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The New Mobility of Knowledge: Digital Information Systems and Global Flagship Networks

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INTRODUCTION

Even the most “market-friendly” governments agree that knowledge is critical for sustaining economic growth and welfare. Hence the focus of policy-makers has shifted to improving the economy’s capacity to create, disseminate and use specialized knowledge more quickly and efficiently. There is a widespread belief that if national governments manage to build robust knowledge-based societies, globalization may become an opportunity rather than a threat (OECD, 1999). An important assumption underlying these policies is that knowledge and skills are stickier in space (i.e. less mobile) than finance or production facilities (Enright, 1998; Markusen, 1996).

This assumption however becomes increasingly problematic in a globally connected “digital economy”. We argue that the mobility of knowledge will increase, due to a combination of two forces: the rapid development and diffusion of digital information systems (DIS), and the spread of flagship-dominated global networks. These changes in corporate (IT-based) networking practices will have far-reaching implications for international cooperation and conflict. If knowledge becomes more spatially fluid, this could provide new opportunities that lower-tier network suppliers should strive to exploit. The combined forces of GFN and DIS may provide new opportunities, pressures and incentives for local firms in developing economies to upgrade their capabilities, provided appropriate policies and support institutions are in place. However, they may also erode the competitiveness of existing clusters and obstruct attempts to upgrade them.

Yet very little is known about what precisely is happening, and about the drivers and impacts of these processes. While large bodies of theoretical and applied work exist

on the individual topics of DIS, the international dimension of corporate networks, and international knowledge diffusion, their mutual interaction is still mostly uncharted territory. There is a need to bridge this gap through “appreciative theories”, as defined in Richard Nelson’s thought-provoking review of economic growth theory (1995)¹.

This paper develops a conceptual framework that links together the above three areas of research, as a first step towards an appreciative theory. We first introduce a new agenda for the economic study of knowledge that reflects the co-evolution of DIS and trans-boundary forms of corporate networking practices. We then highlight forces that drive the development of IT-enabled GFN, and look at the economic structure and peculiar characteristics of the flagship network model that foster the new mobility of knowledge. In a fourth step, we explore prerequisites for knowledge diffusion through GFN. We conclude by assessing resulting policy challenges.

1. A NEW AGENDA FOR THE ECONOMIC STUDY OF KNOWLEDGE

Empirical research on recent globalization trends has shown important transformations. Historically, the main drivers have been multinational corporations (MNCs) which have been around for a long time (e.g., Wilkins, 1970). Until recently, however, their international production has focused on the penetration of protected markets through tariff-hopping investments, and on the use of assets developed at home to exploit international factor cost differentials, primarily for labor (e.g., Dunning, 1981).

¹ In contrast to formal growth theories, appreciative theories do not attempt to compress stylized facts into rigorous formulations. Rather, an attempt is made to include more of the observed empirical richness of IT and transformations in business organization than formal theories. This of course comes at the cost of being unable to model these relationships mathematically. Hence the need for formal theories. But for the latter to be fruitful, they need to be based on appreciative theories, and on the findings of case studies and econometric analysis.

This has given rise to a peculiar pattern of international production: offshore production sites in low-cost locations are linked through triangular trade with the major markets in North America and Europe (e.g., Dicken, 1992).

A progressive liberalization and deregulation of international trade and investment, and the rapid development and diffusion of information and communication technology (IT) have fundamentally changed the global competitive dynamics, in which MNCs operate. While both market access and cost reductions remain important, it became clear that they have to be reconciled with a number of equally important requirements that encompass: the exploitation of uncertainty through improved operational flexibility (e.g., Kogut, 1985; and Kogut and Kulatilaka, 1994); a compression of speed-to-market through reduced product development and product life cycles (e.g., Flaherty, 1986); learning and the acquisition of specialized external capabilities (e.g., Antonelli, 1992; Kogut and Zander, 1993; Zander and Kogut, 1995; Zanfei, 2000; Dunning, 2000); and a shift of market penetration strategies from established to new and unknown markets (e.g., Christensen, 1997).

In response to the increasingly demanding requirements of global competition, three interrelated transformations have occurred in the organization of international economic transactions. We argue that the combination of these three transformations has substantially increased the mobility of knowledge. First, there is a new divide in industrial organization: a transition is under way from “multinational corporations”, with their focus on stand-alone overseas investment projects, to “global network flagships” that integrate their geographically dispersed supply, knowledge and customer bases into global (and regional) production and knowledge networks (GFN) (Ernst, forthcoming).

These networks help the flagships to sustain their competitiveness, by providing them with access to specialized suppliers at lower-cost locations who excel in quick and flexible response to the flagships' requirements.

Second, GFN have acted as a catalyst for international knowledge diffusion, providing a combination of new opportunities, pressures and incentives for local suppliers to upgrade their capabilities. Opportunities include exposure to the flagship's management practices and technological knowledge, involving a substantial amount of tacit knowledge. Equally important are pressures and incentives for local suppliers to invest in their knowledge base and capabilities.

Third, a long-term process of developing digital information systems (DIS) has enabled the same infrastructure to accommodate manipulation and transmission of voice, video, and data (Chandler and Cortada, 2000). The use of DIS as a management tool has experienced three important transformations (Nolan, 2000). From a machine to automate transaction processing, the focus has shifted to the extraction of value from information resources, and then further to the establishment of Internet-enabled flexible information infrastructures that can support the extraction and exchange of knowledge across firm boundaries and national borders. Compared to earlier generations of DIS, the Internet appears to provide much greater opportunities to share knowledge with a much greater number of people faster, more accurately, and in greater detail, even if they are not permanently co-located (Ernst, 2000b, 2001a, and 2001b)². This has created new

² While such forms of interactive learning across borders are still exceptional, they illustrate nevertheless a huge potential for reorganizing the global chain of knowledge creation. Once these developments gather momentum, they will have dramatic implications for established localized clusters. But when this happens, it may be too late to start research on this topic.

opportunities for extending knowledge exchange across organizational and national boundaries, hence magnifying the first two transformations.

If these propositions are correct, the combined forces of globalization and DIS may have serious implications, not the least for developing economies: the competitiveness of existing clusters may erode, as the mobility of knowledge becomes less constrained in space. However, new opportunities may also emerge as enhanced mobility of knowledge may contribute to an upgrading of such clusters. This describes a new agenda for the economic study of knowledge: Do GFN and DIS make knowledge spatially fluid? How will this affect the spatial distribution of knowledge? And what does this imply for policy-making?

2. FORCES DRIVING GLOBAL FLAGSHIP NETWORKS

What has driven the shift in industrial organization from “multinational corporations” to “global network flagships” that integrate their dispersed supply, knowledge and customer bases into global (and regional) production and knowledge networks? To answer this question, we introduce a stylized model of globalization drivers, focusing on three inter-related explanatory variables: institutional change through liberalization, information and communications technology (IT), and competition.

2.1 Institutional Change: Liberalization

North (1996; 12) defines institutions as “the rules of the game of a society that structure human interaction.” They are composed of formal rules (statute law, common law, regulations), informal constraints (conventions, norms of behavior, and self-imposed codes of conduct), and the enforcement characteristics of both. Institutions shape the

allocation of resources, the rules of competition and firm behavior. Liberalization affects all aspects of institutions, but at different speed. While changes will first affect formal rules, informal constraints and enforcement mechanisms are more difficult to change. This implies that there is no homogeneous model of liberalization, but many different and often hybrid forms.

