 2012; Weeks and Feeny, 2008). Similar successes are being reported in other knowledge-based services such as consulting, legal services, computers and electronic components. For example, disaggregated operations and outsourcing are said to have provided several benefits to law firms such as increased efficiency, network expansion and knowledge transfers across markets and continents (Regan and Heenan, 2010).

In a recent study of 300 electronics and semiconductor firms, Shin *et al.* (2012) found that firms with disintegrated structure (decoupling R&D from manufacturing) outperformed the vertically integrated firms in terms of gross margin, Tobin's Q, return on assets, net margin and innovation performance. Similarly, Kapoor (2013) reports that firms with disintegrated (decoupled) structure had more innovation yield for the given R&D investment (in terms of number of patents) than the integrated firms. *Raison d'être* offered for the difference in innovation performance is that disintegrated firms focus their efforts on core competence, whereas within the integrated architecture R&D investments are spread over the entire value chain resulting in less intensity of effort and innovation results (Kapoor, 2013; Shin *et al.*, 2012; Dibiaggio, 2007).

Discussion

Numerous studies have provided evidence for the emergence of the disintegrated approach to managing the value chain, from manufacturing toys to Boeing 777, and in industries from filmmaking to footwear, and from machinery production to mortgage lending over the past several decades (Feenstra, 1998; Jacobides, 2005). A stream of research in economics, using data from South-East Asian, Latin American and European countries, has provided ample support for the rise of global production and the increasing share of multinational labor in economic output (Faustino and Leitao, 2011; Kimura and Ando, 2005; Lall *et al.*, 2004; Langlois, 2003; Whitford and Potter, 2007; Zeddies, 2011). For example, during 1990-2000, the rate of growth of world trade in parts

and components was higher (9.1 per cent) than those for the world trade in general (6.5 per cent) and the world gross domestic product (3.7 per cent) (Jones *et al.*, 2005).

Alexander Yeats (1999), an economist at the World Bank, raised the question "How big is global production sharing?" Based on extensive data analysis, he showed that the share of export in parts and components grew from 26 per cent in 1978 to 30 per cent in 1995 (close to $400 billion) of the total world trade for the machinery and transport equipment for the Organization of Economic Cooperation and Development countries, accounting for a compound growth rate of 9.3 per cent (Yeats, 1999; Zeddies, 2011). Similarly, other economists have documented that developing countries' market share in production of electronic products increased from 25.5 per cent in 1990 to 44.4 per cent in 2000 (Lall *et al.*, 2004). Likewise, since 2004, outsourcing contracts have been valued at nearly $100 billion every year (Blair *et al.*, 2011). On the other hand, as is well-known, the manufacturing value added in the USA has been steadily decreasing over the decades because of relocation of production to other countries, especially to those in Asia (Fuchs and Kirchain, 2010). For instance, during 1980s, the US automakers represented the traditional vertically integrated firms producing, on average, 50-80 per cent of their own inputs (Kwon, 2005). And now they are producing < 25 per cent of the total value of their output. This trend is continuing on to other industries including the knowledge economy firms. Recently, for example, firms such as IBM, HP, Accenture and Oracle have exemplified a new business model of disintegration of the value chain with > 20 per cent of their workforce located in countries such as India (Kenney *et al.*, 2009). According to the United Nation's (2009) figures, the market for the offshoring information technology and business processes has exceeded the value of $100 billion and is growing at a rate between 7 and 10 per cent (Liesch *et al.*, 2012).

A variety of approaches to implement disintegration strategy have emerged that range from spot markets to cooperative alliances (e.g. Toyota) and to networks of independent enterprises (e.g. shoes and apparel firms in Italy) (Herrigel and Zeitlin, 2009). While disintegration is becoming prevalent in the past few decades, researchers have been concerned about whether disaggregation enhances firm performance (Desyllas, 2008). Despite evidence for the positive relationship between disaggregation and firm performance, integration strategies are still actively pursued across industries, especially in developing economies (Herrigel and Zeitlin, 2009; Kapoor, 2013; Khalid, 2006). Likewise, while majority of the knowledge-based firms have been quite successful with the disintegration approach (decoupling the value chain R&D, manufacturing and marketing), there are exceptions such as Dell which is reverting to integration, citing problems with disaggregation and outsourced production (Knowledge@Wharton, 2012; Herrigel and Zeitlin, 2009; Legros and Newman, 2013).

At this juncture, we would like to point out that both integration and disintegration strategies face diminishing returns depending on several factors. Studies suggest that both excessive integration and disintegration are likely to be unsuccessful (Contractor *et al.*, 2010; Desyllas, 2008). Likewise, timing, reasons and firm capabilities may be critical boundary conditions for the success of the either integration or disintegration (Desyllas, 2008; Jacobides and Hitt, 2005). Firms that lack capabilities for coordinating their activities within the firm boundaries or outside cannot expect to gain from either of these strategies (Strange, 2011). In addition, firm technologies and product designs and executives' mental models, strategic choices, commitment, negotiation skills and political power are important factors behind the performance of the corporate strategies,

either integration or disintegration (Fuchs and Kirchain, 2010; Herrigel and Zeitlin, 2009).

