

Location, control and innovation in knowledge-intensive industries

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Abstract

The rising share of intangibles in economies worldwide highlights the crucial role of knowledge-intensive and creative industries in current and future wealth generation. The recognition of this trend has led to intense competition in these industries. At the micro-level, firms from both advanced and emerging economies are globally dispersing their value chains to control costs and leverage capabilities. The geography of innovation is the outcome of a dynamic process whereby firms from emerging economies strive to catch-up with advanced economy competitors, creating strong pressures for continued innovation. However, two distinct strategies can be discerned with regard to the control of the value chain. A vertical integration strategy emphasizes taking advantage of 'linkage economies' whereby controlling multiple value chain activities enhances the efficiency and effectiveness of each one of them. In contrast, a specialization strategy focuses on identifying and controlling the creative heart of the value chain, while outsourcing all other activities. The global mobile handset industry is used as the template to illustrate the theory.

Keywords: innovation, value chains, intangibles, vertical integration, specialization, knowledge-intensive industries

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1. Introduction

The first industrial revolution of the 18th and 19th century moved value creation from the direct application of human labor to tangible assets like industrial plants and machinery. Countries that grew wealthy in this revolution transferred their productive resources out of agriculture and craft manufacture into large-scale manufacturing industry. Over the last several decades, the world economy has been witnessing what can only be described as another revolution in terms of the nature of value creation. The source of value has been shifting from tangible assets to intangible assets at an accelerating pace. For all the G-7 economies put together, intangible assets have been estimated to constitute about 30% of the stock of all long-term assets (IMF, 2006).¹ Intangible assets are the lifeblood

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1 The percentage of market valuation of the S&P 500 US firms related to intangible assets increased from 38% in 1982 to 62% in 1991 (Blair and Wallman, 2001) and to about 85% by 2001 (Nakamura, 2003). By 2004, annual investment in intangibles in the US economy was conservatively estimated at over 8% of GDP or about \$1 trillion [Hofmann (2005), citing unpublished data from Nakamura]. In these estimates, about a third of the \$1 trillion in intangibles is software; one-third is intellectual property, such as patents and copyrights and one-third is advertising and marketing.

of creative and knowledge-intensive industries, which may be defined as those where value creation is disproportionately based on specialized, nonrepetitious activities (Malecki, 1984). These data indicate that such industries will be fundamental to the creation of wealth in the future.

The returns to intangible assets can appear in the form of legally defensible rents as in the case of patents, copyrights and brands (Lev, 2001).² However, they can also appear in the form of superior returns generated by inimitable organizational structures and inter-organizational relationships (Kogut and Zander, 1993; Grant, 1996; Augier and Teece, 2006). A key aspect of intangible assets is the overwhelming importance of human creativity (Florida, 2002; Howkins, 2001). In all cases, the firm controlling an intangible asset is able to generate higher returns, *ceteris paribus*, than a competing firm that does not control the asset.

Intangible assets have also been called 'intellectual assets' (Lev, 2001), a terminology that is more helpful since it makes clear that all these assets are based on various forms of commercial knowledge. The role of commercial knowledge in value generation has long been recognized (Hayek, 1945), especially in creative industries. Value creation in these industries is almost entirely based on intellectual content in the form of texts, music, media, etc. (Caves, 2000; Scott, 2000). Traditionally, creative industries have also been characterized by very strong cluster effects (Florida, 2002; Maskell and Lorenzen, 2004). 'Creative centers' like Hollywood, Hong Kong and Mumbai (movies), Nashville (country music), New York and London (media) have occupied dominant global positions (Malone, 1993; Martin and Sunley, 2003; Scott, 2004, 2005). The economic geography literature has developed fine-grained analyses of location, regional specialization and clustering in knowledge-intensive industries, focusing especially on urbanization, the power of cities and the consequent rise of regional disparities (Scott and Storper, 2003; Lorenzen, 2004; Amin and Thrift, 2005).

However, the geographical dispersion of value creation has recently begun to play an increasingly important role in the analysis of creative industries (Cantwell and Santangelo, 1999; Iammarino and McCann, 2008). National systems of innovation (NSIs) provide 'the location-specific supply base of technological and knowledge externalities that firms draw upon for their competitiveness' (Amin and Cohendet, 2004) and NSIs vary dramatically in terms of their comparative strengths and weaknesses (Lundvall, 2007). Thus, firms can enhance their competitive advantage by dispersing their creative endeavors, tapping into multiple centers of excellence and coordinating knowledge across geographic space (Lorenzen, 2004). For example, Canon U.S. Life Sciences Inc. is networked into the U.S. NSI, specifically into the life sciences cluster along the eastern seaboard, thousands of miles away from its home-based R&D headquarters in Japan (Uchida, 2008).

This example illustrates that understanding the effects of this dispersion on the creation and use of intellectual assets requires relating them to the optimizing decisions made by the individual business firm. The relevant decisions focus on the firm's value chain that is composed of the 'technologically and economically distinct activities that it

2 Intangible assets are intangible in the sense that they cannot be valued with certainty or precision. However, they are assets in that they generate a stream of future returns. Lev (2001) defines an intangible asset as 'a claim to future benefits that does not have a physical or financial (a stock or a bond) embodiment'.

Table 1. Strategic choice: location and control

		Geographical location strategy	
		Concentrated	Dispersed
Control strategy	Vertical integration Specialization	1. Onshore in-house 2. Onshore outsourced	3. Captive Offshore 4. Offshore outsource

performs to do business' (Porter and Millar, 1985). Addressing these questions requires analyzing the value chain along two dimensions: control and location.

Activities within the firm's value chain can be broadly grouped into three categories: the upstream (input) end, the downstream (output or market) end and the middle. Activities at the upstream end generally comprise design, basic and applied research and the commercialization of creative endeavors. Activities at the downstream end typically comprise marketing, advertising and brand management and after-sales services. Activities in the middle comprise manufacturing, standardized service delivery and other repetitious processes in which commercialized prototypes are implemented on a mass scale.

How should the firm control the various parts of the value chain and where should it locate them? More specifically, the research questions addressed in this article are: to what extent should the firm implement vertical integration and geographical dispersion with respect to its value chain activities? These location and control choices are presented in a simplified manner in Table 1. The answers to these fundamental questions with regard to firm organization and activity location are crucial: they will determine the global geography of economic activity in general and creative activity in particular during the coming decades.

There is a voluminous literature in international business examining the organization of the firm across national borders (Buckley and Casson, 1976; Dunning, 1993). The economic geography literature has dealt exhaustively with questions regarding the location of economic activity, both in the regional and international context (Fujita et al., 1999; Dicken, 2003). However, the interface between these two literatures is surprisingly thin (McCann and Mudambi, 2005). This article draws on both literatures in an attempt to incorporate both the firm and the location perspectives on value creation in creative industries. This analysis enables us to highlight both macro (country level) and micro (firm level) implications for creative industries of the ongoing process of globalization.³

At the macro-level, the value chains of individual firms inter-weave through complex relationships and complementarities to form the 'value constellations' of creative industries (Normann and Ramirez, 1993). These are becoming locationally

3 For the purposes of this article, we adopt the relatively narrow definition of globalization as 'the shift towards a more integrated and interdependent world economy...including the globalization of markets and the globalization of production' (Hill, 2008). This is in contrast to those who define globalization as a broader phenomenon that transcends economic development and includes political, technological and cultural dimensions, owing in large part to the rise of 'instantaneous electronic communication' (Giddens, 2003).

disaggregated as discrete parts of firm value chains are coalescing in different country locations. Under the current location pattern, high value-added activities are largely performed in advanced market economies, with low value-added activities performed in emerging market economies.⁴ However, this pattern is under pressure from three separate processes. Firms from emerging market economies are striving to develop competencies in high value-added activities ('catch-up'). Firms from advanced market economies are stripping out standardized parts of their high value-added activities and cutting costs by relocating these in emerging market economies ('spillover'). This spillover process is reinforced by obsolescence that is creating pressures for the relocation of 'sunset' industries to emerging market economies. Rapid innovation, so far largely in advanced market economies, is spawning entirely new value constellations ('industry creation').