We take liberalization as convenient shorthand for institutional changes that affect globalization. Liberalization dates back to the early 1970s: it thrived in response to the breakdown of fixed exchange rate regimes and the failure of Keynesianism to cope with pervasive stagflation. To a large degree, it has been initiated by government policies. But there are also other actors that have played an important role: financial institutions; rating agencies; supra-national institutions like bi-lateral or multi-lateral investment treaties and regional integration schemes, like the EU or NAFTA. In some countries with decentralized devolution of political power, regional governments can also play an important role.

Liberalization covers four main areas: trade, capital flows, FDI policies, and privatization. While each of these has generated separate debates in the literature, they hang together. Earlier success in trade liberalization has sparked an expansion of trade and FDI, increasing the demand for cross-border capital flows. This has increased the pressure for a liberalization of capital markets, forcing more and more countries to open their capital accounts. In turn this has led to a liberalization of FDI policies, and to privatization tournaments.

The overall effect of liberalization has been a considerable reduction in the cost and risks of international transactions and a massive increase in international liquidity.

Global corporations (the network flagships) have been the primary beneficiaries: liberalization provides them with a greater range of choices for market entry between trade, licensing, subcontracting, franchising, etc. (*locational specialization*) than otherwise; it provides better access to external resources and capabilities that a flagship needs to complement its core competencies (*outsourcing*); and it has reduced the constraints for a geographic dispersion of the value chain (*spatial mobility*).

We also need to emphasize a perplexing result: as liberalization has been adopted as an almost universal policy doctrine, it has lost much of its earlier power to influence locational decisions. As their FDI policies become indistinguishable, host countries are forced to differentiate themselves by other means, and to implement much more aggressive policies. The result has been a rapid proliferation of complementary policies geared to “business facilitation” and the “development of created assets” (Dunning, 2000). This explains why a replication of clustering effects at multiple locations may now have greater chances than before.

2.2 The Dual Impact of Information and Communication Technology

A second important driver of GFN has been the rapid development and diffusion of cheaper and more powerful information and communication technologies (IT) (e.g., Sichel, 1997, and Flamm, 1999) that has culminated in the Internet (Naughton, 2000; Abbate, 2000). A combination of technological and economic developments is responsible for the transformation of DIS as a management tool from automation to information resource management, and then on to Internet-enabled cross-border knowledge management (Ernst, 2001e).

On the technology side, the move towards “open standards” in DIS architecture (UNIX, Linux, and HTML) and protocols (TCP/IP) enabled firms to integrate their existing intranets and extranets³ on the Internet, which, by reducing cost and by multiplying connectivity, dramatically extended their reach across firm boundaries and national borders.

On the economic side, increasingly complex information requirements resulted from the long-standing trend toward vertical specialization (Mowery and Macher, 2001). As firms now have to deal with constantly changing, large numbers of specialized suppliers, they need flexible and adaptive information systems to support these diverse linkages. These requirements became ever more demanding, as flagships attempt to integrate their dispersed production, knowledge and customer bases into global and regional flagship networks (GFN) (see below).

Second, far-reaching changes in work organization have fundamentally increased the requirements for information management and for the exchange of knowledge (e.g., Ciborra et al, 2000). The transition from Fordist “mass production” to “mass customization” requires a capacity to constantly adapt products or services to changing customer requirements, “sensing and responding” to individual customer needs in real time (Bradley and Nolan, 1998)⁴. This necessitates dynamic, interactive information systems, and a capacity to rapidly adjust GFN to disruptive changes in markets and technology. Third, real-time resource allocation, performance monitoring and accounting became necessary, due to the short-term pressures of the financial system (quarterly

³ An “intranet” is defined as a private network contained within an organization (a firm) that consists of many inter-linked LANs (= local-area networks). Its main purpose is to share company information and computer resources among employees. An “extranet” in turn is a private network that links the flagship via conventional telecommunications networks with preferred suppliers, customers and strategic partners.

reports) and due to the shortening life cycles of products and technologies. Fourth, to cope with ever more demanding competitive requirements, firms have to continuously adapt their organization and strategy. Internet-enabled computer networking thus can act as a powerful catalyst for organizational change.

The increasing use of DIS has had a dual impact: it has increased the need for globalization, while at the same time facilitating this process. This argument is based on two propositions. First, the cost and risk of developing DIS has been a primary cause for *market* globalization: international markets are required to amortize fully the enormous R&D expenses associated with rapidly evolving process and product information technologies (Kobrin, 1997, p.149). Of equal importance are the huge expenses for developing and implementing DIS, a process that can exhaust the financial means of even the largest global flagships (Brynjolfsson and Hitt, 2000; Ernst and O'Connor, 1992: chapter 1). As the extent of a company's R&D effort is determined by the nature of its technology and competition rather than its size, this rapid growth of R&D spending requires a corresponding expansion of sales, if profitability is to be maintained. No national market, not even the US market, is large enough to amortize such huge expenses.

A second proposition explains why international production, rather than exports, has become the main vehicle for international market share expansion. Of critical importance has been the enabling role played by DIS. These systems substantially increase the mobility, i.e. *dispersion* of firm-specific resources and capabilities across national boundaries. They also provide greater scope for cross-border linkages, i.e. the *integration* of dispersed specialized clusters. This has substantially reduced the friction of

⁴ For good reason, this has given rise to concern about invasion of data privacy.

time and space, both with regard to markets and production: a firm can now serve distant markets equally well as local producers; it can also now disperse its value chain across national borders in order to select the most cost-effective location.

There are widespread expectations that the Internet, the latest incarnation of digital convergence, may further accelerate these transformations (e.g., Department of Commerce, 2000). By transmitting information in digital format instantly, and at much lower cost than earlier technology generations (like electronic data interchange, EDI), the Internet substantially broadens the scope for collaboration across organizational and national boundaries. A new generation of networking software provides flexible infrastructures that, computer scientists claim, “support not only information exchange, but also knowledge sharing, creation and utilization.” (Jørgensen and Krogstie, 2000). The key is the open-ended structure of the Internet, which allows extra networks to be added at any point, creating almost unlimited opportunities for outsourcing and the diffusion of knowledge.

Surprisingly, the impact of the Internet on business organization is still a largely neglected research topic. Until recently, important contributions to information management neglect and hardly mention the Internet and the world-wide web⁵. Very little research exists on how the Internet reshapes business strategy and organization, and how

⁵ An important book like Strategic Planning for Information Systems (Ward and Griffiths, 1996) mentions the Internet just once, but then as a synonym for the information super highway. And the edited volume Global Information Technology and Systems Management (Palvia et al, 1996) mentions the Internet briefly three times on its more than 600 pages, but fails to provide an explicit analysis.

this affects industry structure⁶. Even less research exists on how the Internet transforms international aspects of business networks⁷.

Following Brynjolfsson and Hitt (2000), we argue that the impact of the Internet on economic performance is mediated by a combination of intangible inputs as well as intangible outputs that act as powerful catalysts for organizational innovations. Intangible inputs include, for instance, the development of new software and databases; the adjustment of existing business processes; the recruitment of specialized human resources and their continuous upgrading; and, induced by all of this, the transformation of existing organizational structures and business strategies. Of equal importance are intangible outputs that would not exist without the Internet, like speed of delivery, flexible customization, the transition to a built-to-order (BTO) production model, and improved customer-relations management (CRM).

