International Institute for
Applied Systems Analysis
IIASA www.iiasa.ac.at

The Dynamic Capabilities of Firms: An Introduction

Teece, D. & Pisano, G.

IIASA Working Paper

WP-94-103

October 1994

Working Paper

The Dynamic Capabilities of Firms: An Introduction

David Teece
Gary Pisano

WP-94-103
October 1994

International Institute for Applied Systems Analysis □ A-2361 Laxenburg □ Austria
Telephone: +43 2236 71521 □ Telex: 079 137 iiasa a □ Telefax: +43 2236 71313

The Dynamic Capabilities of Firms: An Introduction

David Teece
Gary Pisano

University of California, Berkeley, and Harvard University, respectively.

WP-94-103
October 1994

The work benefitted from discussions at he International Institute of Applied Systems Analysis (IIASA), Laxenburg, Austria with other members of of the *Technological and Economic Dynamics Project.* Also, we would like to thank Amy Shuen for useful comments. This introduction draws from D.J. Teece, G. Pisano, and A. Shuen, "Dynamic Capabilities and Strategic Management," **Strategic Management Journal**, forthcoming.

International Institute for Applied Systems Analysis □ A-2361 Laxenburg □ Austria
Telephone: +43 2236 71521 □ Telex: 079 137 iiasa a □ Telefax: +43 2236 71313

Preface

The research project on *Systems Analysis of Technological and Economic Dynamics* at IIASA is concerned with modeling technological and organisational change; the broader economic developments that are associated with technological change, both as cause and effect; the processes by which economic agents – first of all, business firms – acquire and develop the capabilities to generate, imitate and adopt technological and organisational innovations; and the aggregate dynamics – at the levels of single industries and whole economies – engendered by the interactions among agents which are heterogeneous in their innovative abilities, behavioural rules and expectations. The central purpose is to develop stronger theory and better modeling techniques. However, the basic philosophy is that such theoretical and modeling work is most fruitful when attention is paid to the known empirical details of the phenomena the work aims to address: therefore, a considerable effort is put into a better understanding of the 'stylized facts' concerning corporate organisation routines and strategy; industrial evolution and the 'demography' of firms; patterns of macroeconomic growth and trade.

From a modeling perspective, over the last decade considerable progress has been made on various techniques of dynamic modeling. Some of this work has employed ordinary differential and difference equations, and some of it stochastic equations. A number of efforts have taken advantage of the growing power of simulation techniques. Others have employed more traditional mathematics. As a result of this theoretical work, the toolkit for modeling technological and economic dynamics is significantly richer than it was a decade ago.

During the same period, there have been major advances in the empirical understanding. There are now many more detailed technological histories available. Much more is known about the similarities and differences of technical advance in different fields and industries and there is some understanding of the key variables that lie behind those differences. A number of studies have provided rich information about how industry structure co-evolves with technology. In addition to empirical work at the technology or sector level, the last decade has also seen a great deal of empirical research on productivity growth and measured technical advance at the level of whole economies. A considerable body of empirical research now exists on the facts that seem associated with different rates of productivity growth across the range of nations, with the dynamics of convergence and divergence in the levels and rates of growth of income, with the diverse national institutional arrangements in which technological change is embedded.

As a result of this recent empirical work, the questions that successful theory and useful modeling techniques ought to address now are much more clearly defined. The theoretical work has often been undertaken in appreciation of certain stylized facts that needed to be explained. The list of these 'facts' is indeed very long, ranging from the microeconomic evidence concerning for example dynamic increasing returns in learning activities or the persistence of particular sets of problem-solving routines within business firms; the industry-level evidence on entry, exit and size-distributions – approximately log-normal – all the way to the evidence regarding the time-series properties of major economic aggregates. However, the connection between the theoretical work and the empirical phenomena has so far not been very close. The philosophy of this project is that the chances of developing powerful new theory and useful new analytical techniques can be greatly enhanced by performing the work in an environment where scholars who understand the empirical phenomena provide questions and challenges for the theorists and their work.

In particular, the project is meant to pursue an 'evolutionary' interpretation of technological and economic dynamics modeling, first, the processes by which individual agents and organisations learn, search, adapt; second, the economic analogues of 'natural selection' by which inter-

active environments – often markets – winnow out a population whose members have different attributes and behavioural traits; and, third, the collective emergence of statistical patterns, regularities and higher-level structures as the aggregate outcomes of the two former processes.

Together with a group of researchers located permanently at IIASA, the project coordinates multiple research efforts undertaken in several institutions around the world, organises workshops and provides a venue of scientific discussion among scholars working on evolutionary modeling, computer simulation and non-linear dynamical systems.

The research focuses upon the following three major areas:

1. Learning Processes and Organisational Competence.
2. Technological and Industrial Dynamics
3. Innovation, Competition and Macrodynamics

I. INTRODUCTION

The global competitive battles in high technology industries such as semiconductors, information services, and software have demonstrated the need for an expanded paradigm to understand how competitive advantage is gained and held. Well-known companies like IBM, Texas Instruments, Phillips, and others appear to have followed a "resource-based strategy" of accumulating valuable technology assets, often guarded by an aggressive intellectual property stance. However, this strategy is often not enough to support a significant competitive advantage. Winners in the global marketplace have been firms that can demonstrate timely responsiveness and rapid and flexible product innovation, coupled with the management capability to effectively coordinate and redeploy internal and external competences. Not surprisingly, industry observers have remarked that companies can accumulate a large stock of valuable technology assets and still not have many useful capabilities.

We refer to this source of competitive advantage as "dynamic capabilities" to emphasize two key aspects which were not the main focus of attention in previous strategy perspectives. The term "dynamic" refers to the shifting character of the environment; certain strategic responses are required when time-to-market and timing is critical, the pace of innovation accelerating, and the nature of future competition and markets difficult to determine. The term "capabilities" emphasizes the key role of strategic management in appropriately adapting, integrating, and re-configuring internal and external organizational skills, resources, and functional competences toward changing environment.

The notion that competitive advantage requires both the exploitation of existing internal and external firm-specific capabilities and of developing new ones is partially developed in Penrose (1959), Teece (1982), and Wernerfelt (1984). However, only recently have researchers begun to focus on the specifics of how some

organizations first develop firm-specific capabilities and how they renew competences to respond to shifts in the business environment.[1] These issues are intimately tied to the firm's business processes, market positions, and expansion paths. Several writers have recently offered insights and evidence on how firms can develop their capability to adapt and even capitalize on rapidly changing environments.[2] The dynamic capabilities approach provides a coherent framework which can both integrate existing conceptual and empirical knowledge, and facilitate prescription. In doing so, it builds upon the theoretical foundations provided by Schumpeter (1934), Penrose (1959), Williamson (1975, 1985), Barney (1986), Nelson and Winter (1982), and Teece (1988), and Teece et al. (1994).