Examining global creative industries at the firm level, distinct trends are emerging. Two divergent strategies can be discerned with regard to the control of the value chain. A vertical integration strategy emphasizes taking advantage of 'linkage economies' whereby controlling multiple value chain activities enhances the efficiency and effectiveness of each one of them. In contrast, a specialization strategy focuses on identifying and controlling the creative heart of the value chain, while outsourcing all other activities. However, along the location dimension, a common pattern of geographical dispersion appears to be developing. Firms are increasingly implementing strategies to take advantage of the comparative advantages of locations. This results in a wider geographic dispersion of firms' activities, with direct implications for the future of creative industries' global value constellations.

The article is organized as follows. A theoretical framework for the analysis of the economic organization of creative and knowledge-intensive industries is developed in Section 2. The theory is illustrated within the context of a case study of the global mobile handset industry in Section 3. Implications of the theory and research propositions are presented in Section 4.

2. Control, location and economic organization in creative industries

In his seminal work, Caves (2000) indicated that 'arts and entertainment' are exemplars of creative industries. Several attempts have been made at more specific definitions. For example, in 2001 the UK government specified the creative industries sector to include advertising, architecture, arts and antique markets, crafts, design, designer fashion, film, interactive leisure software, music, television and radio, performing arts, publishing and software (Creative Industries Task Force, 2001; quoted in Cunningham, 2002). This specification includes an eclectic mix of commercial and noncommercial activities. A broader definition is provided by Howkins (2001), who includes all sectors covered with significant copyright, patent, trademark and design activity. This is a

4 For the purposes of this article, the advanced market economies may be taken to be the Triad economies of North America, Western Europe and Japan, also including Oceania. Emerging market economies range from the large BRIC economies (Brazil, Russia, India and China) to many smaller economies in Asia, transition economies of Central and Eastern Europe and some economies in South America (BIS, 2007).

dramatic expansion of the UK government definition since it includes all patent-based R&D in all science-engineering-technology sectors. It is not the purpose of this article to offer a resolution of this debate. Rather, the article draws from this discussion the core idea that creative industries are those where the production and control of knowledge-based assets have crucial roles in value creation and appropriation (Kogut and Zander, 1993; Grant, 1996; Augier and Teece, 2006).

Further, there is no well accepted definition of knowledge-intensive industries (Malecki, 1984). The OECD definition of 'high technology' industries is limited to manufacturing (OECD, 1996). More importantly, for the purposes of the article, we are interested in knowledge-intensive activities, not knowledge intensive firms. We specify that high knowledge activities are creative and specialized, whereas low knowledge activities are repetitious and standardized (Nelson and Winter, 1982). In other words, the difference between high knowledge and low knowledge activities is based on a 'fundamental difference between a focus on new products and a primary concern with low-cost, standardized production' (Malecki, 1984). This definition underpins the conceptualization of knowledge used in the article as related to 'new concept development' and 'marketing': the two ends of the firm's value chain. Thus, the R&D activities of a textile manufacturer are included, while the repetitious printing and binding activities of a book publisher are not.

The macro data indicating the rapidly rising share of intangible assets in major economies implies that creative and knowledge-intensive industries account for an increasing share of value created. Creating and capturing value from knowledge assets is becoming a cornerstone of firm strategy (Teece, 1998). We argue that our understanding of the strategic aspects of creating and capturing value from knowledge can be enhanced by placing them within the context of the firm's value chain (Porter and Millar, 1985, p. 150), i.e. a conceptualization of value creation, identifying the value-added by each activity. The value chain should *not* be read as an intertemporal sequence going from inputs to outputs. It is quite possible that sources of value at the 'market' or right end may be created before sources of value at the 'input' or left end. For instance, market research efforts may occur first or jointly with product or service design, with prototyping and production occurring later.

Successfully extracting and capturing value in creative industries depends on two crucial strategic nexuses: the control and location of value chain activities. In other words, for a firm to be successful in creating and capturing value from knowledge it is essential that it makes optimal decisions within these two domains.

2.1. Organization and control: Coasian approaches to the firm

Optimal decisions regarding the governance of the firm's value chain emerge from the application of transaction cost analysis. Traditionally, transaction costs have been defined as the costs of using the market mechanism (Coase, 1937; Williamson, 1975). Since this definition means that almost anything can be explained as a suitably defined transaction cost (Williamson, 1979), subsequent literature has specified transaction costs to be those associated with coordinating and policing market transactions (Ricketts, 2002). It readily follows that whenever firms obtain significant benefits from vertical integration, the costs of using market transactions to perform these activities is relatively high and outsourcing is unattractive.

The firm simultaneously disaggregates the value chain and selects the activities over which to maintain control. Coasian analysis implies that the firm should retain control over the activities or operations where it can create and appropriate the most value. Conversely, operations where it can create and appropriate less value should be implemented through market transactions. In their seminal work, Buckley and Casson (1976) applied this reasoning to the geographical context, providing a theoretical rationale for the existence and organization of multinational enterprises (MNEs).

Technological advances, especially in the areas of information and communication have made it possible to disaggregate the firm's business processes into progressively finer slices. Firms are able to specialize in increasingly narrow niches, which need not even be contiguous in the value chain. This makes it crucial for the firm to identify the process activities over which it has competitive advantage, since these are the basis of the firm's core competencies (Hamel and Prahalad, 1990) and enable it to generate rents.

For example, the US motion picture industry has moved from the vertically integrated studio system to what has been called 'flexible specialization', where much of the actual production work is carried out by crews that are employed on a film by film basis (Christopherson and Storper, 1989). Flexible specialization increases the importance of external linkages (Storper, 1997), since film companies undertake market transactions with producers who assemble appropriate crews for each film project. The firms retain tight internal control only of global distribution and marketing—the downstream end of the value chain (Scott, 2005).

For some firms, the logic of transaction cost analysis pushes them towards exercising high control over and concentrating resources on specific activities while having a strong tendency to outsource others (Calantone and Stanko, 2007). Other firms tend to exercise greater control over the entire value chain, with much less outsourcing, though bounded rationality arguments—decreasing returns to management in the words of Coase (1937)—imply that such control cannot be extended indefinitely. In the terminology of industrial organization, these strategies correspond to greater and lesser degrees of vertical integration and focus on the strategic choice between cells 1 and 2 in Table 1.⁵

A critical research question that arises in this context pertains to the observation that competing firms within the same industry often implement widely differing levels of vertical integration. For example, in the US auto industry GM typically implemented the highest degree of vertical integration followed by Ford and Chrysler (including its successor, DaimlerChrysler).⁶ Through its ownership of Denso, Toyota has maintained an even higher level of vertical integration than GM (Conybeare, 2003). These differences have been observed over long periods of time and have not historically been related to differences in firm performance (Mudambi and Helper, 1998; Rubenstein, 2001). The persistence of these differences along with the lack of a systematic link to firm performance suggests that they are not disequilibrium phenomena.

5 Attempts at developing internal hybrids by introducing market forces within the firm have been dogged by severe problems. It is very difficult for managers to make credible commitments to workers that they will consistently allow internal market forces to work. Hence the motivational benefits of internal markets are seldom realized and almost never sustained. See for example, Foss (2003).

6 In the 1990s, GM controlled the production of about two-thirds of the parts that went into its cars, while Ford controlled about half and Chrysler a third (Rubenstein, 2001).