After a while, these induced organizational changes lead to productivity growth, by reducing the cost of coordination, communications and information processing. Most importantly, these organizational changes enable firms “to increase output quality in the form of new products or in improvements in intangible aspects of existing products like convenience, timeliness, quality and variety.” (Brynjolfsson and Hitt, 2000, p.4). In short, we are talking about a complex process that involves a set of inter-related (“systemic”) changes: by combining the Internet with changes in work practices, strategies, and

⁶ Noteworthy exceptions are Nolan (2000), Hagstrøm (2000), Brynjolfsson and Hitt (2000), and Evans and Wurster (2000).

⁷ On the impact of the Internet on GFN, see Mowery and Macher (2001), Luethje (2001) and Ernst (2000b, 2001a, and 2001b). On Internet-enabled knowledge exchange, see Lerner and Tirole (2000), and Weber (2001).

products and services, a firm transforms its organization as well as its relations with suppliers, partners and customers.

Once we adapt such a framework, it becomes clear that the possible benefits from an Internet-enabled transformation of business organizations are enormous. The Internet provides ample scope for cost reduction across all stages of the production process both for the flagship company and Asian suppliers. Procurement costs can be reduced by means of expanded markets and increased competition through Internet-enabled online procurement systems. Another cost-reducing option is to shift sales and information dissemination to lower-cost on-line channels.

The Internet can also drastically accelerate speed-to-market by reducing the time it takes to transmit, receive, and process routine business communications such as purchase orders, invoices, and shipping notifications. The Internet has greatly expanded the scope for information management: documents and technical drawings can be exchanged in real time, legally recognized signatures can be authenticated, browsers can be used to access the information systems of suppliers and customers, and transactions can be completed much more quickly.

A further advantage can be found in the low cost of expanding a functioning network. While establishing a network requires large upfront fixed investment costs (purchasing equipment, laying new cable, training), the cost of adding an additional user to the network is negligible. The value of the network thus increases with the number of participants (“network externalities”). An especially important benefit is a reduced trade-off between the richness and the reach of information (Evans and Wurster, 2000). Until recently, more complex, detailed, nuanced information could only be shared by a very

small number of people; in-creasing the “reach” of such information sharing requires a reduction in “richness.” The Internet provides far greater opportunities to share rich information with a far greater number of people⁸.

In addition, the Internet and related organizational innovations provide effective mechanisms for constructing flexible infrastructures that can link together and coordinate knowledge exchange between distant locations (Hagström, 2000; Pedersen et al, 1999; Antonelli, 1992). This has important implications for organizational choices and locational strategies of firms. In essence, Internet-enabled DIS foster the development of leaner, meaner and more agile production systems that cut across firm boundaries and national borders. The underlying vision is that of a *network of networks* that enable a global network flagship to respond quickly to changing circumstances, even if much of its value chain has been dispersed.

2.3 Competition and Industrial Organization

Both liberalization and DIS have drastically changed the dynamics of competition. Again, we reduce the complexity of these changes and concentrate on two impacts: a broader geographic scope of competition; and a growing complexity of competitive requirements. Competition now cuts across national borders - a firm’s position in one country is no longer independent from its position in other countries (e.g., Porter, 1990). This has two implications. The firm must be present in all major growth markets (*dispersion*). It must also integrate its activities on a worldwide scale, in order to exploit and coordinate linkages between these different locations (*integration*). Competition also cuts across sector boundaries and market segments: mutual raiding of

⁸ The book by Evans and Wurster has been widely quoted. Unfortunately, their terminology is confusing. I

established market segment fiefdoms has become the norm, making it more difficult for firms to identify market niches and to grow with them.

This has forced firms to engage in complex strategic games to pre-empt a competitors' move. This is especially the case for knowledge-intensive industries like electronics (Ernst, 2001d). Intense price competition needs to be combined with product differentiation, in a situation where continuous price wars erode profit margins. Of critical importance, however, is speed-to-market: getting the right product to the largest volume segment of the market right on time can provide huge profits. Being late can be a disaster, and may even drive a firm out of business. The result has been an increasing uncertainty and volatility, and a destabilization of established market leadership positions (Richardson, 1996; Ernst, 1998).

This growing complexity of competition has changed the determinants of firm organization and growth, as well as the determinants of location. No firm, not even a dominant market leader, can generate all the different capabilities internally that are necessary to cope with the requirements of global competition. Competitive success thus critically depends on a capacity to selectively source specialized capabilities *outside* the firm that can range from simple contract assembly to quite sophisticated design capabilities. This requires a shift from individual to increasingly collective forms of organization, from the multidivisional (M-form) functional hierarchy (e.g., Williamson, 1975 and 1985; Chandler, 1977) of “multinational corporations” to the networked global flagship model.

prefer a distinction between codified and tacit knowledge. See, Ernst, Fagerberg, Hildrum, 2001

Take the electronics industry, which has become the most important breeding ground for this new industrial organization model. Over the last decades, a massive process of vertical specialization has segmented an erstwhile vertically integrated industry into closely interacting horizontal layers (fig.1)(Grove, 1996). An important catalyst was the availability of standard components, which allowed for a change in computer design away from centralized (IBM mainframe) to decentralized architectures (PC, and PC-related networks). Equally important has been the impact of the Internet that has facilitated the modularization and geographic dispersion of software design and engineering (Ernst, 2001f). This mirrors earlier developments for the manufacturing of electronics hardware. The Internet facilitates the exchange of knowledge between actors that are not permanently co-located.

Fig.1. Vertical Specialization: Electronics Industry

This has given rise to the co-existence of complex, globally organized product-specific value chains (e.g., for microprocessors, memories, board assembly, PCs, operating systems, applications software, and networking equipment). Each of these value chains consists of a variety of GFN that compete with each other, but that may also cooperate (Ernst, 2001c). The number of such networks, and the intensity of competition varies across sectors, reflecting their different stage of development and their idiosyncratic industry structures.

3. THE FLAGSHIP NETWORK MODEL

In short, by integrating their dispersed supply, knowledge and customer bases into global (and regional) production networks, “multinational corporations” are being transformed into “global network flagships”. Until recently, these fundamental changes in the organization of international production have been largely neglected in the literature, both in research on knowledge spill-overs through FDI, and in research on the internationalization of corporate R&D. This is now beginning to change. There is a growing acceptance in the literature that, to capture the impact of globalization on industrial organization and upgrading, the focus of our analysis needs to shift away from the industry and the individual firm to the international dimension of business networks (e.g., Ghoshal and Bartlett, 1990; UNCTAD, 1993; Rugman and D’Cruz, 2000; Birkinshaw and Hagstrøm, 2000).

3.1. Peculiar Features

Let us now look at peculiar features of the concept of a GFN. It covers both intra-firm and inter-firm transactions and forms of coordination (fig.2): a GFN links together the flagship’s own subsidiaries, affiliates and joint ventures with its subcontractors, suppliers, service providers, as well as partners in strategic alliances. A network flagship like IBM or Intel breaks down the value chain into a variety of discrete functions and locates them wherever they can be carried out most effectively, where they improve the flagship’s access to resources and capabilities, and where they are needed to facilitate the penetration of important growth markets. GFN differ from foreign direct investment (FDI) in that a great variety of governance structures is possible. These networks range from loose linkages that are formed to implement a particular project and that are

dissolved after the project is finished⁹, to highly formalized networks, with clearly defined rules, common business processes and shared information infrastructures. What matters is that formalized networks do not require common ownership: these arrangements may, or may not involve control of equity stakes.