II. TOWARD A DYNAMIC CAPABILITIES FRAMEWORK

II.1 Markets and Strategic Capabilities

Different approaches to strategy view sources of wealth creation and the essence of the strategic problem faced by firms differently. The competitive forces framework sees the strategic problem in terms of market entry, entry deterrence, and positioning; game-theoretic models view the strategic problem as one of interaction between rivals with certain expectations about how each other will behave;[3] resource-based perspectives have focused on the exploitation of firm-specific assets. Each approach asks different, often complementary questions. A key step in building a conceptual framework related to dynamic capabilities is to identify the foundations upon which distinctive and difficult to replicate advantages can be built.

A useful way to vector in on the strategic elements of the business enterprise is to first identify what isn't strategic. To be strategic, a capability must be honed to a

---

[1] See, for example, Iansiti and Clark (1994), and R. Henderson (1994).

[2] See Hayes, Wheelwright and Clark (1988), Prahalad and Hamel (1990), Direrickx and Cool (1989), Chandler (1990), and Teece (1993).

[3] In sequential move games, each player looks ahead and anticipates his rivals future responses in order to reason back and decide action, i.e., look forward, reason backward.

user need (so that there are customers), unique (so that the products/services produced can be priced without too much regard to competition) and difficult to replicate (so profits won't be competed away). Accordingly, any assets or entity which is homogeneous and can be bought and sold at an established price cannot be all that strategic (Barney, 1986). What is it, then, about firms which undergirds competitive advantage?

To answer this, one must first make some fundamental distinctions between markets and internal organization (firms). The essence of the firm, as Coase (1937) pointed out, is that it displaces market organization. It does so in the main because inside the firms one can organize certain types of economic activity in ways one cannot using markets. This is not only because of transaction costs, as Williamson (1975, 1985) as emphasized, but also because there are many types of arrangements where injecting high powered (market like) incentives might well be quite destructive of the cooperative activity and learning. Indeed, the essence of internal organization is that it is a domain of unleveraged or low-powered incentives. By unleveraged we mean that rewards are determined at the group or organization level, not primarily at the individual level, in an effort to encourage team behavior, not individual behavior, in order to accomplish certain tasks well. Inside an organization, exchange cannot take place in the same manner that it can outside an organization, not just because it might be destructive to provide high powered individual incentives, but because it is difficult if not impossible to tightly calibrate individual contribution to a joint effort. Hence, contrary to Arrows (1969) view of firms as quasi markets, and the task of management to inject markets into firms, we recognize the inherent limits and possible counterproductive results of attempting to fashion firms into clusters of internal markets. In particular, learning and internal technology transfer may well be jeopardized.

Indeed, what is distinctive about firms is that they are domains for organizing activity in a non market like fashion. According, as we discuss what is distinctive about firms, we stress competences/capabilities which are ways of organizing and getting things done which cannot be accomplished by using the price system to coordinate activity. The very essence of capabilities/ competences is that they cannot be readily assembled through markets (Teece, 1982, 1986a; Kogut and Zander, 1992). If the ability to assemble competences using markets is what is meant by the firm as a nexus of contracts (Fama, 1980), then we unequivocally state that the firm about which we theorize cannot be usefully modeled as a nexus of contracts. By contract we are referring to a transaction undergirded by a legal agreement, or some other arrangement which clearly spells out rights, rewards, and responsibilities. Moreover, the firm as a nexus of contracts suggests a series of bilateral contracts orchestrated by a coordinator, where our view of the firm is that the organization takes place in a more multilateral fashion, with patterns of behavior and learning being orchestrated in a much more decentralized fashion.

The key point, however, is that the properties of internal organization cannot be replicated by a portfolio of business units amalgamated through formal contracts as the distinctive elements of internal organization simply cannot be replicated in the market.[4] That is, entrepreneurial activity cannot lead to the immediate replication of unique organizational skills through simply entering a market and piecing the parts together overnight. Replication takes time, and the replication of best practice may be illusive. Indeed, firm capabilities need to be understood not in terms of balance sheet items, but mainly in terms of the organizational structures and managerial processes which support productive activity. By construction, the firm's balance sheet contains items that can be valued, at least at original market prices (cost). It is

---

[4] As we note in Teece et al. (1994), the conglomerate offers few if any efficiencies because there is little provided by the conglomerate form that shareholders cannot obtain for themselves simply by holding a diversified portfolio of stocks.

necessarily the case, therefore, that the balance sheet is a poor shadow of a firm's distinctive competence.[5] That which is distinctive cannot be bought and sold short of buying the firm itself, or one or more of its subunits.

There are many dimensions to the business firm that must be understood if one is to grasp firm-level distinctive competences/capabilities. In this paper we merely identify several classes of factors that will help determine a firm's dynamic capabilities. We organize these in three categories: processes, positions, and paths.

II.2. Processes, Positions, and Paths

We advance the argument that the strategic dimensions of the firm are its managerial and organizational processes, its present position, and the paths available to it. By managerial and organizational processes, we refer to the way things are done in the firm, or what might be referred to as its routines, or patterns of current practice and learning. By position we refer to its current endowment of technology and intellectual property, as well as its customer base and upstream relations with suppliers.[6] By paths we refer to the strategic alternatives available to the firm, and the attractiveness of the opportunities which lie ahead. Our focus throughout is on asset structures for which no ready market exits, as these are the only assets of strategic interest. A final section focuses on replication and imitation, as it is these phenomena which determine how readily a competence or capability can be cloned by competitors, and therefore the durability of its advantage.

The firms' processes and positions collectively encompass its capabilities or competences. A hierarchy of competences/capabilities ought be recognized, as some competences may be on the factory floor, some in the R&D labs, some in the

---

[5] Owners' equity may reflect, in part, certain historic capabilities. Recently, some scholars have begun to attempt to measure organizational capability using financial statement data. See Baldwin and Clark (1991) and Lev and Sougiannis (1992).

[6] We also recognize its strategic alliances with competitors.

executive suites, and some in the way everything is integrated. A difficult to replicate or difficult to imitate competence/capability can be considered a distinctive competence. As indicated, the key feature of distinctive competences and capabilities is that there is not a market for them, except possibly through the market for business units[7] or corporate control. Hence competences and capabilities are intriguing assets as they typically must be built because they cannot be bought. Dynamic capabilities are the subset of the competences/capabilities which allow the firm to create new products and processes, and respond to changing market circumstances.