A direct implication of these observations is that transaction costs have significant firm-level components in addition to industry-level components. The study of technology in neoclassical economics has tended to focus on the industry level of analysis. The industrial organization literature has developed sophisticated analyses explaining why and how industries to differ from each other in terms of the extent of vertical integration. However, it is the firm-level components cause firms within a single industry to differ from each other in terms of the control of their value chain activities. We argue that these firm-level transaction costs are not easily captured using standard tools of neoclassical economics.

Technologies largely determine economies of scale, scope and experience and these are generally common across leading edge firms in most industries (Mansfield 1985; Pavitt 1998). This implies that these economies cannot be the source of firm-level transaction costs; they cannot be used to explain systematic and persistent differences in the extent of vertical integration amongst these leading firms (Appendix A).

A particularly important aspect of value chain organization concerns not its constituent activities *per se*, but the linkage between them. Economies of scale, scope and experience relate to the technologies associated with individual activities, i.e. they are properties of individual production functions and are directly determined by technology. However, firms may also realize economies simply because they control multiple activities in the value chain. Design activities may become more efficient due to control of manufacturing, since information may flow more readily between units within a single firm. These economies may be defined as linkage economies. Linkage economies arise from linkages between the production functions associated with *different* activities. An illustrative theoretical model demonstrating the nature of linkage economies and distinguishing them from economies of scale, scope and experience is presented in Appendix A.

Hirschman (1968, 1977) was one of the first to note that linkages in the value chain of inputs and outputs create benefits beyond the direct gains from trade. Within his generalized analysis of linkages, his conceptualization of ‘technological linkages’ is the most relevant for purposes of this article. Technological ‘linkages can be expected to be rather weak if the required input comes from an industry whose process and technique is totally unfamiliar . . . The linkage dynamic may thus be held back by the difficulties of making a technological leap’ (Hirschman, 1977, p. 77). This idea translates quite readily to an input–output interface at the level of the individual firm. Some firms will have the competencies to devise better routines to stimulate cross-activity coordination, learning and innovation. Such firms enjoy high levels of linkage economies. Vertical integration is attractive for such firms since it results in falling costs and improved quality for both inputs and outputs. Other firms will find that controlling a wide range of activities detracts from their focus on each one. Such firms have low linkage economies or may even suffer from linkage diseconomies. Specialization is attractive for such firms and they have lower costs and superior quality by focusing on a narrow spectrum of activities while buying inputs from market.

High linkage economies mean that controlling multiple activities in the value chain improves the efficiency and effectiveness of each one of them. Linkage economies are likely to be based on firm-specific routines and procedures (Zollo and Winter, 2002). These routines often vary across firms even when the underlying technologies being implemented are common (Rosenberg, 1982, p. 257). Linkage economies are likely to arise from the transfer of knowledge from one activity to another within the firm; the

intra-firm context is expected to be particularly efficient when transfers involve highly tacit knowledge and skills (Nelson and Winter, 1982; Cantwell and Santangelo, 1999; Maskell and Malmberg, 1999). Further, different firms within the same industry have been shown to implement different knowledge management strategies (McMillan et al., 2000). Thus, linkage economies are an important knowledge-based means of explaining different levels of vertical integration within an industry.⁷

It is beyond the scope of the present article to explore the sources of linkage economies in detail. However, a few conjectures may be offered. A firm that is able to minimize knowledge 'stickiness' (Szulanski, 1996) may enjoy high levels of linkage economies, since it is able to stimulate intra-firm knowledge transfer. Such transfers are likely to occur over activity boundaries, e.g. between production engineering and marketing, suggesting that an effective boundary spanning function may be a key resource in this context (Marrone et al., 2007).

2.2. Location: value-added and the value chain

Mechanization and standardization have reduced the costs of manufacturing and logistics processes. Processes supporting mass customization (Kotha, 1995) have become widely available and subject to rapid imitation. This in turn has reduced the scope for the use of such processes to generate the differentiation required to support value creation. It is difficult for firms to extract high value-added from either tangible products or standardized services (Maskell and Malmberg, 1999). Firms are finding that value-added is becoming increasingly concentrated at the upstream and downstream ends of the value chain (Mudambi, 2007). Activities at both ends of the value chain are intensive in their application of knowledge and creativity.

Activities at the left or 'input' end are supported by R&D knowledge (basic and applied research and design), while activities at the right or 'output' end are supported by marketing knowledge (marketing, advertising and brand management, sales and after-sales service). The pattern of value-added along the value chain may, therefore, be represented by the 'smiling curve' (Everatt et al., 1999) or the 'smile of value creation' as depicted in Figure 1 (Mudambi, 2007). Firms combine the comparative advantages of geographic locations with their own resources and competencies to maximize their competitive advantage (McCann and Mudambi, 2005). The classic international diversification question focuses on evaluating the comparative advantage of different geographic locations against the costs of geographically dispersed operations, i.e. the strategic choices between cells 1 and 3 or between cells 2 and 4 in Table 1.

The geographic realities associated with the smile of value creation are that the activities at the ends of the overall value constellation are largely located in advanced market economies, while those in the middle of the value chain are moving (or have moved) to emerging market economies (Gereffi, 1999; Smakman, 2003; Pyndt and

7 Spulber (1989) defines economies of sequence, a concept that is related to linkage economies. Economies of sequence arise when 'cost gains (are) achieved by combining a sequence of production stages.' (Spulber, 1989, p. 113). These economies arise from the firm's technology, as defined within the neoclassical paradigm; a logical implication is that if two firms have access to the same technology, they are able to enjoy the same economies of sequence. In other words, they are not meant to explain firm-level differences.

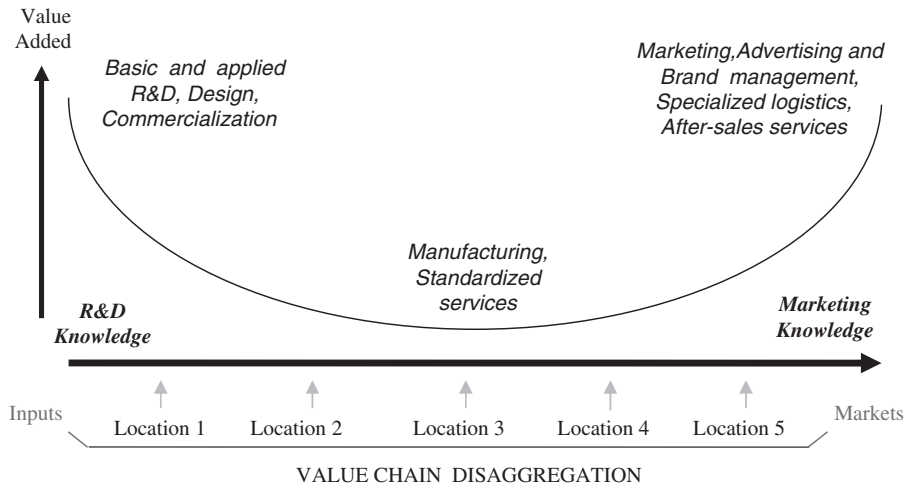


Figure 1. The smile of value creation (Mudambi, 2007).

Pedersen, 2006).⁸ Trade across national borders is increasingly in terms of value chain activities (so-called ‘tasks’) rather than complete goods or services (see for example, Pyndt and Pedersen, 2006, p. 14; Smakman, 2003, p. 17). These realities emerge naturally from the application of the classic product cycle model (Vernon, 1966), at a point in time, to industry value constellations.