Fig.2 The Nodes of a Global Flagship Network

The main purpose of these networks is to provide the flagship with quick and low-cost access to resources, capabilities and knowledge that are complementary to its core competencies. In other words, transaction cost savings matter. Yet, the real benefits result from the dissemination, exchange and outsourcing of knowledge and complementary capabilities. This indicates that GFN also differ from traditional forms of subcontracting: much denser interaction between design and production and other stages of the value chain require substantially more intense exchange of information and knowledge. This reflects the growing reliance of network flagships on the skills and knowledge of specialized suppliers to enhance their core competencies.

A focus on international knowledge diffusion through an extension of firm organization across national boundaries distinguishes our concept of GFN from network theories developed by sociologists, economic geographers and innovation theorists that focus on localized, mostly inter-personal networks (e.g., Powell and Smith-Doerr, 1994). The central problem of these theories is that industries now operate in a global rather than a localized setting (Ernst, Guerrieri et al, 2001). Important complementarities exist

⁹ In the computer networking literature, such arrangements are often called “virtual enterprises” (e.g.,

however with work on global commodity chains (GCC) (e.g., Gereffi and Korzeniewicz, 1994). A primary concern of the GCC literature has been to explore how different value chain stages in an industry (i.e. textiles) are dispersed across borders and how the position of a particular location in such GCC affects its development potential¹⁰.

As for the dynamics of network evolution, our approach complements the transaction cost approach to networks and vertical disintegration that centers on the presumed efficiency gains from these organizational choices (e.g., Williamson, 1985 and 1997; Milgrom and Roberts, 1990). The latter approach skips some of the more provocative chapters in the economic history of the modern corporation. Chandler's vibrant histories (e.g., 1962 and 1990) show that the quest for profits and market power via increased throughput and speed of coordination were more important in explaining hierarchy than the traditional emphasis on transaction costs. This implies that the analysis of the determinants of institutional form must move beyond a narrow focus on transactions costs to the broader competitive environment in which firms operate. It is time to bring back into the analysis market structure and competitive dynamics, as well as the role played by knowledge and innovation. Like hierarchies, GFN not only promise to improve efficiency, but can permit flagships to sustain quasi-monopoly positions, generate market power through specialization, and raise entry barriers; they also enhance the network flagships' capacity for innovation (Ernst, 1997b; Borrus, Ernst, Haggard, 2000: chapter1) .

Pedersen et al, 1999: 16)

¹⁰ Strong complementarities also exist with research on computer-based flexible information infrastructures that frequently uses the terms "extended enterprise" or "virtual enterprise", where the first stands for more durable network arrangements, while the latter for very short-term ones (e.g., Pedersen, 1999; Jørgesen and Krogstie, 2000).

Two distinctive characteristics of GFN that are enhanced by DIS shape the scope for international knowledge diffusion: a rapid yet concentrated dispersion of value chain activities, and, simultaneously, their integration into hierarchical networks.

3.2. Concentrated Dispersion

IT-enabled GFN typically combine a breath-taking speed of geographic dispersion with spatial concentration on a growing, but still limited number of specialized clusters. To simplify, we distinguish two types of clusters: “centers of excellence” that combine unique resources, such as R&D and precision mechanical engineering, and “cost and time reduction centers” that thrive on the timely provision of lower-cost services¹¹. The inclusion of both types of clusters into GFN creates new opportunities for knowledge diffusion between network flagships and local suppliers. Different clusters face different opportunities and constraints, depending on their specialization, and on the product composition of the GFN. The dispersion of clusters differs across the value chain: it increases, the closer one gets to the final product, while dispersion remains concentrated especially for critical precision components (fig.3).

Fig.3. Product Composition and Geographic Dispersion of Clusters

(geo disp nrc.oslo)

Let us look at some indicators in the electronics industry, a pace setter of the flagship network model (Ernst, 2001d). On one end of the spectrum is final PC assembly

¹¹ “Cost & time reduction centers” include the usual suspects in Asia (Korea, Taiwan, China, Malaysia, Thailand, and now also India for software engineering and web services), but also exist in once peripheral locations in Europe (e.g., Ireland, Central and Eastern Europe and Russia), in Brazil, and Mexico in Latin

that is widely dispersed to major growth markets in the US, Europe and Asia. Dispersion is still quite extended for standard, commodity-type components, but less so than for final assembly. For instance, flagships can source keyboards, computer mouse devices and power switch supplies from many different sources, both in Asia, Mexico and the European periphery, with Taiwanese firms playing a major role as intermediate supply chain coordinators. The same is true for lower-end printed circuit boards. Concentration of dispersion increases, the more we move toward more complex, capital-intensive precision components: memory devices and displays are sourced primarily from “centers of excellence” in Japan, Korea, Taiwan and Singapore; and hard disk drives from a Singapore-centered triangle of locations in Southeast Asia. Finally, dispersion becomes most concentrated for high-precision, design-intensive components that pose the most demanding requirements on the mix of capabilities that a firm and its cluster needs to master: microprocessors for instance are sourced from a few globally dispersed affiliates of Intel, two secondary American suppliers, and one recent entrant from Taiwan (Via Technologies).

The hard disk drive (HDD) industry provides another example both for quick dispersion, as well as for spatial concentration (Ernst, 1997b). Until the early 1980s, almost all HDD production was concentrated in the U.S., with limited additional production facilities in Japan and Europe. Today, only 1 percent of the final assembly of HDDs has remained in the US, while Southeast Asia dominates with almost 70% of world production, based on units shipped. Slightly less than half of the world’s disk

America, in some Caribbean locations (like Costa Rica), and in a few spots elsewhere in the so-called RoW (= rest of the world).

drives come from Singapore, with most of the rest of the region's production being concentrated in Malaysia, Thailand, and the Philippines.

Seagate, the current industry leader provides a good example of the flagship model of concentrated dispersion. Today, Seagate operates 22 plants worldwide: 14 of these plants, i.e. 64% of the total, are located in Asia. Asia's share in Seagate's worldwide production capacity, as expressed in sq-ft, has increased from roughly 35% in 1990 to slightly more than 61% in 1995 - an incredible speed of expansion. Concentrated dispersion is also reflected in the regional breakdown of Seagate's employment. Asia's share increased from around 70% in 1990 to more than 85% in 1995.

In short, rapid cross-border dispersion coexists with agglomeration. GFN extend national clusters across national borders. This implies two things: First, some stages of the value chain are internationally dispersed, while others remain concentrated. And second, the internationally dispersed activities typically congregate in a limited number of overseas clusters. This clearly indicates that agglomeration economies continue to matter, hence the path-dependent nature of development trajectories for individual specialized clusters.

3.3. Integration: Hierarchical Layers of Network Participants

A GFN encompasses both intra-firm and inter-firm linkages and integrates a diversity of network participants who differ in their access to and in their position within such networks, and hence face very different opportunities and challenges. This implies that networks do not necessarily give rise to less hierarchical forms of firm organization (as predicted for instance in Bartlett and Ghoshal, 1989, and in Nohria and Eccles, 1993).