II.2.a. Organizational and Managerial Processes

Integration: While the price system supposedly coordinates the economy, managers coordinate or integrate activity inside the firm. How efficiently and effectively internal coordination or integration is achieved is very important (Aoki, 1990).[8] Likewise for external coordination.[9] Increasingly, strategic advantage requires the integration of external activities and technologies. The growing literature on strategic alliances, the virtual corporation, and buyer-supplier relations and technology collaboration evidences the importance of external integration and sourcing.

There is some field-based empirical research that provides support for the notion that the way production is organized by management inside the firm is the

---

[7] Such competences may unravel if the subunit is separated from the parent.

[8] Indeed, Ronald Coase, author of the pathbreaking 1937 article "The Nature of the Firm," which focused on the costs of organizational coordination inside the firm as compared to across the market, half a century later has identified as critical the understanding of "why the costs of organizing particular activities differs among firms" (Coase 1988: 47). We argue that a firm's distinctive ability needs to be understood as a reflection of distinctive organizational or coordinative capabilities. This form of integration (i.e. inside business units) is different from the integration between business units; they could be viable on a stand-alone basis (external integration). For a useful taxonomy, see Iansiti and Clark, *op. cit.* (1994).

[9] Amy Shuen (1994) examines the gains and hazards of the technology make vs. buy decision and supplier co-development.

source of differences in firms' competence in various domains. For example, Garvin's (1988) study of 18 room air conditioning plants reveals that quality performance was not related to either capital investment or the degree of automation of the facilities. Instead, quality performance was driven by special organizational routines. These included routines for gathering and processing information, for linking customer experiences with engineering design choices, and for coordinating factories and component suppliers.[10] The work of Clark and Fujimoto (1991) on project development in the automobile industry also illustrates the role played by coordinative routines. Their study reveals a significant degree of variation in how different firms coordinate the various activities required to bring a new model from concept to market. These differences in coordinative routines and capabilities seem to have a significant impact on such performance variables as development cost, development lead times, and quality. Furthermore, they tended to find significant firm-level differences in coordination routines and these differences seemed to have persisted for a long time. This suggests that routines related to coordination are firm-specific in nature.

Also, the notion that competence/capability is embedded in distinct ways of coordinating and combining helps to explain how and why seemingly minor technological changes can have devastating impacts on incumbent firms' abilities to compete in a market. Henderson and Clark (1990), for example, have shown that incumbents in the photolithographic equipment industry were sequentially devastated by seemingly minor innovations that, nevertheless, had major impacts on how systems had to be configured. They attribute these difficulties to the fact that systems level or "architectural" innovations often require new routines to integrate and coordinate engineering tasks. These findings and others suggest that productive systems display high interdependency, and that it may not be possible to change one

[10] Garvin (1994) provides a typology of organizational processes.

level without changing others. This appears to be true with respect to the "lean production" model (Womack et al.) which has now transformed the Taylor or Ford model of manufacturing organization in the automobile industry.[11] Lean production requires distinctive shop floor practices and processes as well as distinctive higher order managerial processes. Put differently, organizational processes often display high levels of coherence, and when they do, replication may be difficult because it requires systemic changes throughout the organization and also among interorganizational linkages which might be very hard to effectuate. Put differently, partial imitation or replication of a successful model may yield zero benefits.

The notion that there is a certain rationality or coherence to processes and systems is not quite the same concept as corporate culture, as we understand the

---

[11] Fujimoto (1994, pp. 18-20) describes key elements as they existed in the Japanese auto industry as follows: "The typical volume production system of effective Japanese makers of the 1980s (e.g., Toyota) consists of various intertwined elements that might lead to competitive advantages. Just-in-Time (JIT), Jidoka) (automatic defect detection and machine stop), Total Quality Control (TQC), and continuous improvement (Kaizen) are often pointed out as its core subsystems. The elements of such a system include inventory reduction mechanisms by Kanban system; levelization of production volume and product mix (heijunka); Reduction of "muda" (non-value adding activities), "mura" (uneven pace of production) and muri (excessive workload); production plans based on dealers' order volume (genyo seisan); reduction of die set-up time and lot size in stamping operation; mixed model assembly; piece-by-piece transfer of parts between machines (ikko-nagashi); flexible task assignment for volume changes and productivity improvement (shojinka); multi-task job assignment along the process flow (takotei-mochi); U-shape machine layout that facilitates flexible and multiple task assignment, on-the-spot inspection by direct workers (tsukurikomi); fool-proof prevention of defects (poka-yoke); real-time feedback of production troubles (andon); assembly line stop cord; emphasis on cleanliness, order, and discipline on the shop floor (5-S); frequent revision of standard operating procedures by supervisors; quality control circles; standardized tools for quality improvement (e.g., 7 tools for QC, QC story); worker involvement in preventive maintenance (Total Productive Maintenance); low cost automation or semi-automation with just-enough functions); reduction of process steps for saving of tools and dies, and so on. The human-resource management factors that back up the above elements include stable employment of core workers (with temporary workers in the periphery); long-term training of multi-skilled (multi-task) workers; wage system based in part on skill accumulation; internal promotion to shop floor supervisors; cooperative relationships with labor unions; inclusion of production supervisors in union members; generally egalitarian policies for corporate welfare, communication and worker motivation. Parts procurement policies are also pointed out often as a source of the competitive advantage; relatively high ratio of parts out-sourcing; multi-layer hierarchy of suppliers; long-term relations with suppliers; relatively small number of technologically capable suppliers at the first tier; subassembly functions of the first-tier parts makers; detail-engineering capability of the first tier makers (design-in, back box parts); competition based on long-term capability of design and improvements rather than bidding; pressures for continuous reduction of parts price; elimination of incoming parts inspection; plant inspection and technical assistance by auto makers, and so on."

latter. Corporate culture refers to the values and beliefs that employees hold; culture can be a *de facto* governance system as it mediates the behavior of individuals and economizes on more formal administrative methods. Rationality or coherence notions are more akin to the Nelson and Winter (1982) notion of organizational routines. However, the routines concept is a little too amorphous to properly capture the congruence amongst processes and between processes and incentives that we have in mind. Consider a professional service organization like an accounting firm. If it is to have relatively high-powered incentives that reward individual performance, then it must build organizational processes that channel individual behavior; if it has weak or low-powered incentives, it must find symbolic ways to recognize the high performers, and it must use alternative methods to build effort and enthusiasm. What one may think of as styles of organization in fact contain necessary, not discretionary, elements to achieve performance. Recognizing the congruences and complementarities among processes, and between processes and incentives, is critical to the understanding of organizational capabilities. In particular, they can help us explain why architectural and radical innovations are so often introduced into an industry by new entrants. The incumbents develop distinctive organizational processes that cannot support the new technology, despite certain overt similarities between the old and the new. The frequent failure of incumbents to introduce new technologies can thus be seen as a consequence of the mismatch that so often exists between the set of organizational processes needed to support the conventional product/service and the requirements of the new. Radical organizational re-engineering will usually be required to support the new product, which may well do better embedded in a separate subsidiary where a new set of coherent organizational processes can be fashioned.[12]

---

[12] See Abernathy and Clark, 1985.