Examples of the ‘smile of value creation’ are ubiquitous. In the athletic shoe industry, the locational disaggregation of Nike’s value chain has been in place for decades. Research, design and marketing are located in advanced market economies, intermediate manufacture and assembly in emerging market economies and basic component manufacture in low cost locations (Yoffie, 1991). Nike concentrates on design and marketing, while outsourcing and closely coordinating production through a hierarchical offshore network of low cost suppliers. Nike controls and owns the core intangible asset, the brand. The value of this intangible asset is crucially dependent on the highly creative design and marketing activities that Nike controls at the two ends of the value chain. Nike has been particularly successful at decoupling the tangible from the intangible aspects of its business, both in space and in time. However, a similar pattern of locational disaggregation may be seen in the operations of firms in many other industries. In the auto industry, the value chains underlying GM’s Pontiac Le Mans and Ford’s Fiesta incorporate design and marketing in advanced market economies and assembly in emerging market economies (Cao, 2002). In the pop music industry, ‘artistic’ and ‘humdrum’ activities are often locationally disaggregated with the former driven by creativity and the latter by cost (Maskell and Lorenzen, 2004). In the film industry, Vang and Chaminade (2007) report that the Toronto cluster services the creative center in Hollywood by specializing in ‘humdrum’ activities.

⁸ Pyndt and Pedersen (2006) present compelling and in-depth evidence of this trend for Denmark at both the firm and industry levels. Smakman (2003) presents consistent evidence for the Singapore garment industry.

This analysis provides the rationale for the enormous efforts by some technologically leading firms to break their final products or services into separable self-contained elements or modules (Kotabe et al., 2007). Increasing modularization allows the firm to amplify its focus on narrower activities within the value chain associated with the highest value-added, an approach which may be called 'fine slicing'. In tandem, it allows the firm to outsource other activities (associated with lower value-added) more cheaply and efficiently (Ernst and Lim, 2002).

The firms to which these lower value-added activities are outsourced view them as stepping stones in the course of moving into higher value-added activities. This is what underlies the enormous efforts of firms from emerging markets to develop R&D and marketing capabilities (Everatt et al., 1999; Smakman, 2003). These efforts often generate negative cashflow in the short run as resources are withdrawn from low margin contract manufacturing and assembly or standardized service delivery and transferred to R&D and marketing where the firm has little experience. However, many emerging market firms view these short run losses as investments in developing crucial competencies.

2.3. Location: dynamic analysis of the value constellation

2.3.1. Firm strategy

Over time, a firm's dynamic competencies are based on linking the two ends of the 'smile' so that marketing knowledge is used to calibrate and focus R&D-based knowledge creation (Leenders and Wierenga, 2002; Winter, 2003). At the firm level, such an integration of marketing with design and R&D underpins the ability to sustain competitive advantage by a constant process of market led innovation.

Improving process technology depresses the middle of the smile and pulls up the ends, making the smile more intense. The middle of the smile is driven down by increased efficiency in the operation of standardized processes that are not however, rare, inimitable or organizationally embedded (Maskell and Malmberg, 1999). The ends of the smile are pulled upwards by increased personalization and customization in design and delivery. These competencies are based on R&D and market knowledge and skills that are rare, highly tacit, inimitable and unique to each organization (Wernerfelt, 1984). Such resources often reside within the firm's human capital that then becomes a crucial source of value creation (Amit and Schoemaker, 1993).

2.3.2. Economy-wide processes

As noted above, firms controlling various activities within the value chain have differing incentives. Their responses to these incentives generate processes that change economy-wide patterns of economic activity. These processes can be broadly grouped into three categories that may be labeled 'catch-up', 'spillover' and 'industry creation' (Figure 2).

Firms controlling activities in the middle of the value chain have strong incentives to acquire the resources and competencies that will enable them to control higher value-added activities. Thus, firms from emerging market economies like China, India, Brazil and Mexico are moving to develop their own brands and marketing expertise in advanced economies to increase their control over the downstream end of the value chain. Locating their R&D and marketing operations in advanced market economies also enables them to increase their absorptive capacity (Zahra and George, 2002;

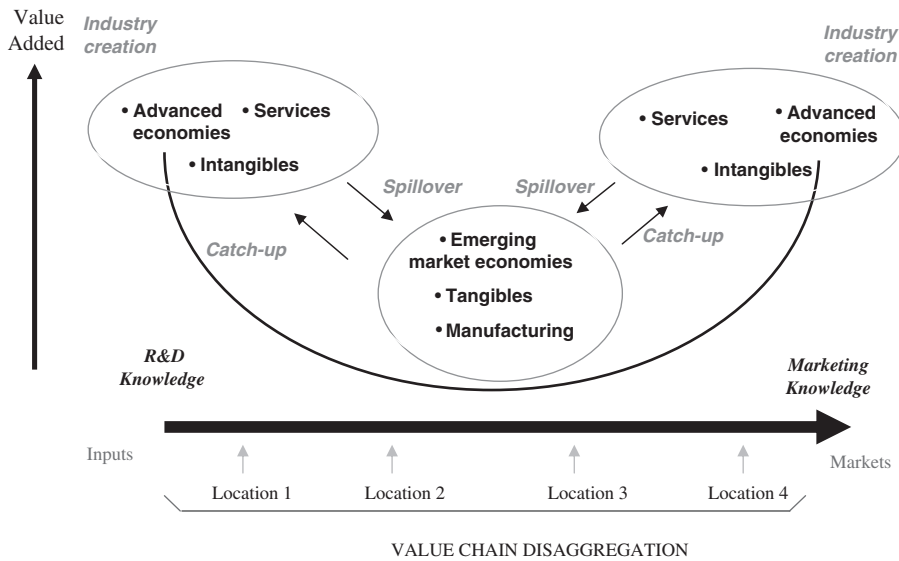


Figure 2. The smile—dynamic analysis.

Phelps, 2008). They are attempting to develop capabilities to ‘catch-up’ with rivals based in advanced market economies.

Firms that control the ends of the value chain, mostly from advanced market economies, are faced with an increasingly competitive landscape, including aggressive new entrants from emerging market economies intent on catching up. They have strong incentives to increase the efficiency and effectiveness of the high value-added activities that they control. Modularization enables these firms to strip out standardized activities from both the upstream R&D and downstream marketing activities that can then be relocated to emerging market economies. Thus, as firms like Microsoft and IBM locate R&D sites in India they improve the cost efficiency of their overall R&D operations. The high value-added local activities of such MNEs create knowledge ‘spillover’ into emerging market economies.

The two processes can act in concert when MNE subsidiaries established with the objective of controlling cost through implementing low level tasks, evolve over time to compete for more advanced mandates within the firm. This process of subsidiary evolution is well documented (Cantwell and Mudambi, 2005). Motorola’s Singapore subsidiary may be considered a case in point (Natarajan and Tan, 1992).

Finally, the ends of the ‘smile’ are not static. Innovation at these two ends is the essence of Schumpeterian entrepreneurship (Schumpeter, 1934). New industries emerge from basic and applied R&D at the upstream end (e.g. biotech, nanotech) and through marketing and distribution innovations at the downstream end (e.g. e-tailing, online auctions). At the moment, this process is overwhelmingly concentrated in advanced market economies. The process of ‘industry creation’ is the manifestation of Schumpeter’s gale of creative destruction. It accelerates obsolescence in advanced market economies and pressures some sunset industries to relocate to emerging market economies.

3. An illustration: the mobile handset industry

The mobile handset industry provides a particularly useful setting to illustrate both the micro and macro aspects of the theory developed in this article.⁹ Mobile handsets are the product of the successful convergence of technology and design aimed at fitting into cultural and lifestyle niches. They are rapidly morphing from 'technological objects' into key 'social objects'. Firms in the industry strive to provide mobility to a range of desired functionalities, ranging from simple internet access through audio and video entertainment to social networking. As with personal computers, consumers want mobile devices to serve as platforms to run a wide range of work and leisure applications supplied by creative industries. In this role, the mobile handset industry provides the consumer interface that creative industries use to deliver content like text, audio, video and application services.

Perhaps more importantly, mobile devices are argued to be the linchpin of the next technocultural shift, following personal computing in the 1980s and the Internet in the 1990s (Rheingold, 2002). Super efficient mobile communications (cellular phones, personal digital assistants, wireless paging and Internet-access devices) allow people to connect with anyone, anywhere, anytime. Mobile devices make possible the new convergence of pop culture, cutting-edge technology and social activism. The cultural impact of these devices comes not from the technology itself, but from how people adapt to it and ultimately use it to transform themselves, their communities and their institutions.