GFN typically consist of various hierarchical layers that range from network flagships that dominate such networks, down to a variety of usually smaller, local specialized network suppliers. This taxonomy helps to assess the different capacities of network participants to engage in and benefit from knowledge diffusion. Our focus here is on network flagships¹²

Network flagships

We distinguish two types of global flagships: i) “brand leaders” (BL), like Cisco, GE, IBM, Compaq or Dell; and ii) “contract manufacturers” (CM), like for instance Solectron or Flextronics, that establish their own GFN to provide integrated global supply chain services to the “global brand leaders”. Cisco is an interesting example of a “brand leader”¹³: its GFN connects the flagship to 32 manufacturing plants worldwide. These suppliers are formally independent, but they go through a lengthy process of certification to ensure that they meet Cisco’s demanding requirements. Outsourcing volume manufacturing and related support services enables “brand leaders” to combine cost reduction, product differentiation and time-to-market. Equally important are financial considerations: getting rid of low-margin manufacturing helps the BL to increase shareholder returns¹⁴.

¹² The role of local suppliers has been addressed in Ernst and Kim, 2001.

¹³ Other examples can be found in Ernst, 1997a and 1997b, Ernst and Ravenhill, 1999, and in Borrus, Ernst, and Haggard, 2000.

¹⁴ Other important drivers of outsourcing include hedging against damage due to volatile markets and periodic excess capacity; and scale economies: surface-mount-technology (SMT) requires large production runs, reflecting its growing capital and knowledge intensity.

“Contract manufacturers” have rapidly increased in importance since the mid-1990s¹⁵. This represents an acceleration of a long-standing trend towards vertical specialization in the electronics industry (Mowery and Macher, 2001). The role model of CM-type network flagships is Solectron that only a few years ago was a typical SME, but has transformed itself into the electronics industry’s largest CM. With a CAGR of 43% over the past five years, Solectron has increased its worldwide locations from about 10 in 1996 to almost 50 today (Luethje, 2001). The company defines itself now as a global supply chain facilitator: global brand leaders “... can turn to Solectron at any stage of the supply chain, anywhere in the world, and get the highest-quality, most flexible solutions to optimize their existing supply chains “.(Solectron, 2000: 1).

The flagship is at the heart of a network: it provides strategic and organizational leadership beyond the resources that, from an accounting perspective, lie directly under its management control (Rugman, 1997: 182). The strategy of the flagship company thus directly affects the growth, the strategic direction and network position of lower-end participants, like specialized suppliers and subcontractors. The latter, in turn, “ have no reciprocal influence over the flagship strategy” (Rugman and D’Cruz, 2000, p.84)¹⁶. The flagship derives its strength from its control over critical resources and capabilities that facilitate innovation (e.g., Lazonick, 2000), and from its capacity to coordinate

¹⁵ With an average annual growth of more than 25% between 1995 and 2000, the so-called *electronics manufacturing services* (EMS) market has been one of the fastest growing electronics sectors, expanding twice as quickly as the total electronics industry.

¹⁶ With Rugman’s flagship model, we share the emphasis on the hierarchical nature of these networks. However, there are important differences. Rugman and D’Cruz (2000) focus on localized networks within a region; they also include “non-business infrastructure” as “network partners”. We do not share their assumption that a combination of transaction cost and resource-based theory is sufficient to explain such forms of business organization.

transactions and knowledge exchange between the different network nodes. Both are the sources of its superior capacity for generating profits.

Increasing vertical specialization is the fundamental driver of this flagship model of industrial organization. Flagships retain in-house activities in which they have a particular strategic advantage; they outsource those in which they do not. It is important to emphasize the diversity of such outsourcing patterns (Ernst,1997b). Some flagships focus on design, product development and marketing, outsourcing volume manufacturing and related support services. Other flagships outsource as well a variety of high-end, knowledge-intensive support services. This includes for instance trial production (prototyping and ramping-up), tooling and equipment, benchmarking of productivity, testing, process adaptation, product customization and supply chain coordination. It may also include design and product development.

DIS, and especially the open-ended structure of the Internet substantially broadens the scope for outsourcing. Both network flagships and first-tier suppliers have shifted from *partial* outsourcing, covering the nuts and bolts of manufacturing, to *systemic* outsourcing that includes knowledge-intensive support services. This has intensified the competition among the providers of outsourcing services: competition now focuses on the capacity to provide manufacturing and design services wherever required¹⁷. What matters is the variety of outsourcing arrangements that the Internet has generated. Our first example concerns the outsourcing of logistics services. FedEx, for example orchestrates the assembly and shipping of laptop computers for Fujitsu; this has

¹⁷ Take the electronics industry. For lower-cost outsourcing, network flagships can now choose between alternative locations, established by major contract manufacturers in Asia, Latin America, the former Soviet bloc, and the European periphery. For higher-end outsourcing, flagships can choose between

enabled Fujitsu to reduce the time consumers have to wait for an order from 10 days to 3 or 4 days. By turning over much of its computerized distribution system to FedEx, Fujitsu has been able to remove the warehousing and inventory costs from its supply chain, cutting inventory 90 percent.

Increasingly however the focus of outsourcing is shifting to knowledge-intensive support services, including most aspects of information management. For instance, Internet service providers (ISP) provide fee-based access to Internet applications and resources for individuals and companies. Web hosting refers to the outsourcing of web site design and maintenance to specialized third party companies that can reap economies of scale and scope. And application service providers (ASP) provide mission-critical applications, such as ERP, HRM, SCM and CRM on a subscription basis.

While the Internet acts as an important enabling technology, there are additional reasons to expect outsourcing pressures to grow: the IT skills shortage¹⁸; the speed and unpredictability of changes in Internet technologies and markets, which makes it risky anyway to sustain large in-house IT work forces; and the high life-cycle costs of purchasing and maintaining networking equipment and Internet applications¹⁹. Equally important is that intense competition among major producers of Internet software and

specialized clusters in Nordic countries, the US, France and Germany, as well as Israel, Ireland, and Hungary.

¹⁸ During 2000, it was projected that 50% of the 1.6 million IT-related jobs in the US would remain unfilled (Information Technology Association of America, May 10, 2000, at: www.ita.org). Since then, however, the global downturn in the electronics industry has relieved this pressure. Massive retrenchments in the US and Europe may now increase (at least for a while) developing Asia's access to IT skills.

¹⁹ While intense competition reduces unit prices of Internet software and networking equipment, the frantic pace of technological change in both areas has drastically cut product-life cycles. For each generation, this has increased the life cycle costs of purchase and maintenance. Again, the current downturn in the electronics industry may slow down these developments.

networking equipment has created a buyers` market, forcing major vendors to rely on outsourcing as an important market penetration strategy.

The result is that an increasing share of the value-added becomes dispersed across the boundaries of the firm as well as across national borders. Even if these activities do not involve formal R&D, they may still require a substantial exchange of knowledge. Hence, under certain conditions, GFN may enhance the diffusion of knowledge across firm boundaries and national borders and, arguably, improve the opportunities for knowledge sharing and interactive learning without co-location.

4. PREREQUISITES FOR KNOWLEDGE DIFFUSION

Under what conditions can GFN generate effective knowledge diffusion? And what needs to be done to strengthen the position of local suppliers? The missing link in our argument is that local suppliers are exposed to a combination of pressures and incentives from network flagships to upgrade their capabilities (see fig.4). This provides important upgrading opportunities for those, mostly higher-tier, local suppliers that possess a critical mass of resources and capabilities.

Fig. 4 Global Flagship Networks: Catalysts for Knowledge Diffusion?

Let us recapitulate the fundamental rationale of GFN: they help flagships to sustain their competitiveness, by providing them with access to specialized suppliers at lower-cost locations that excel in quick and flexible response to the flagships` requirements. The flagships can exert considerable pressure on local suppliers, especially in developing countries: they can discipline suppliers by threatening to drop them from

the networks whenever they fail to provide the required services at low price and world class quality.