Learning: Perhaps even more important than integration is learning. Learning is a process by which repetition and experimentation enable tasks to be performed better and quicker and new production opportunities to be identified.[13] In the context of the firm, if not more generally, learning has several key characteristics. First, learning involves organizational as well as individual skills.[14] While individual skills are of relevance, their value depends upon their employment, in particular organizational settings. Learning processes are intrinsically social and collective and occur not only through the imitation and emulation of individuals, as with teacher-student or master-apprentice, but also because of joint contributions to the understanding of complex problems. Learning requires common codes of communication and coordinated search procedures. Second, the organizational knowledge generated by such activity resides in new patterns of activity, in "routines," or a new logic of organization. As indicated earlier, routines are patterns of interactions that represent successful solutions to particular problems. These patterns of interaction are resident in group behavior, though certain subroutines may be resident in individual behavior. The concept of dynamic capabilities as a coordinative management process opens the door to the potential for inter-organizational learning. Researchers (Doz and Shuen, 1989; Mody, 1990) have pointed out that collaborations and partnerships can be a vehicle for new organizational learning, helping firms to recognize dysfunctional routines, and preventing strategic blindspots.

Reconfiguration and Transformation. In rapidly changing environments, there is obviously value in the ability to sense the need to reconfigure the firm's asset structure, and to accomplish the necessary internal and external transformation (Amit and Schoemaker, 1992; Langlois, 1994). This requires constant surveillance of

---

[13] For a useful review and contribution, see Levitt and March, 1988.
[14] See Mahoney (1994).

markets and technologies and the willingness to adopt best practice. In this regard, benchmarking is of considerable value as an organized process for accomplishing such ends (Camp, 1989). In dynamic environments, narcissistic organizations are likely to be impaired. The capacity to reconfigure and transform is itself a learned organizational skill. The more frequently practiced, the easier accomplished.

Change is costly and so firms must develop processes to minimize low payoff change. The ability to calibrate the requirements for change and to effectuate the necessary adjustments would appear to depend on the ability to scan the environment, to evaluate markets and competitors, and to quickly accomplish reconfiguration and transformation ahead of competition. Decentralization and local autonomy assists these processes. Firms that have honed these capabilities are sometimes referred to as "high flex."

II.2.b. Positions

The strategic posture of a firm is determined not only by its learning processes and by the coherence of its internal and external processes and incentives, but also by its location at any point in time with respect to its business assets. By business assets we do not mean its plant and equipment unless they are specialized; rather we mean its difficult-to-trade knowledge assets and assets complementary to them, as well as its reputational and relational assets. These will determine its market share and profitability at any point in time.

Technological Assets. While there is an emerging market for know-how (Teece, 1981), much technology does not enter it. This is either because the firm is unwilling to sell it[15] or because of difficulties in transacting in the market for know-how (Teece 1980). A firm's technological assets may or may not be protected by the

---

[15] Managers often evoke the "crown jewels" metaphor. That is, if the technology is released, the kingdom will be lost.

standard instruments of intellectual property law. Either way, the ownership protection and utilization of technological assets are clearly key differentiators among firms. Likewise for complementary assets.

Complementary Assets. Technological innovations require the use of certain related assets to produce and deliver new products and services. Prior commercialization activities require and enable firms to build such complementarities (Teece, 1986b). Such capabilities and assets, while necessary for the firm's established activities, may have other uses as well. Such assets typically lie downstream. New products and processes either can enhance or destroy the value of such assets (Tushman, Newman and Romanelli 1986). Thus the development of computers enhanced the value of IBM's direct sales force in office products, while disc brakes rendered useless much of the auto industries' investment in drum brakes.

Financial Assets. In the short run, a firm's cash position and degree of leverage may have strategic implications. While there is nothing more fungible than cash, it cannot always be raised from external markets without the dissemination of considerable information to potential investors. Accordingly, what a firm can do in short order is often a function of its balance sheet. In the longer run, that ought not be so, as cash flow ought be more determinative.

Locational Assets. Geography matters too. Uniqueness in certain businesses can stem from locational assets which are non-tradable (e.g., positioning of a refinery in a certain geographic market). While real estate markets are well developed, land use and environmental restrictions often make locational assets non-tradable, and hence may be the source of difficult to replicate advantages which manifest themselves in lower transport costs, superior convenience, and the like.

II.2.c. Paths

Path Dependencies. Where a firm can go is a function of its current position and the paths ahead. It is of course also shaped by the path behind. In standard economics textbooks, firms have an infinite range of technologies from which they can choose and markets they can occupy. Changes in product or factor prices will be responded to instantaneously, with technologies moving in and out according to value maximization criterion. Only in the short run are irreversibilities recognized. Fixed costs – such as equipment and overhead – cause firms to price below fully amortized costs but never constrain future investment choices. "Bygones are bygones." Path dependencies are simply not recognized.

The notion of path dependencies recognizes that "history matters." Bygones are rarely bygones, despite the predictions of rational actor theory. Thus a firm's previous investments and its repertoire of routines (its "history") constrains its future behavior. This follows because learning tends to be local. That is, opportunities for learning will be "close in" to previous activities and thus will be transaction and production specific (Teece, 1988). This is because learning is often a process of trial, feedback, and evaluation. If too many parameters are changed simultaneously, the ability of firms to conduct meaningful natural quasi experiments is attenuated. If many aspects of a firm's learning environment change simultaneously, the ability to ascertain cause-effect relationships is confounded because cognitive structures will not be formed and rates of learning diminish as a result. One implication is that many investments are much longer term than is commonly thought.