Examples abound of new social and cultural activities made possible by mobile devices. 'Lovegetty' devices in Japan light up when a person with the right date potential characteristics appears in the vicinity (Iwatani, 1998). Social networking applications allow users to instantly share experiences using voice, data and video (Donath and Boyd, 2004). Video sharing services like YouTube are increasingly dependent on mobile devices for uploads and viewers. Political activists have used mobile devices to galvanize support and organize demonstrations (Pertierra, 2005) while on the dark side, terrorists have used them to coordinate strikes (van Meter, 2002).

The industry has global importance with sales exceeding \$100 billion and volume growth of 29% in 2004 (Maheshwari, 2005). However, revenue growth in 2004 was more modest at 18%, reflecting the increasing intensity of competition along the lines discussed above. Markets in emerging economies like India and China are expanding rapidly as the penetration rate of mobile devices rises, while markets in most advanced market economies have matured. In all markets, consumers are becoming more design conscious and resistant to standardized offerings. Over the period 1991–2003, the industry has coalesced around a core set of product features in both voice and data communications, reflecting the emergence a dominant design (Koski and Kretschmer, 2007).

Analyzing the industry's value chain reveals the 'smile of value creation'. As illustrated in Figure 3, high value-added activities appear at the ends of the value chain. Firms from emerging market economies like Huawei of China that began as electronics manufacturing service companies, supplying private label products to firms from advanced market economies, are building marketing competencies to develop and

9 This case was developed using secondary sources. Industry studies, consulting reports, company annual reports and web sources were used.

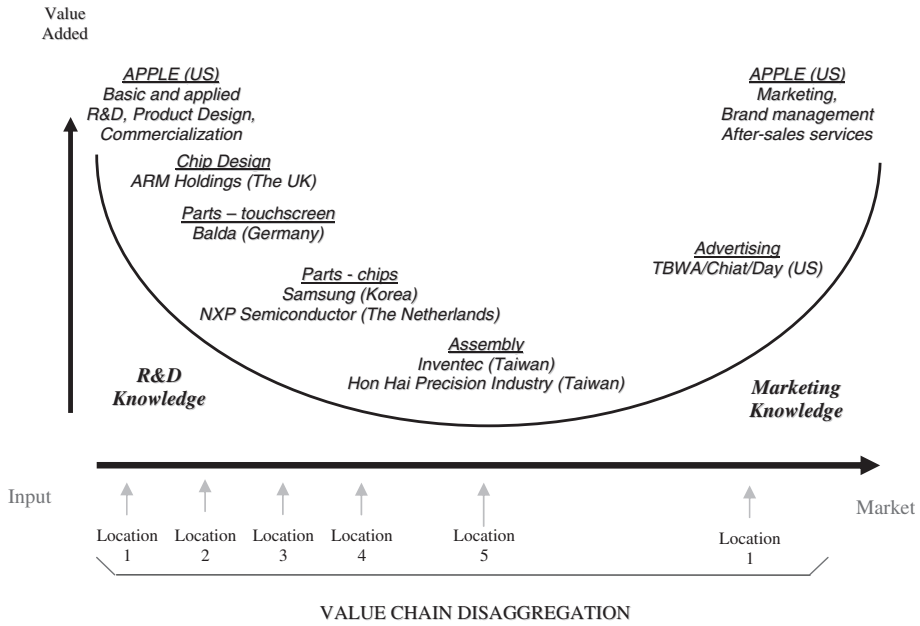


Figure 3. Value creation in the iPhone.

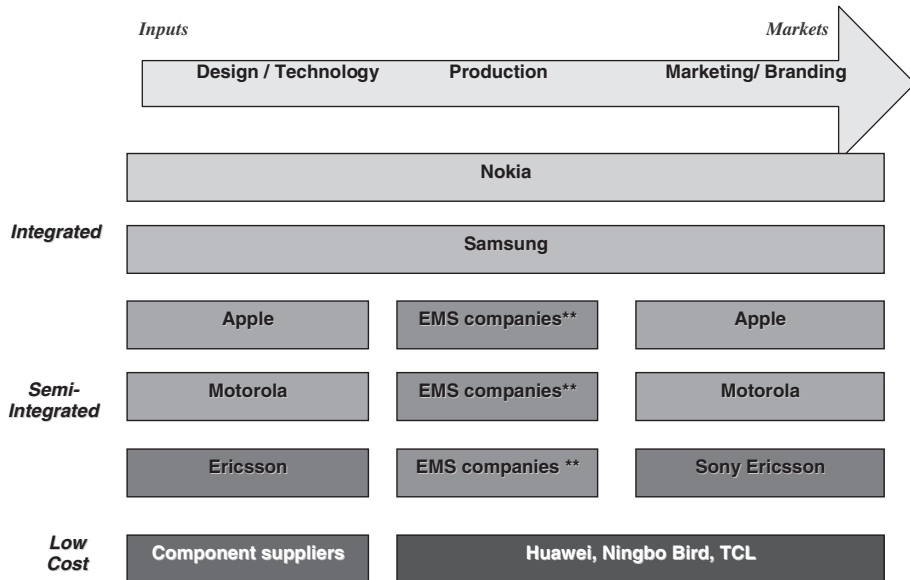


Figure 4. Competitors in the mobile handset industry.
Sources: Gartner Dataquest, HSBC, BCG (**Electronics Manufacturing Service Companies).

support their own brands (Figure 4). At the moment such firms compete on the basis of low cost. However, it is likely that over time their brands will become more valuable. This puts pressure on manufacturers in advanced market economies like Nokia, Motorola, Apple and Ericsson to continually innovate to maintain their high levels of value-added. These established players' innovations are increasingly design driven, recognizing the highly variegated needs of individual markets. All these firms' design strategies are aimed at buttressing and enhancing the value of their brands.

Firms from recently developed countries like Samsung of Korea find themselves pushed to differentiate themselves from their competitors from emerging market economies. This poses a significant challenge since they often remain dependent on suppliers from advanced market economies for their core technologies. For example, in common with Chinese manufacturers, Samsung depends on Qualcomm for its CDMA base-band chips.¹⁰ It has accelerated its R&D efforts to minimize this dependency by attempting to develop its own chipsets. In addition to efforts in manufacturing, it is implementing a design driven strategy with design centers in London and Milan in Europe, Tokyo in Japan and Silicon Valley in the US. However, it faces a creativity challenge, since at the moment it excels 'only in technologies such as . . . mobile phones for which there are industry standards with clear trajectories' (Chang, 2008, p. 58).

Thus, we observe a convergence in the location strategies of all firms in the industry. Firms from advanced market economies, those from emerging market economies and those from recently developed countries are all conforming to the 'smile of value creation'. In the short run, these strategies increase the concentration of high value-added activities in advanced market economies. However, local demands in emerging market economies are already imposing demands on the design capabilities of firms from advanced market economies. Nokia Design, a unit comprising 250 people worldwide has implemented design projects in locations as diverse as Uganda and India. The unit involves psychologists, industrial designers, materials experts and anthropologists. It leverages human behavioral research to deliver location-focused product design.