4.1. Opportunities

At the same time, GFN also act as powerful carriers of knowledge. First, flagships need to transfer technical and managerial knowledge to the local suppliers. This is necessary to upgrade the suppliers' technical and managerial skills, so that they can meet the technical specifications of the flagships. It has been argued that flagship- dominated business networks can be a boon rather than a bane for knowledge transfer (Rugman and D'Cruz, 2000: p.58). Their asymmetric distribution of resources, power and decision-making can facilitate trust and credible commitments, enhancing stability, coherence and organizational learning. This, it is argued, reduces the risks that flagships encounter when sharing technology²⁰.

Second, once a network supplier successfully upgrades its capabilities, this creates an incentive for flagships to transfer more sophisticated knowledge, including engineering, product and process development. This reflects the increasingly demanding competitive requirements that we referred to earlier. In the electronics industry for instance, product-life-cycles have been cut to six months, and sometimes less (Ernst, 2001d). Overseas production thus frequently occurs soon after the launching of new products. This is only possible if flagships share key design information more freely with overseas affiliates and suppliers. Speed-to-market requires that engineers across the

²⁰ The authors acknowledge that this knowledge-sharing is limited to a select group of key suppliers, customers and strategic competitors who collaborate in selective alliances.

different nodes of a GFN are plugged into the flagship's design debates on a regular basis.

DIS, and especially the Internet generate new opportunities for improving communication routines, blending old forms of communication (e.g., face-to-face) with new forms (e.g. on-line). Of course, the Internet is no substitute for traditional modes of communication. However, it facilitates knowledge exchange without co-location, *provided* that the agents involved know each other through earlier face-to-face informal conversations that has allowed them to establish mutual trust. Once this basis exists, the Internet provides previously unavailable opportunities for knowledge exchange among distant locations.

In short, GFN expose local suppliers to the flagship's management practices and technological knowledge. International technology transfer has been extensively studied, but research has primarily focused on such formal mechanisms as foreign direct investment and foreign licensing. These formal mechanisms, however, are only the tip of the iceberg. A larger amount of technical knowledge is transferred through various informal mechanisms that involve a substantial amount of tacit knowledge (e.g., Wong, 1991; Bell and Pavitt, 1993; Kim, 1997; Ernst, Ganiatsos and Mytelka, 1998; Saxenian, 2001; Ernst and Lundvall, 2000; Ernst, 2000a). This includes early supplier involvement in product design and prototype development; access to proprietary technical and marketing information on end users' requirements and on competitors' products; informal sharing of technical information and ideas between the flagship and different network nodes; and knowledge exchange through informal, transnational peer group networks.

4.2. Pressures and Incentives

Of course, knowledge transfer is not a sufficient condition for effective knowledge diffusion. Diffusion is completed only when transferred knowledge is internalized and translated into the capability of the local suppliers (e.g., Kim, 1997, and Ernst, Mytelka and Ganiatsos, 1998). Important constraints exist that can derail this process. Once a network flagship extends its value chain across national boundaries, it is faced with complex coordination problems. This has given rise to a debate about how firms can improve “corporate coherence”, as more and more value chain activities migrate to external actors (Teece, Rumelt, Dosi and Winter, 1994).

Another constraint to the diffusion of knowledge within GFN are differences in the approach to knowledge creation. It has been argued that peculiar features of national institutions, especially with regard to education, labor markets and occupational systems, have led to distinctive national approaches of firms to learning and knowledge formation, and that this constrains knowledge sharing and inter-organizational learning across national borders (Lam, 1998).

Equally important for effective knowledge diffusion are the motivations, resources and capabilities of local suppliers (Ernst and Kim, 2001). This brings us back to the pressures exerted by network flagships. Under certain conditions, these pressures can catalyze local suppliers into concerted upgrading efforts. Typically, the flagships’ outsourcing requirements have become more demanding. Cisco for instance selects suppliers according to three criteria: a solid financial standing; high ratings on a quarterly scoreboard measuring performance in delivery, quality etc.; and speed of response. The latter is of critical importance: suppliers are expected to respond within hours with a

price, a delivery time, and a record on their recent performance on reliability and product quality. This implies that local suppliers can only upgrade or perish. To stay on the GFN, local suppliers must develop their capabilities through internalizing transferred knowledge. The only way for suppliers to survive the intense pressures imposed by the flagships, is to upgrade from a position of simple contract manufacturers (so-called “box shifters”) to providers of integrated, knowledge-intensive support service packages.

At the same time, network participation can also provide incentives for local suppliers to invest in their knowledge base and capabilities. This requires however that the flagship reduces the perceived risk of such investments through a longer-term commitment; that network participation provides the supplier with a stable source of income to finance the investment; and that the network offers access to superior market and technology information that may reduce the risks involved in the investment decision. These are fairly demanding requirements that not all networks meet. There is a clear need for government policies and support institutions that enable local suppliers to exploit the opportunities and pressures that result from network participation, and that induce flagships to provide the above incentives. Realistically, the focus of such policies has to be on the promotion of local suppliers (as illustrated for instance by Singapore). Most governments (with the exception of quasi-continental economies like China, India and Brazil) are simply too weak to influence flagship behavior. There is however room for policies to exploit existing differences in flagship behavior. It is now well established that nationality of ownership of network flagships, home country institutions and product mix (specialization) explain why GFN differ in their governance structures, and hence in

the incentives they provide for capability upgrading investment by local suppliers (Ernst and Ravenhill, 1999; Borrus, Ernst and Haggard, 2000, chapter1).

CONCLUSIONS

In short, under certain circumstances, GFN may provide a combination of new opportunities, pressures and incentives for local suppliers to upgrade their capabilities. Two effects can be distinguished: First, GFN can act as a conduit for knowledge diffusion for state-of-the-art management approaches as well as product and process technologies, including the required tacit knowledge. At the same time, the requirements of network flagships can also provide both pressures and incentives to catalyze knowledge creation and capability development within firms and industrial districts in developing economies.

But these networks are no substitute of course for domestic upgrading efforts. Without the latter, network integration may equally well erode a country's sources of competitive advantage. It may also sap the strengths of existing clusters and truncate their upgrading possibilities. Network integration of some "higher-tier" suppliers may well increase the divide between firms and districts that have and those that do not have access to the information and knowledge that is necessary to reap the benefits of network participation. Many people are understandably concerned that this may lead to a decline in economic growth and welfare. There is however cause for cautious optimism: network participation may provide new opportunities for effective knowledge diffusion to local firms and industrial districts in developing countries, *provided* appropriate policies and support institutions are in place.

To reap the benefits of network participation, developing countries must broaden their domestic knowledge base and generate specialized capabilities. This cannot be left to market forces alone. Markets are notoriously weak in generating knowledge and capabilities, as both are subject to “externalities”: investments are typically characterized by a gap between private and social rates of return (K. Arrow, 1962). Reducing this gap requires corrective policy interventions that provide incentives, as well as the necessary infrastructure, support services and human resources.

While the neo-classical concept of “market failure” provides a rationale for policy intervention, it is of limited value for designing its contents (Lipsey, 2001). A fundamental weakness of this concept is its general equilibrium assumption: defined as a deviation from the market clearing equilibrium under conditions of perfect competition, the remedy is to return to a theoretically achievable static optimum. It is now well accepted that perfect competition hardly ever reigns in markets that characterize modern industry. It is thus misleading to think of market failure as something that can, or should, be ‘remedied’ so that the economy can be brought back to a desired static optimum.