Technological Opportunities: The concept of path dependencies can be given forward meaning through the consideration of an industry's technological opportunities. It is well recognized that how far and how fast a particular area of industrial activity can proceed is in part due to the technological opportunities that lie before it. Such opportunities are usually a lagged function of foment and

diversity in basic science, and the rapidity with which new scientific breakthroughs are being made.

However, technological opportunities may not be completely exogenous to industry, not only because some firms have the capacity to engage in or at least support basic research, but also because technological opportunities are often fed by innovative activity itself. Moreover, the recognition of such opportunities are affected by the organizational structures that link the institutions engaging in basic research (primarily the university) to the business enterprise. Hence, the existence of technological opportunities can be quite firm specific.

Important for our purposes is the rate and direction in which relevant scientific frontiers are being rolled back. Firms engaging in R&D may find the path dead ahead closed off, though breakthroughs in related areas may be sufficiently close to be attractive. Likewise, if the path dead ahead is extremely attractive, there may be no incentive for firms to shift the allocation of resources away from traditional pursuits. The depth and width of technological opportunities in the neighborhood of a firm's prior research activities thus are likely to impact a firm's options with respect to both the amount and level of R&D activity that it can justify. In addition, a firm's past experience conditions the alternatives management is able to perceive. Thus, not only do firms in the same industry face "menus" with different costs associated with particular technological choices, they also are looking at menus containing different choices.[16]

II.2.d. Assessment

The assessment of a firm's strategic capability at any point in time is presented here as a function of the firm's processes, positions, and paths. What it can do and where it can go is thus heavily constrained by the typography of its processes,

16 This is a critical element in Nelson and Winter's (1982) view of firms and technical change.

positions, and paths. Each component of this capability framework needs to be analyzed in a strategic audit.

We submit that if one can identify each of these components and understand their interrelationships, one can at least predict the performance of the firm under various assumptions about changes in the external environment. One can also evaluate the richness of the menu of new opportunities from which the firm may select, and its likely performance in a changing environment.

The parameters we have identified for determining performance are radically different from those in the standard textbook theory of the firm, and in the competitive forces and strategic conflict approaches to strategy.[17] Moreover, the agency theoretic view of the firm as a nexus of contracts would put no weight on processes, positions, and paths. While agency approaches to the firm may recognize that opportunism and shirking may limit what a firm can do, they do not recognize the opportunities and constraints imposed by processes, positions, and paths. Moreover, the firm in our conceptualization is much more than the sum of its parts – or a team tied together by contracts.[18] Indeed, to some extent individuals can be moved in and out of organizations and, so long as the internal processes and structures remain in place, performance will not necessarily be impaired. A shift in the environment is a far more serious threat to the firm than is the loss of key individuals, as individuals can be replaced more readily than organizations can be transformed. Furthermore, the dynamic capabilities view of the firm would suggest that the behavior and performance of particular firms may be quite hard to replicate, even if its coherence and rationality are observable. This matter and related issues involving replication and imitation are taken up in the section that follows.

---

[17] In both the firm is still largely a black box. Certainly, little or no attention is given to processes, positions, and paths.

[18] See Alchian and Demsetz, 1972.

II.3. Replicability and Imitatability of Organizational Processes and Positions

Thus far, we have argued that the capabilities of a firm rests on processes, positions, and paths. However, distinctive organizational capabilities can provide competitive advantage and generate rents only if they are based on a collection of routines, skills, and complementary assets that are difficult to imitate.[19] A particular set of routines can lose their value if they support a competence which no longer matters in the marketplace, or if they can be readily replicated or emulated by competitors. Imitation occurs when firms discover and simply copy a firm's organizational routines and procedures. Emulation occurs when firms discover alternative ways of achieving the same functionality. There is ample evidence that a given type of competence (e.g. quality) can be supported by different routines and combinations of skills. For example, the Garvin (1988) and Clark and Fujimoto (1990) studies both indicate that there was no one "formula" for achieving either high quality or high product development performance.

Replication. Replication involves transferring or redeploying competences from one concrete economic setting to another. Since productive knowledge is embodied, this cannot be accomplished by simply transmitting information. Only in those instances where all relevant knowledge is fully codified and understood can replication be collapsed into a simple problem of information transfer. Too often, the contextual dependence of original performance is poorly appreciated, so unless firms have replicated their systems of productive knowledge on many prior occasions, the act of replication is likely to be difficult (Teece 1976). Indeed, replication and transfer are often impossible absent the transfer of people, though this can be minimized if investments are made to convert tacit knowledge to codified knowledge. Often, however, this is simply not possible.

---

19 See Dierickx and Cool (1989) for a discussion of the characteristics of assets which make them a source of rents.

In short, organizational capabilities, and the routines upon which they rest, are normally rather difficult to replicate.[20] Even understanding what all the relevant routines are that support a particular competence may not be transparent. Indeed, Lippman and Rumelt (1992) have argued that some sources of competitive advantage are so complex that the firm itself, let alone its competitors, does not understand them.[21] As Nelson and Winter (1982) and Teece (1982) have explained, many organizational routines are quite tacit in nature. Imitation can also be hindered by the fact few routines are "stand-alone"; coherence may require that a change in one set of routines in one part of the firm (e.g. production) requires changes in some other part (e.g., R&D).

Some routines and competences seem to be attributable to local or regional forces that shape firms' capabilities at early stages in their lives. Porter (1990), for example, shows that differences in local product markets, local factor markets, and institutions play an important role in shaping competitive capabilities. Differences also exist within populations of firms from the same country. Various studies of the automobile industry, for example, show that not all Japanese automobile companies are top performers in terms of quality, productivity, or product development (see e.g. Clark and Fujimoto 1990). The role of firm-specific history has been highlighted as a critical factor explaining such firm-level (as opposed to regional or national level) differences (Nelson and Winter 1982). Replication in a different context may thus be rather difficult.

At least two types of strategic value flow from replication. One is the ability to support geographic and product line expansion. To the extent that the capabilities

---

[20] See Gabriel Szulanski's (1993) discussion of the intra-firm transfer of best practice. He quotes a senior vice president of Xerox as saying "you can see a high performance factory or office, but it just doesn't spread. I don't know why." Szulanski also discusses the role of benchmarking in facilitating the transfer of best practice.