3.1. Differences in firm strategy and organization

Along with the convergence in location strategies, we observe a divergence in control strategies. Nokia at the high value end and Samsung at the low cost end of the industry, remain highly vertically integrated, while Apple, Motorola and Ericsson have largely outsourced the middle of the value chain. Both strategies are responses to the same pressures being exerted by mobile service providers like Vodafone and AT&T. As service providers face tougher market competition, they are increasingly using the unique software and features (different menus, features, branding, languages, etc.) built into the devices they offer to generate competitive advantage. They want that software to be installed by manufacturers before the handsets leave the factory. Further, they

10 As recently as the end of 2004 no domestic firm in China or Korea had yet grasped the core technology of GSM and CDMA mobile phones. In fact, as of 2004, this was true also for many companies from advanced economies like Japan. The core technologies of chip design were controlled by Texas Instruments, Qualcomm and a few other companies (Ding and Haynes, 2006). This underlines the importance of controlling knowledge assets in this industry.

want the handsets to be capable of supporting an increasingly wide range of application software.

Mobile handset manufacturers have responded and oriented production into two distinct processes. In the first, they build the internal components of the handset, the so-called 'engine'. These are generic devices that can be customized to take on different jobs. In the second process, the raw engines are customized to the requirements of different service providers and markets. Vertically integrated manufacturers retain control over both processes, while so-called 'semi-integrated' players retain design and customization while outsourcing actual manufacture. This organizational divergence may be explored by comparing Nokia on the one hand with Apple on the other.

Nokia is an engineering driven company with a focus on manufacturing excellence. In 2006, it shipped more than 300 million units: twice as many handsets as it did just 4 years earlier. To do so, it handled more than 100 billion parts in its 10 factories scattered around the world.¹¹ These plants are in located advanced market economies as well as in emerging market economies. The challenges of handling such huge volumes are enormous, but over the past 15 years Nokia has turned high tech manufacturing and logistics into one of its core competencies.

Nokia's control of manufacturing enables it to execute the second process of customization extremely rapidly, transforming raw engines into hundreds of thousands of built-to-order phones in a matter of days. The need to control this complex process with the highest precision and quality is the reason Nokia has never chosen to outsource its manufacturing.¹² Indeed, Nokia sees its manufacturing expertise as a key means of enhancing its design skills. Reciprocally, its huge volume and customization requirements put pressure on its design capabilities. In short, Nokia is a firm with high levels of linkage economies.

Apple, on the other hand is a company that focuses on the intangible aspects of its product offering. From its earliest days, it recognized that style and ease of use are as important as substance in terms of developing a brand. This strategic approach implies that it is crucial to control the fundamental building blocks that support the brand, i.e. design and marketing. On the other hand, manufacturing is less important for such a firm.

In the mobile handset industry, Apple's well-known iPhone provides an apt illustration of the implementation of its strategy (Figure 3). Apple controls R&D intensive activities at the upstream end of the value chain and marketing intensive activities associated with brand management at the downstream end. However, the more manufacturing and applications oriented activities in the middle of the value chain are outsourced. These activities are more strongly connected to the tangible aspects of the iPhone and less linked to the intangible aspects. Like Nike, Apple has decoupled the tangible and intangible aspects of its business.

Reinforcing its strategy to appropriate value from intangibles, Apple runs the iTunes, an online service that delivers audio, video and gaming content. While the iTunes service is only marginally profitable in its own right, it is a powerful complementary asset that supports Apple's iPod and iPhone sales (Carr, 2004). The ability of Apple's

11 Source: Nokia annual reports.

12 It does use contractors for a small number of handsets, mainly older models that do not require customization or rapid delivery.

products to run device neutral content like MP3 audio and Mpg video, along with the incompatibility of iTunes with competitors' hardware products establishes a powerful competitive advantage in the crucial link between the device and creative content. Users of Apple's devices face large switching costs since their portfolio of music from iTunes will not work on a rival device.

Apple's focus on the core intangibles within the value proposition has enabled it to take advantage of huge network externalities. It has carved out its own iPod- and iPhone-related community, which has been buttressed by the general acceptance of 'podcasts' (a technology that aggregates audio content into easily downloadable files) by a wide variety of content producers (McFedries, 2005). As complementary products compatible with iPods and iPhones appear in cars, clubs, airlines and commercial establishments to service this community, the so-called iWorld subculture expands and Apple benefits.

Apple's outsourcing pattern conforms to the 'smile of value creation', whereby higher value-added activities are located in the UK and Germany and controlled by firms like ARM Holdings (chip design) and Balda AG (touchscreens). Marketing support activities at the downstream end are located in the US and controlled by firms like TBWA/Chiat/Day. Repetitious manufacturing and assembly is undertaken in Taiwan by firms like Inventec and Hon Hai Precision Industry. Relatively complex items like chips are manufactured to design specifications by Samsung in Korea and NXP Semiconductor in The Netherlands. The subassemblies subsumed within the iPhone may be subjected to similar analysis. Thus, there may be a 'smile' underlying the value chain of Balda's touchscreens. 'Smiles of value creation' may be nested one inside the other, like Russian dolls.

The differences between the vertical integration strategy of Nokia and the specialization strategy of Apple illustrate some fundamental differences in the approaches to generating knowledge, innovation and value in creative industries. The stark differences between the two appear in their approaches to the nexus of control. Apple implements a very high degree of outsourcing, while Nokia is highly vertically integrated. We have argued that one of the key drivers of this difference is the extent of linkage economies. Linkage economies may, therefore, be seen as an aspect of 'organizational architecture' on the basis of which firms to differ in terms of their ability to replicate the intimacy of local networks over long distances (Amin and Cohendet, 2005).

Nokia's manufacturing generates significant economies in its (upstream) design and (downstream) marketing activities and vice versa. This creates strong incentives to choose a hierarchical approach to firm organization, since the marginal value product of investments in manufacturing are relatively high. Apple, on the other hand, has relatively strong brand intangibles. These provide strong incentives to outsource manufacturing, since the marginal value product of investments in manufacturing are relatively low. Conversely, Apple has strong incentives to reinforce its brand as the center of a loyal community by investing in complementary corporate assets like iTunes.

While both Nokia and Apple have geographically dispersed value chain activities, their strategic decisions regarding control affect their location patterns. Nokia maintains manufacturing facilities in Salo, Finland as well as Germany and the UK, in addition to facilities in emerging market economies like China, India, Brazil and Mexico. The location of Apple's outsourced manufacturing is determined more flexibly, since it can simply choose the best partner or supplier for the components that it designs.

Finally, Apple's R&D is focused on specific activities in the value chain. It does not need to spend its R&D budget on activities that are outsourced. Thus, it is able to piggy back and profit from the R&D expenditures of its suppliers. Nokia is obliged to spread its R&D budget over the entire value chain. The two different control strategies, therefore, have direct implications with regard to innovation performance. Apple's focused R&D has produced significantly better financial performance in recent years. Apple's R&D/sales ratio was 3.8% in 2005, compared with Nokia's 11%. However, Apple outperformed Nokia on a wide range of measures of financial performance over the 2001–2005 period, reflecting greater leverage of its R&D spending.¹³

4. Discussion and concluding remarks

The large and growing share of intangibles in wealthy economies underscores the importance of knowledge-intensive and creative industries as the engines of wealth generation, now and into the future. Definitions of what does and what does not constitute a creative industry vary widely and are rapidly overtaken by events. What is clear is that technology and culture are increasingly interlinked and difficult to disconnect. Technology and the resulting tools and devices strongly influence the nature, form and social context of popular culture. In turn devices like the iPod have become inseparable parts of popular culture (McFedries, 2005).

It is also clear that knowledge-based assets are becoming the most important source of value. Strategies to control these assets and their output of content, whether in the form of a design, a video or a software application, are now the key to firm-level value appropriation. The success or failure of such strategies depends crucially on the firm's ability to span the technocultural divide. Apple's relatively successful use of iTunes (Carr, 2004) stands in contrast with the attempts of Hollywood studios to resist technology and create a "closed" sphere of innovation on a global scale' (Currah, 2007). The results of resistance to technological advances can also be seen in the recorded music industry, where record labels continue to push digital music CDs despite plummeting sales (Bockstedt et al., 2006).