Furthermore, institutional factors such as tariffs, laws and regulations guiding contracts, cultural ties and factors of production and their costs (e.g. educated workforce and wage differentials among regions, transportation costs and communication technologies) have long been recognized as boundary conditions for vertical integration and disintegration to succeed (Blair *et al.*, 2011; Faustino and Leitao, 2011; Whitford and Potter, 2007; Zeddies, 2011). Because markets represent other firms that have capabilities to provide required goods and services, availability of competent firms in the markets with the necessary skills, expertise and knowledge will determine whether disaggregated approach to managing the value chain will yield returns (Gross, 2006; Jacobides and Winter, 2005; Jacobides and Hitt, 2005; Langlois, 2003).

Conclusion

Strategic managers are increasingly realizing that conventional integrated corporate architecture is less germane for organizing the businesses in the knowledge economy in which firms are experiencing turbulent, hyper-competitive environments inundated with disruptive technologies. Corporations need to become nimble and responsive, and their structure should be agile, networked, permeable and compatible with the host of suppliers, competitors, research institutions and related industry players spread across the globe to capture and leverage their knowledge. Such a complex demand poses an organization design challenge, which requires the firms to have a wide reach on a global scale and their strategic functions to be closely connected to the activities and markets providing high value addition.

Integration of value chain and assets through mergers, acquisitions or wholly controlled subsidiaries would be imprudent if there is huge sunk cost due to uncertainty in business. The cost of organizational inertia would be very high if the firm lacks responsiveness in dynamic industries and disruptive industry conditions. In contrast, scale reduction and disaggregation of the functions, processes or business units and operating in a dispersed mode – like a shoaling form – would help the companies exploit the fleeting opportunities without incurring the opportunity cost and risking high investment. While outsourcing and offshoring of non-value adding processes result in scale reduction and cost-reduction, what is proposed in this article is the disaggregation of the core competence or primary business activity itself to achieve high innovation and dynamic capability. Given the context of knowledge economy, which has lessened the information asymmetry and trust chasm and flattened the transaction cost, it is better to conceptualize the firm as a bundle or constellation of value-generating resources and capabilities, including networks and alliances, rather than a hierarchical structure to reduce the transaction cost. The knowledge-centered network structure would enable a firm to organize the core activity and its subunits in the form of franchises, alliances and long-term partnerships and would enable the delegation of autonomy and freedom necessary to sustaining the entrepreneurial dynamism and innovativeness. Within the organization, managers need to rely more on relational coordination processes that unleash the intellectual capital, and that help build the reservoir of social capital as exemplified by Southwest Airlines and Gore Associates.

While disaggregation may result in several strategic advantages, it is not a panacea or the only alternative to avoid the problems of vertical control. And it is important to keep in mind

disintegration's limitations and boundary conditions as well. There are industrial, geographic and locational contexts in which too much disaggregation and dispersion may increase the complexity of the interface between dispersed units and thus can exceedingly increase the coordination cost. For example, Contractor and associates (2010) have observed that in global outsourcing and offshoring of value chain operations, too much dispersion results in suboptimization. The coordination cost may escalate due to conditions such as locating two sequential/concurrent activities in different countries, high vendor search cost in unfamiliar foreign locations and a high number of discrete slices of the value chain. Similarly, a study of R&D outsourcing by Grimpe and Kaiser (2010) suggests that there is a trade-off between incremental benefits and incremental costs of value chain dispersion and that there are pains due to high dispersion such as dilution of resources, deterioration of integrative capabilities and high demands on management attention. They find evidence for an inverted U-shaped relationship between R&D outsourcing/offshoring and innovation performance. Furthermore, whether a firm has the capability to coordinate the dispersed operations would offer additional explanation as to why some firms are more or less successful with disaggregation (Gross, 2006; Jacobides and Winter, 2005; Langlois, 1998). A firm's capability, that is, knowledge, experience and skills required for coordinating diverse but complementary productive activities by intra-firm governance, inter-firm cooperation or market exchanges determine the boundaries of the firm (Kench *et al.*, 2012; Langlois, 1998). Learning by the firm and its external constituents over time dynamically alters both transaction costs and bureaucratic costs and creates incentives for disintegration or integration (Jacobides and Winter, 2005; Kench *et al.*, 2012).

Also, disaggregation may not provide the environmental and sustainability advantages in all situations. Although scale reduction and dispersion may reduce the cost of externalities that may arise due to industrial accidents and disasters and/or lessen the social cost associated with concentration of wealth and assets, there are industrial settings in which disaggregation of firms may result in asset idleness, more waste and proliferation of hazardous technologies and materials. In this light, the post-bureaucratic organization designed to enhance knowledge-based advantage has to emphasize the importance of mission, strategy and strategic controls more than ever. While the mission and strategy would help reinforce the shared goals among internal and external parts, strategic incentives and controls need to be judiciously designed to ensure self-regulation, given the autonomous nature of actors and subunits that are part of the network. Mission, strategy and control systems need to emphasize the values and norms that provide meaning to the activities of the network and communicate the benefits that would accrue to the actors. The knowledge-era organization design will reveal new corporate functions such as alliance management, will use many boundary-spanning roles between subunits and partners and will create jobs that are multidimensional, enriched and flexible. More than delineating the property rights and contractual obligations, specifying the value of knowledge created, accrued and shared would become the central strategic function in the postmodern firm that belongs to the knowledge economy.

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