[21] If so, it is our belief that the firm's advantage is likely to fade, as luck does run out.

in question are relevant to customer needs elsewhere, replication can confer value.[22] Another is that the ability to replicate also indicates that the firm has the foundations in place for learning and improvement. Considerable empirical evidence supports the notion that the understanding of processes, both in production and in management, is the key to process improvement. In short, an organization cannot improve that which it does not understand. Deep process understanding is often required to accomplish codification. Indeed, if knowledge is highly tacit, it indicates that underlying structures are not well understood, which limits learning because scientific and engineering principles cannot be as systematically applied. Instead, learning is confined to proceeding through trial and error, and the leverage that might otherwise come from the application of modern science is denied.

Imitation: Imitation is simply replication performed by a competitor. If self replication is difficult, imitation is likely to be even harder. In competitive markets, it is the ease of imitation that determines the sustainability of competitive advantage. Easy imitation implies the rapid dissipation of rents.

Factors that make replication difficult also make imitation difficult. Thus, the more tacit the firm's productive knowledge, the harder it is to replicate by the firm itself or its competitors. When the tacit component is high, imitation may well be impossible, absent the hiring away of key individuals and the transfer of key organizational processes.

However, another set of barriers impede imitation of certain capabilities in advanced industrial countries. This is the system of intellectual property rights, such as patents, trade secrets, and trademarks, and even trade dress.[23] Intellectual

---

[22] Needless to say, there are many examples of firms replicating their capabilities inappropriately by applying extant routines to circumstances where they may not be applicable, e.g., Nestles transfer of developed country marketing methods for infant formula to the third world (Hartley, 1989). A key strategic need is for firms to screen capabilities for their applicability to new environments.

23 Trade dress refers to the "look and feel" of a retail establishment, e.g. the distinctive marketing and presentation style of The Nature Company.

property protection is of increasing importance in the United States, as since 1982 the legal system has adopted a more pro-patent posture. Similar trends are evident outside the United States. Besides the patent system, several other factors cause there to be a difference between replication costs and imitation costs. The observability of the technology or the organization is one such important factor. Whereas vistas into product technology can be obtained through strategies such as reverse engineering, this is not the case for process technology, as a firm need not expose its process technology to the outside in order to benefit from it.[24] Firms with product technology, on the other hand, confront the unfortunate circumstances that they must expose what they have got in order to profit from the technology. Secrets are thus more protectable if there is no need to expose them in contexts where competitors can learn about them.

One should not, however, overestimate the overall importance of intellectual property protection; yet it presents a formidable imitation barrier in certain particular contexts. Intellectual property protection is not uniform across products, processes, and technologies, and is best thought of as islands in a sea of open competition. If one is not able to place the fruits of one's investment, ingenuity, or creativity on one or more the islands, then one indeed is at sea.

We use the term appropriability regimes to describe the ease of imitation. Appropriability is a function both of the ease of replication and the efficacy of intellectual property rights as a barrier to imitation. Appropriability is strong when a technology is both inherently difficult to replicate and the intellectual property system provides legal barriers to imitation. When it is inherently easy to replicate

---

[24] An interesting but important exception to this can be found in second sourcing. In the microprocessor business, until the introduction of the 386 chip, Intel and most other merchant semi producers were encouraged by large customers like IBM to provide second sources, i.e., to license and share their proprietary process technology with competitors like AMD and NEC. The microprocessor developers did so to assure customers that they had sufficient manufacturing capability to meet demand at all times.

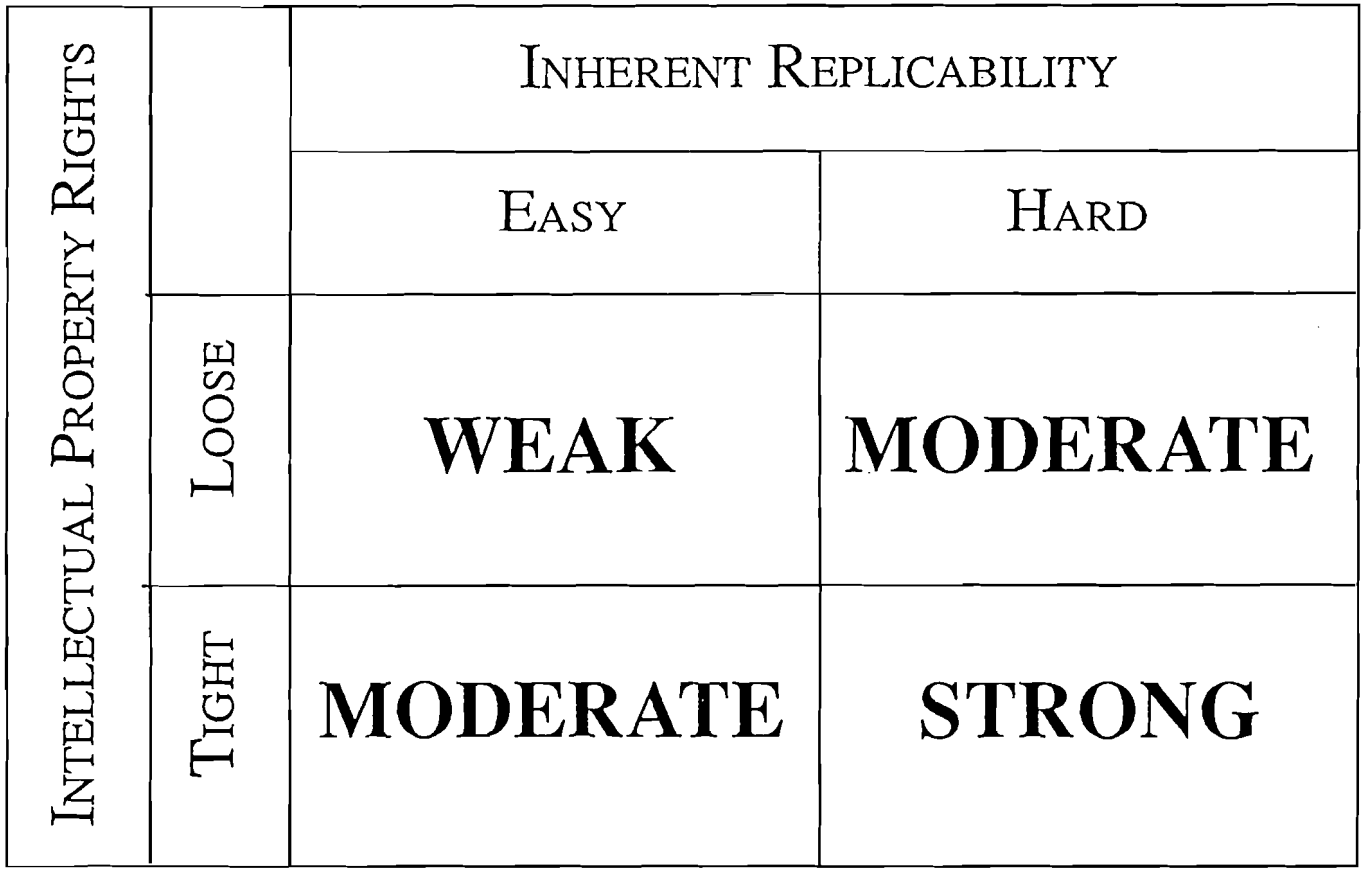
and intellectual property protection is either unavailable or ineffectual, then appropriability is weak. Intermediate conditions also exist (see Figure 1).