4.1. Implications

The current study presents a theoretical analysis of the future of creative processes over geographical space. The evidence presented is based on a case study: it is illustrative and suggestive, but does not provide any conclusive results. Its objective is to highlight and delineate the research questions that should be addressed in more in-depth empirical research.

The implications of this analysis for businesses appear along the two basic nexuses of location and control. There appears to be strong evidence that strategies along the location nexus will lead firms in creative industries to geographically disperse their value chain activities. The evidence here is impossible to ignore (Smakman, 2003; Pyndt and

13 These data were drawn from Apple and Nokia annual reports and other public sources. Financial performance was measured in terms of sales growth, gross margin percentage, gross profit growth, operating margin percentage, operating income growth, total shareholder returns and market capitalization growth. However, using Nokia's larger total sales, its brand was judged to be considerably more valuable than Apple's in 2005 and 2006 by the marketing consulting company, Interbrand.

Pedersen, 2006). The continual dispersion of design, R&D and other creative activities by even smaller firms is moving hand in hand with the emergence of increasingly specialized niche business activities, many of which are strongly anchored in geographic space (Calderini and Scellato, 2005).

However, it appears that two fundamentally different strategies are emerging in terms of how the value chain is controlled. One strategy is based on maintaining high control over both tangible and intangible aspects of the firm's value proposition. Such a strategy is likely to appeal to firms that have relatively strong competencies in repetitive or 'humdrum' activities (Caves, 2000) as well as the ability to link these competencies to the high value-added upstream and downstream activities within the value chain. In other words, such firms have strong linkage economies whereby their repetitive activities become more efficient and their creative activities become more effective through common ownership. The successful value propositions that emerge from such firms are likely to deliver excellence based on a deep understanding of current market expectations. The implication of the above argument is that the vertical integration strategy involves being attuned to and closely following current market demands. It follows that this strategy requires the firm to continually improve the quality and lower the cost of individual activities, while 'the underlying core design concepts, and the links between them, remain the same' (Henderson and Clark, 1990, p. 12), i.e. to excel at incremental innovation.

An alternative strategy is based on focusing on the activities in the value chain that require the highest levels of commercial creativity and generate the highest levels of value-added. Such a strategy is likely to appeal to firms that have relatively stronger competencies at the ends of the value chain in design and marketing. Specialized firms that outsource their repetitive activities to focused suppliers (that therefore do not enjoy linkage economies) may not be able to match the costs of their vertically integrated rivals. This disadvantage implies that for specialized firms to survive and excel, they must look beyond the expectations of the existing market by developing entirely new value propositions. The specialization strategy involves predicting where the market is going and leading it.

Firms that implement specialized strategies often create and maintain competitive advantage by reconfiguring existing core technologies in novel ways i.e. through 'architectural innovation' (Henderson and Clark, 1990). Architectural innovation falls between incremental innovation, where vertically integrated firms are likely to have an edge and radical innovation where considerations of uncertainty are so acute that it is difficult to fund within the firm. Firms with specialized strategies implementing successful architectural innovation make 'modest changes to the existing technology . . . that have quite dramatic competitive consequences' (Henderson and Clark, 1990, p. 10).¹⁴ In short, successful architectural innovation requires developing and controlling system design by, for example, black-boxing proprietary intellectual assets.

A successful specialized strategy also requires the implementation of modularization. For instance, in the case of manufacturing, individual technologies must be compartmentalized, developed as modular subassemblies and contracted to specialist suppliers

14 In the formative years of the personal computer industry in the late 1970s and early 1980s, Apple implemented a specialized strategy, focusing on a novel system architecture made up of relatively modest (and outsourced) component technologies (Christensen, 1997). This control of system design and outsourcing of modular components persists in the iPhone as seen in Figure 3.

as illustrated by the example of the iPhone (Figure 3). Activities in the value chain must be decoupled from each other. Coordination across organizational boundaries and orchestration of the entire network is particularly important to the success of modularization (Dhanaraj and Parkhe, 2006).

4.2. Propositions for future research

A number of testable propositions emerge from the above analysis. Greater vertical integration based on linkage economies should enhance a firm's advantage in delivering excellence to an existing customer base. Further, a greater extent of vertical integration is likely to be associated with a tendency to favor incremental innovation. Vertical integration also implies that intra-firm coordination of value chain activities is a crucial source of competitive advantage, while modularization is relatively less important. The firm tends to be better at in-house cross-functional innovation.

By the same token, specialized firms are likely to counter these advantages by developing new value propositions, aimed at extending the existing customer base or developing a new one. This strategy is more likely to be associated with architectural innovation. Firms implementing a specialized strategy are likely to use modularization as a crucial basis of competitive advantage and to develop more sophisticated external networks as noted in the example of the US motion picture industry (Scott, 2005).

The high linkage economies that increase the attractions of vertical integration are likely to lead to continually falling costs in repetitive activities and improved quality in knowledge-intensive activities. Low linkage economies that predispose the firm towards a specialization strategy also increase the appeal of technology black boxing and modularization. Both strategies of vertical integration and specialization become self-reinforcing, so that firms are unlikely to switch between the two. It is unclear that either strategy dominates the other. Both are knowledge-based strategies that generate value on the basis of creative endeavors.

In terms of economic geography, the specialization strategy is based on the cost-driven outsourcing of standardized activities to local firms in emerging market economies. It is likely that the strategy of specialization will generate greater flexibility, at the firm and geographic levels (Doh, 2005; Graf and Mudambi, 2005). Outsourced activities can be rapidly transferred to competing vendors in alternative locations. Through the industry life cycle, more and more complex activities become commodified and require greater technical and managerial sophistication in the emerging economy supplier network (Ernst and Lim, 2002). This process supports capability formation in the emerging economy and provides the basis for local firms to begin the process of 'catch-up'. As the catch-up process gathers steam, emerging economy firms, often from these supplier networks, begin making competency-seeking R&D investments in advanced market economies. Thus, a critical research question concerns whether firms implementing a specialized strategy will lose the key complementary knowledge assets associated with standardized activities and become technologically hollow over time.¹⁵

15 Examples abound of firms that transferred technology to outsourcers in emerging market economies only to be eventually surpassed and supplanted by their former suppliers. In 1981, Schwinn Bicycle Company of Chicago transferred equipment and technology to Giant Bicycles of Taiwan and outsourced millions of bicycles for the US market. Over time Giant drove its former mentor into bankruptcy and today is the dominant firm in the industry (Witte, 2004).

The strategy of vertical integration is also driven by cost considerations. However, since the need for modularization and black boxing is considerably lower and firm-specific knowledge tends to be geographically bounded (Pinch et al., 2003; Henderson et al., 2005), the firm retains a wider repository of activities and competencies in advanced market economies. It also has a lower risk of finding itself without key competencies as technology trajectories change. It is more resilient in institutional contexts with weak intellectual property rights, since it transfers less knowledge to its supplier network (Gertler, 2003).

The local activities of the firm in an emerging market economy are nonetheless likely to create opportunities for ‘spillover’ as cost pressures drive it to locate increasingly creative and knowledge-intensive activities there. Local wholly owned units of MNEs function as hubs of local networks within which there are inevitable intentional and unintentional knowledge flows (Carlsson and Mudambi, 2003). Over time, local firms in the network arise as competitors to their MNE partners (Ding and Haynes, 2006).

Finally, the entire dynamic system is driven by the entrepreneurial process of ‘industry creation’ at the two ends of the value chain. This process has a strong cultural component as the boundary between arts and commerce is becoming increasingly blurred (Caves, 2000). More and more creative firms are recognizing that technology platforms can enrich their interface with their customers or audiences. Conversely, business firms are recognizing that their brands, suitably managed, can be leveraged to become the hubs of virtual communities, enhancing their presence in the popular culture. Ironically, the extent to which firms and locations can benefit from the entrepreneurial value propositions that they create depends on the extent to which the key creative and knowledge assets are embedded within organizational and geographical boundaries, and, therefore, resistant to imitation by rivals in competing locations (Maskell and Malmberg, 1999). Success in this dynamic environment depends on not only creating value, but also appropriating it.