In any case, this concept is patently inappropriate for defining the agenda for public policy response to the new mobility of knowledge. DIS and GFN both reduce the friction of time and space to knowledge exchange. This, in turn, accelerates the pace of change in markets and technology and increase uncertainty and the volatility of market structures, industrial organization and firm behavior (e.g., Ernst, 2001d). Equally important, almost all aspects of knowledge creation and learning are characterized by market failure: this is true for information and codified knowledge, and even more so for tacit knowledge. Information/codified knowledge is difficult to trade in a market:

whenever information is imperfect, “externalities” diffuse and markets incomplete, which is invariably the case with technical change, free markets cannot in principle meet the strict requirements of optimal resource allocation (Stiglitz, 1998).

The design of public policy thus must move beyond the “market failure” rationale. This does not imply a return to the status quo ante of the strong developmental state (as suggested for instance by Wade and Veneroso, 1998). The challenge is to redefine the role of government intervention (Rodrik, 2000). The real question, then, is no longer whether national policies and institutions can make a difference. Instead, it is what kind of policies and institutions will prove most conducive for unlocking new sources of economic growth in a globally connected “digital economy”

Globalization, paradoxically enough, has increased the necessity of such policies. But there is also now more space for national policy and politics to vary and to make a difference. A growing body of research on economic policy-making in advanced industrial countries has demonstrated that choice is possible, in terms of institutions and policy instruments, and that this applies to macro-economic policy-making as well as to industrial and technology policies (e.g. Berger and Dore (eds.), 1996). The same is true for developing countries.

There is a growing consensus that liberalization of trade and investment flows should not be equalized with a retreat of the state (e.g., Rodrik, 1999; UNCTAD, 1999). Liberalization needs to be complemented with proactive and sophisticated industrial, innovation and investment policies. Equally important, the spread of DIS to manage GFN will raise increasingly demanding requirements for regulatory and policy responses (Garcia, 2000). We need to discard the naïve belief that technology, combined with

market forces, will automatically improve a country's growth and welfare. The overall impact of DIS depends not only on the technical performance features of these technologies, "but also on their design and architecture as well as the rules governing their access and use. To establish and execute such rules, and to resolve competing claims with respect to them, some form of governance - operating at all levels - will be required. Absence governance, electronic networks will not reduce transaction costs, but will, instead, generate greater uncertainty. Networked markets will then - if they do not cease to exist - function very inefficiently as a result."(Garcia, 2000, p.3).

In short, not less, but different policies are required. The scope for sophisticated regulatory schemes and pro-active technology and industrial policies in a liberal ownership regime is far greater than commonly assumed, as demonstrated by the example of small Nordic countries and the Netherlands. Taiwan, Singapore and recent developments in Korea also illustrate that a variety of approaches is possible to such policies, involving a variety of interesting hybrid combinations (Ernst, 2000a, and Ernst, 2001g). The choice is much larger than is normally assumed.

This happens at the same time as requirements for public policy response increase to adapt economic structures and institutions to the relentless pace of change now taking place. The recent advancements in corporate (IT-based) networking practices will generate turmoil, growing uncertainties, and social dislocations. In one indication of the seriousness of this, the Organization for Economic Cooperation and Development (OECD) is now focusing its efforts on changes in policies and economic governance that will be necessary to respond to these dramatic changes. The severity of coming economic problems was captured in testimony before the U.S. Congress by Andy Grove, former

chairman of Intel and one of the forces behind these changes. The Internet, Grove observed, “is about to wipe out entire sections of the economy.” Unless politicians start moving “at Internet rather than Washington speed,” America may see “a repeat of the social disaster that followed the mechanization of agriculture” (Economist, 1999). This warning to the world’s richest country is even more ominous for developing countries and transformation economies, and highlights the need for concerted action.

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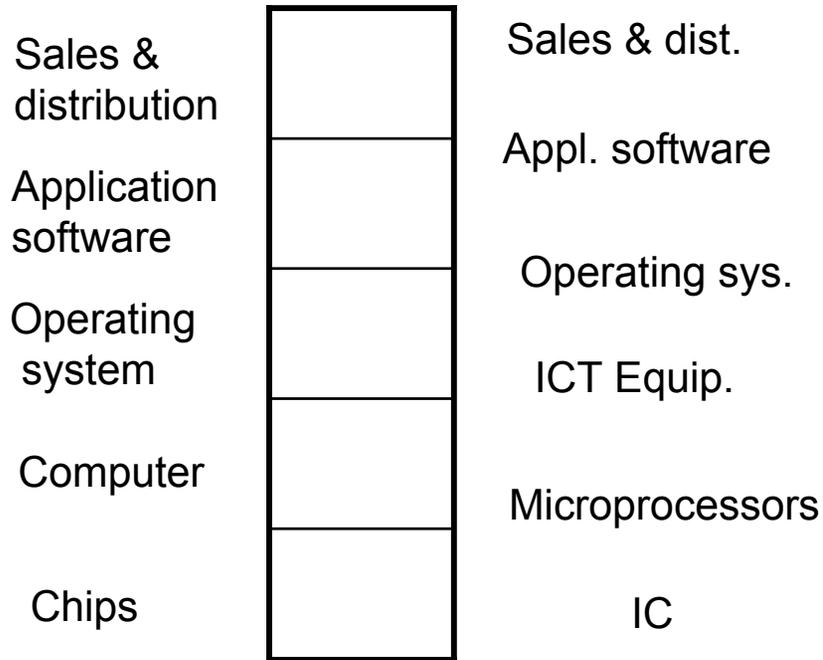
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VERTICAL SPECIALIZATION: ELECTRONICS INDUSTRY

Vertical Integration (ca. 1980)