II.4. Strategic Issues from a Dynamic Capabilities Perspective

The dynamic capabilities approach views competition in Schumpeterian terms. This means, at one level, that firms compete on the basis of product design, product quality, process efficiency, and other attributes. However, in a Schumpeterian world, firms are constantly seeking to create "new combinations," and rivals are continuously attempting to improve their competences or to imitate the competence of their most qualified competitors. Rivalry to develop new competences or to improve existing ones is critical in a Schumpeterian world. Such processes drive creative destruction. Differences in firms' capabilities to improve their distinctive competences or to develop new distinctive domains of competence play a critical role in shaping long-term competitive outcomes.

The strategic problem facing an innovating firm in a world of Schumpeterian competition is to decide upon and develop difficult to imitate processes and paths most likely to support valuable products and services. Thus, as argued by Dierickx and Cool (1989), choices about how much to spend (invest) on different possible areas are central to the firm's strategy. However, choices about domains of competence are influenced by past choices. At any given point in time, firms must follow a certain trajectory or path of competence development. This path not only defines what choices are open to the firm today, but it also puts bounds around what its repertoire is likely to be in the future. Thus, firms, at various points in time, make *long-term, quasi-irreversible* commitments to certain domains of competence. Deciding, under significant uncertainty about future states of the world, which long-

Figure 1. APPROPRIABILITY REGIMES



term paths to commit to and when to change paths is the central strategic problem confronting the firm. [25]

III. CONCLUSION

We posit that the competitive advantage of firms stems from dynamic capabilities rooted in high performance routines operating inside the firm, embedded in the firm's processes and conditioned by its history. Because of imperfect factor markets, or more precisely the non-tradability of "soft" assets like values, culture, and organizational experience, these capabilities generally cannot be bought; they must be built. This may take years – possibly decades. In some case, as when the competence is protected by patents, imitation by a competitor is illegal as a means to access the technology. The capabilities approach accordingly sees definite limits on strategic options, at least in the short run. Competitive success occurs in part because of processes and structures already established and experience obtained in earlier periods.

The notion that competitive success arises from the continuous development, exploitation, and protection of firm-specific assets, while not the dominant view in industrial organization, nevertheless has a long tradition going back at least to Schumpeter. Schumpeter, in his Theory of Economic Development (1934), saw economic development as consisting of a process where entrepreneurs dipped into a stream of technical opportunities ostensibly made for reasons independent of particular markets and brought those innovations to market. The successful innovator achieved a monopoly in a particular market through bringing to market something which was quite unique, only to have that monopoly successfully whittled away by the entry (swarming) of imitators. The dynamic capabilities

---

25 In this regard, the work of Ghemawat (1991) is highly germane to the dynamic capabilities approach to strategy.

approach is a descendant of the Schumpeterian. However, it emphasizes organizational processes inside the firm more than Schumpeter ever did; nor is it just a positive theory of industrial change. It can also offer prescription because of its firm-level orientation, and it looks inside firms to help explain market processes.

Because it's hard to transform organizational processes, the dynamic capabilities approach sees value augmenting strategic change as being difficult and costly. Moreover, it can generally occur only incrementally. Because capabilities cannot easily be bought and must be built,[26] opportunities for growth from diversification are thus likely to be limited, lying "close in" to the firm's existing lines of product (Rumelt, 1974; Teece et al., 1994). In attempting to explicate competitive advantage, the dynamic capabilities approach places emphasis on the firm's internal processes, assets and market positions, the path along which it has traveled, and the paths that lie ahead. The framework also explicitly takes into account replicability and imitatability.

We offer dynamic capabilities as an emerging paradigm of the modern business firm. It is an eclectic paradigm drawing from multiple disciplines, and advancing with the help of industry studies in the U.S. and elsewhere. There are, of course, a wide variety of theories of the firm, each sometimes highlighting a different aspect.[27] It appears that the dynamic capabilities approach is seeking attention by promising to explain matters such as the limits of diversification, the feasibility of "converting" firms from military to civilian purposes, the adaptability of some firms and the intransigence of others, etc. Perhaps a decade from now we will be able to assess whether the promise has been honored, and whether as a consequence the

---

[26] Robert Hayes (1985) has noted that American companies tend to favor "strategic leaps." while, in contrast, Japanese and German companies tend to favor incremental, but rapid, improvements. If this is correct, it seems to indicate the Japanese and German managers more fully recognize the validity of the dynamic capabilities framework than do their American counterparts.

[27] Thus transaction cost economics highlights boundaries, agency theory highlights incentives and control, and the production function highlights the role of fixed factors.

fields of industrial organization and business strategy can help us solidly come to grips with the challenges of our times.

REFERENCES

Abernathy, W. J. and K. Clark. 1985. "Innovation: Mapping the Winds of Creative Destruction," Research Policy, 14: 3-22.

Alchian, A. A., and H. Demsetz. 1972. "Production, Information Costs, and Economic Organization," American Economic Review, 62: 777-795.

Amit, R. and P. Schoemaker. 1992. "Strategic Assets and Organizational Rent," Working Paper, University of British Columbia, Canada, August 7.

Aoki, M. 1990. "The Participatory Generation of Information Rents and the Theory of the Firm." In M. Aoki et al. (eds.), The Firm as a Nexus of Treaties. London: Sage.

Arrow, K. 1969. "The Organization of Economic Activity: Issues Pertinent to the Choice of Market vs. Nonmarket Allocation." In *The Analysis and Evaluation of Public Expenditures: The PPB System*, 1, U.S. Joint Economic Committee, 91st Session. Washington, DC: U.S. Government Printing Office, 59-73.

Baldwin, C. and K. Clark. 1991. "Capabilities and Capital Investment: New Perspectives on Capital Budgeting," Harvard Business School Working Paper #92-004.