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Appendix A

Consider a value chain composed of two processes—downstream and upstream. Define the downstream firm to be the focal firm that uses an input k . The quantity of the input used by the downstream firm is denoted by k_i . The downstream firm's production function is denoted by

$$q(k_i), q' > 0, q'' < 0.$$

The production function $q(\cdot)$ can be generalized to include multiple inputs without affecting any of the analysis presented here.

The upstream production function may be written as

$$k_T = g(z_T), g' > 0, g'' < 0.$$

where z is the upstream input. For simplicity, it is assumed that the upstream input ‘ z ’ produced using a constant returns technology in a competitive market. Therefore, it is available at the competitive price (equal to marginal cost) and this is denoted by ‘ c ’.

The downstream producer can produce the input in-house at an average cost of $\rho(k_i)$ per unit. There are economies of scale in the production of k so that $\rho' < 0$.

Alternatively, the downstream firm can purchase the input k in the market from an upstream firm at a price of ‘ r ’ per unit. The upstream producer sells the input to ‘ n ’ downstream firms and its optimal price may be written as:

$$r^* = r(k_T), \quad \text{where } k_T = \sum k_j, j = 1, 2, \dots, n$$

Normalizing the downstream price to unity, the downstream profit may be written as:

$$\Pi^d(k_i) = q(k_i) - (1 - \theta)r(k_T)k_i - \theta \rho(k_i)k_i \quad (1)$$

A fraction θ of the input k is produced in-house while a fraction $(1-\theta)$ is outsourced to the external upstream producer.

The corresponding upstream profit may be written as:

$$\Pi^u(k_T) = (1 - \theta)[r(k_T)g(z_T) - cz_T]$$

With total vertical integration, $\theta = 1$ and the downstream profit function reduces to

$$\Pi^d(k) = q(k_i) - \rho(k_i)k_i \quad (2)$$

At the other extreme of complete outsourcing, $\theta = 0$ so that

$$\Pi^d(k) = q(k_i) - r(k_T)k_i \quad (3)$$

Within this simple model, firm optimization leads to a corner solution where the downstream firm chooses total vertical integration ($\theta = 1$) or complete outsourcing ($\theta = 0$) of the input. The crucial determinants of organizational choice are (i) the extent of economies of scale in the production of the input k and (ii) the extent of the upstream price markup. The extent of the price markup depends mainly on the market structure of the input good. For a given market structure, the economies of scale in production become the determining factor. (In general, the more competitive the market for the input good, the smaller the price markup.) We will assume a given market structure throughout the analysis, so that we can focus on the production technology.

If economies of scale are strong, the unit cost of internally producing the relatively small requirement of the input is very high. The external firm’s large production volume ensures that even with the price markup, $r(k_T) < \rho(k_i)$. The firm’s optimal organization involves complete outsourcing.

On the other hand, if economies of scale are weak, the relatively small volume of internal production is not such a disadvantage and the associated unit cost of is not very high. Corresponding, the external firm’s large volume is not such an advantage, so that $r(k_T) > \rho(k_i)$. The firm’s optimal organization involves total vertical integration.

The model may be generalized to introduce economies of scope by setting up either the downstream production function $q(\cdot)$ or the upstream production function $g(\cdot)$ (or both) to include multiple outputs (as vector-valued functions). Economies of scope are measured in terms of the effect of the level of one output on the marginal product of another output. The basic insights from the simple model carry over to this more

general model. (The details are not presented in interests of brevity.) For a given level of economies of scale, stronger economies of scope make vertical integration more attractive as they reduce the burden of small internal production volume. Weaker economies of scope raise the unit costs of internal production and make outsourcing more attractive.

Economies of experience may also be included at the expense of some cumbersome notation. The average cost function of in-house production of the upstream input is time variant and includes cumulative production as a second argument. At time 't' this specification is written as:

$$\rho_t \left(k_{it}, \sum_{s=1}^{t-1} k_{is} \right), \rho_{t1} < 0, \rho_{t2} < 0.$$

This specification incorporates both economies of scale ($\rho_{t1} < 0$) and experience ($\rho_{t2} < 0$). Greater economies of experience, *ceteris paribus*, lower average costs and make outsourcing less attractive.

Finally, economies of sequence arise when quantity of downstream production appears as an argument reducing the average cost function of in-house production of the upstream input (Spulber, 1989). The general Coasian insight remains intact all these situations—the firm makes its optimal organizational choice by comparing internal production with outsourcing.

Economies of scale, scope and experience relate separately to the production functions at each stage of the value chain. Thus, the production functions $q(\cdot)$ and $g(\cdot)$ independently display economies of scale and generate the relevant cost functions. Similarly, when $q(\cdot)$ and $g(\cdot)$ are set up to include multiple outputs, economies of scope measured in terms of the effect of the level of one output on the marginal cost of another output. Economies of experience are measured in terms of the effect of cumulative past output on current costs. None of these economies relate the two functions $q(\cdot)$ and $g(\cdot)$.

However, there is considerable empirical evidence that suggests that joint control of the production functions $q(\cdot)$ and $g(\cdot)$ can affect the efficiencies of each. In other words, this is the extent to which the control of upstream production improves the efficiency of the downstream production process and vice versa. Since these economies arise from linking different production processes we define these to be 'linkage economies'. We may rewrite Equation (1) to include linkage economies in the following form:

$$\Pi^d(k) = q[(1 + \theta)^{\alpha(i)} k_i] - (1 - \theta)r(k_T)k_i - \theta \rho(k_i)k_i \quad (4)$$

In other words, the productivity of the input k depends on the extent of vertical integration. The parameter $\alpha(i)$ is a measure of the extent of linkage economies. In this specification, $\alpha(i) = 0$ is a situation of no linkage economies so that Equation (4) collapses to Equation (1). Whenever $\alpha(i) > 0$, we have positive linkage economies, i.e. increasing vertical integration increases the efficiency of the input k in the downstream production process. This can occur either through innovation or improved quality (which increases effective output by reducing the rejection rate). If $\alpha(i) < 0$, we have linkage diseconomies, so that increasing vertical integration actually reduces the

efficiency of the input k . The existence of coordination and scheduling costs would suggest that in most cases, $\alpha(i) \geq 0$.

The indicator 'i' in the measure $\alpha(i)$ is a specification that implies that linkage economies are firm-specific. In other words, two firms in the same industry may have different levels of linkage economies. This perspective strongly differentiates linkage economies from economies of scale, scope, experience and sequence.

Economies of scale, scope and experience are largely based on technology and are generally common across leading edge firms in an industry (Mansfield, 1985; Pavitt 1998). Economies of sequence also have in-built performance implications, so that for firms with access to a common technology, *ceteris paribus*, the optimum extent of vertical integration is the same (Spulber, 1989). Therefore, none of these theoretical concepts can be used to explain the observed intra-industry diversity in firm organization. On the other hand, linkage economies are explicitly firm specific and vary across firms even when the underlying technologies being implemented are common (Rosenberg, 1982, p. 257).

Thus, a firm with strong linkage economies (say, firm A) and a firm with weak linkage economies (say, firm B) may coexist within the same industry. Firm A is likely to be more vertically integrated while firm B is likely to undertake more outsourcing. However, the concept of linkage economies has further implications regarding the processes implemented in the two firms. Since firm A has a higher level of linkage economies, it is likely to have superior internal production processes as these get progressively enhanced. Since firm B has a higher level of outsourcing, it is likely to be more reliant on economies of scale at its supplier firms. Over time, it is likely that firm A will be more focused on production excellence within the entire vertically integrated value chain. Firm B is more likely to be focused on excellence in the specific niches of the value chain over which it retains control.