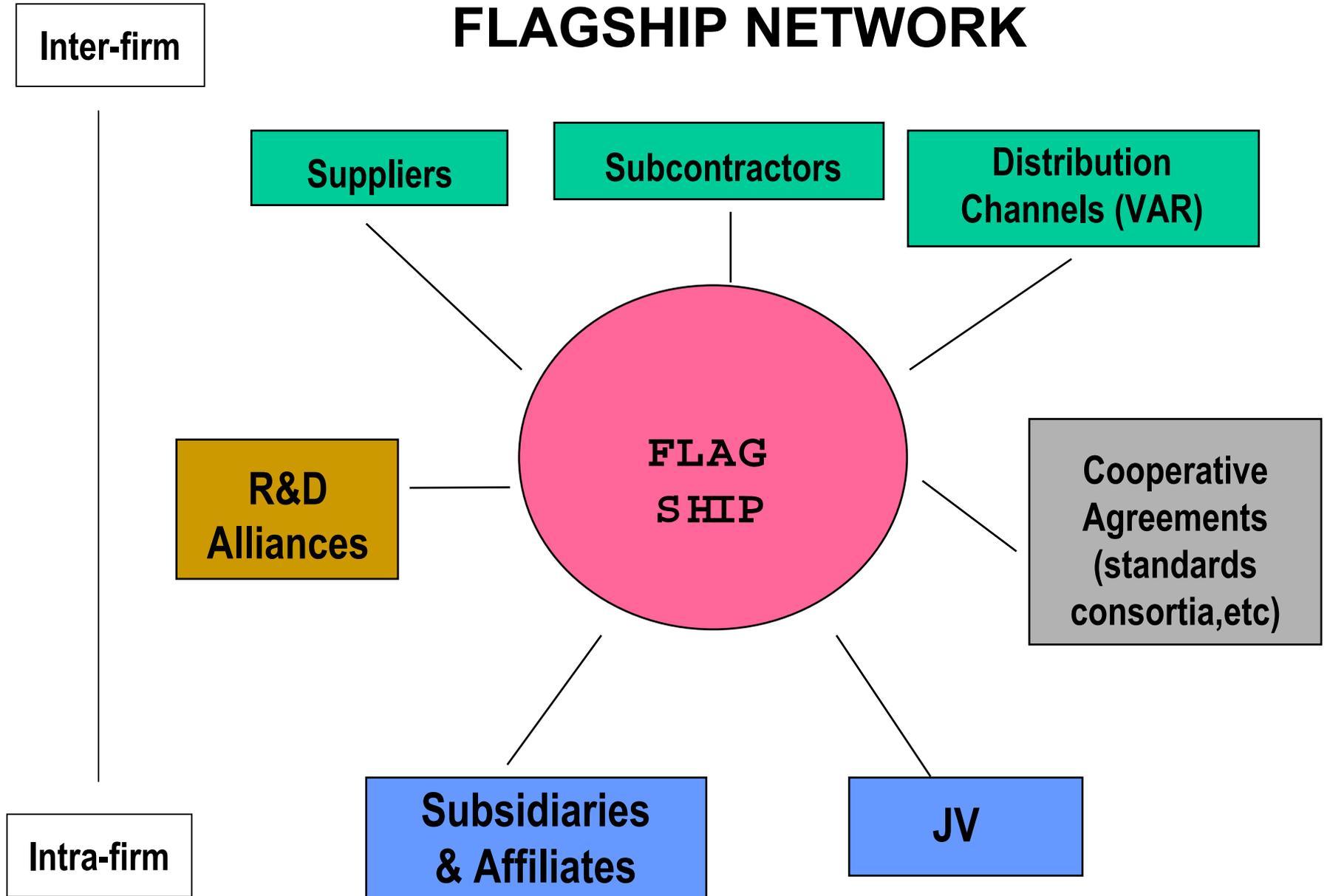


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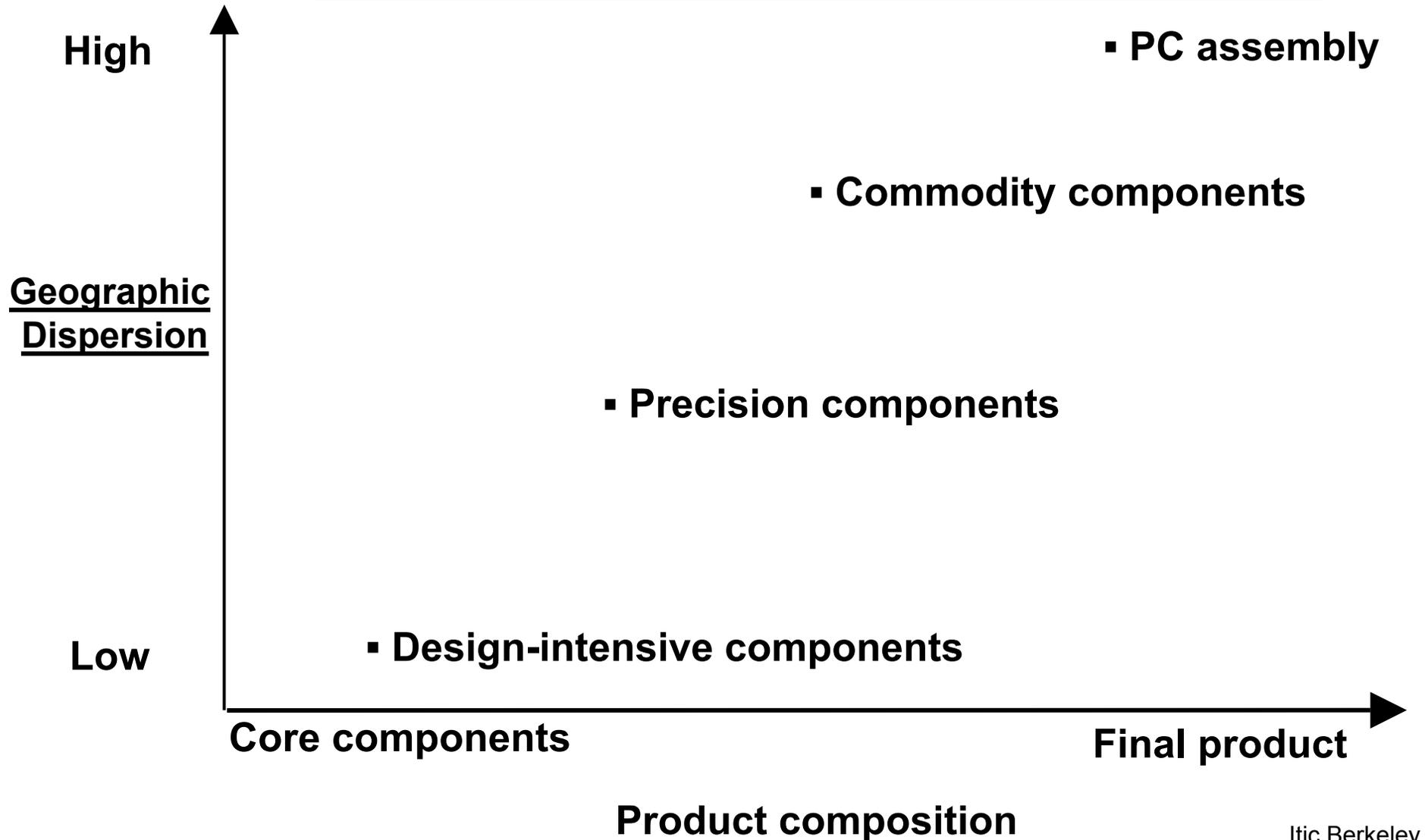
Vertical Specialization

Retail stores		Dealers		Mail order	
Word	HRM	SCM	CRM	KM	
PC windows		Open source Linux		Internet based	
PC		Networking equipment		Mobile	
Intel		Motorola		RISC	
Commodities Dram		Higher-end: SOC, DSP & ASIC			

THE NODES OF GLOBAL FLAGSHIP NETWORK



PRODUCT COMPOSITION AND GEOGRAPHIC DISPERSION OF SPECIALIZED CLUSTERS



GLOBAL FLAGSHIP NETWORKS: CATALYSTS FOR KNOWLEDGE DIFFUSION?

Rationale

=GPN provide flagships with access to specialized suppliers at lower-cost locations that excel in quick and flexible response to the flagships' requirements

Opportunities

- expose local suppliers to the flagship's management practices & technological knowledge
- cross-border knowledge exchange (“informal peer group networks”)

Pressures

- Flagships drop suppliers from the networks whenever they fail to provide the required services at low price and world class quality
- increasingly demanding outsourcing requirements

Incentives for Investment in Capability Formation

- flagship reduces perceived risk through longer term commitment
- network participation provides supplier with a stable source of income to finance the investment
- network offers access to superior market and technology knowledge

Required: Government policies and support institutions that:

- **enable local suppliers to cope with opportunities, pressures & incentives**
- **induce flagships to provide incentives**