Barney, J. B. 1986. "Strategic Factor Markets: Expectations, Luck, and Business Strategy," Management Science, 32:10 (October 1986), 1231-1241.

Camp, R. 1989. Benchmarking: The Search for Industry Best Practice That Lead to Superior Performance. White Plains, NY: Quality Resources.

Chandler, A. D., Jr. 1990. Scale and Scope: The Dynamics of Industrial Competition. Cambridge, MA: Harvard University Press.

Clark, K. and T. Fujimoto. 1991. Product Development Performance: Strategy, Organization and Management in the World Auto Industries. Cambridge, MA: Harvard Business School Press.

Coase, R. 1937. "The Nature of the Firm," Economica.

Coase, R. 1988. "Lecture on the Nature of the Firm, III," Journal of Law, Economics and Organization, 4: 33-47.

Dierickx, I. and K. Cool. 1989. "Asset Stock Accumulation and Sustainability of Competitive Advantage," Management Science, 35:12 (December), 1504-1511.

Doz, Y. and A. Shuen. 1990. "From Intent to Outcome: A Process Framework for Partnerships," INSEAD Working Paper.

Fama, E. F. 1980. "Agency Problems and the Theory of the Firm," Journal of Political Economy, 88 (April): 288-307.

Fujimoto, T. 1994. "Reinterpreting the Resource-Capability View of the Firm: A Case of the Development-Production Systems of the Japanese Automakers." Draft working paper, Faculty of Economics, University of Tokyo (May).

Garvin, D. 1988. Managing Quality. New York: Free Press.

Garvin, D. 1994. "The Processes of Organization and Management," Harvard Business School Working Paper #94-084.

Ghemawat, P. 1991. Commitment: The Dynamics of Strategy. New York: Free Press.

Hartley, R. F. 1989. Marketing Mistakes. New York: John Wiley.

Hayes, R. 1985. "Strategic Planning: Forward in Reverse," Harvard Business Review (November-December): 111-119.

Hayes, R., S. Wheelwright, and K. Clark. 1988. Dynamic Manufacturing: Creating the Learning Organization. New York: Free Press.

Henderson, R. M. 1994. "The Evolution of Integrative Capability: Innovation in Cardiovascular Drug Discovery," Industrial and Corporate Change, Special Issue, forthcoming.

Henderson, R. M. and K. B. Clark. 1990. "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms," Administrative Science Quarterly, 35 (March): 9-30.

Iansiti, M. and K. B. Clark. 1994. "Integration and Dynamic Capability: Evidence from Product Development in Automobiles and Mainframe Computers, Industrial and Corporate Change, Special Issue, forthcoming.

Kogut, 1. and U. Zander. 1992. "Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology," Organizational Science.

Langlois, R. 1994. "Cognition and Capabilities: Opportunities Seized and Missed in the History of the Computer Industry," Working Paper, University of Connecticut. Presented at the conference on Technological Oversights and Foresights, Stern School of Business, New York University, March 11-12, 1994.

Lev, B. and T. Sougiannis. 1992. "The Capitalization, Amortization and Value-Relevance of R&D." Unpublished manuscript, University of California, Berkeley, and University of Illinois, Urbana-Champaign (November).

Levitt, B. and J. March. 1988. "Organizational Learning," Annual Review of Sociology, 14: 319-340.

Lippman, S. A. and R. P. Rumelt. 1992. "Demand Uncertainty and Investment in Industry-Specific Capital," Industry and Corporate Change (forthcoming 1992).

Mahoney, J. 1994. "The Management of Resources and the Resources of Management," Journal of Business Research, forthcoming.

Mody, A. 1990. "Learning through Alliances," Working Paper, The World Bank, Washington, DC, September 6.

Nelson, R., and S. Winter. 1982. An Evolutionary Theory of Economic Change. Cambridge, MA: Harvard University Press.

Penrose, E. 1959. The Theory of the Growth of the Firm. London: Basil Blackwell.

Porter, M. E. 1990. The Competitive Advantage of Nations. New York: Free Press.

Prahalad, C. K. and G. Hamel. 1990. "The Core Competence of the Corporation," Harvard Business Review (May-June), 79-91.

Rumelt, R. P. 1974. Strategy, Structure, and Economic Performance. Cambridge, MA: Harvard University Press.

Schumpeter, J. A. 1934. Theory of Economic Development. Cambridge, MA: Harvard University Press.

Shuen, A. 1994. "Technology Sourcing and Learning Strategies in the Semiconductor Industry." Unpublished Ph.D. dissertation, University of California, Berkeley.

Szulanski, G. 1993. "Intrafirm Transfer of Best Practice, Appropriate Capabilities, Organizational Barriers to Appropriation," Working Paper, INSEAD (March).

Teece, D. J. 1976. The Multinational Corporation and the Resource Cost of International Technology Transfer. Cambridge, MA: Ballinger.

Teece, D. J. 1980. "Economics of Scope and the Scope of an Enterprise," Journal of Economic Behavior and Organization, 1: 223-247.

Teece, D. J. 1982. "Towards an Economic Theory of the Multiproduct Firm," Journal of Economic Behavior and Organization, 3: 39-63.

Teece, D. J. 1986a. "Transactions Cost Economics and the Multinational Enterprise," Journal of Economic Behavior and Organization, 7: 21-45.

Teece, D. J. 1986b. "Profiting from Technological Innovation," Research Policy, 15:6 (December).

Teece, D. J. 1988. "Technological Change and the Nature of the Firm." In G. Dosi, et al. (eds.), Technical Change and Economic Theory.

Teece, D. J. 1993. "The Dynamics of Industrial Capitalism: Perspectives on Alfred Chandler's *Scale and Scope* (1990)," Journal of Economic Literature, 31 (March 1993).

Teece, D. J., R. Rumelt, G. Dosi, and S. Winter. 1994. "Understanding Corporate Coherence: Theory and Evidence," Journal of Economic Behavior and Organization, 23 (1994), 1-30.

Tushman, M. L., W. H. Newman, and E. Romanelli. 1986. "Convergence and Upheaval: Managing the Unsteady Pace of Organizational Evolution," California Management Review, 29:1 (Fall), 29-44.

Wernerfelt, B. 1984. "A Resource-Based View of the Firm," Strategic Management Journal, 5: 171-180.

Williamson, O. E. 1975. Markets and Hierarchies. New York: Free Press.

Williamson, O. E. 1985. The Economic Institutions of Capitalism. New York: Free Press.

Womack, J., D. Jones and D. Roos. 1991. The Machine That Changed the World. New York: Harper-Perennial.