

Introduction

This volume contains a selection of articles that I have written over the last two decades which analyze business issues associated with technological innovation. Each article constitutes a separate chapter. The reader will hopefully find that each chapter is written to address very practical management and policy issues, in a way that is explicitly linked to research in the social sciences. Put differently, I have endeavored to keep inquiry both scholarly and practical at the same time. This approach runs the risk of pleasing neither scholars nor practitioners. Hopefully, however, there is a constituency of executives of an intellectual persuasion who will find this book helpful, along with scholars interested in understanding management issues surrounding technological innovation, technology transfer and licensing.

Part I contains a series of papers that develop the conceptual foundations necessary for the analysis of strategic management in a world characterized by rapid technological change.

The first chapter, written for the *California Management Review*, discusses the importance of knowledge as a source of competitive advantage. The transformation of developed economies from raw-material processing and manufacturing activities to the development, application and transfer of new knowledge requires that firms not only combine factor inputs, but that they generate new knowledge and become excellent at storing knowledge, drawing from it, and combining knowledge inside the firm with know-how obtained externally. The evolution of competitive markets for final products as well as many inputs leaves the creation, augmentation and orchestration of intangible assets as a primary (if not in the primary) basis for competitive differentiation in many sectors. Competitive environments in new technology-based industries also require business enterprises to develop the ability to sense as well as seize new opportunities, and to reconfigure and protect knowledge assets so as to achieve sustainable competitive advantage.

Chapter 2 contains my *Strategic Management Journal* article co-authored with Gary Pisano and Amy Shuen that develops the “dynamic capabilities” approach to strategic management. This paper has had considerable impact on the study of strategic management and was recently identified by *Science Watch* magazine (December 2005) as the most cited article in economics, business and finance for the decade 1995–2005. The “dynamic capabilities” approach derives

from the resource-based or “firm competence” theory of the firm; but while the resource-based theory focuses on those capabilities which form the basis for competitive advantage in a static environment, dynamic capabilities emphasize those traits which enable the firm to sustain its competitive advantage over time in response to change. This chapter explains the significance of processes, positions and paths, and defines some of the key terminology used in strategic management analysis today.

Chapter 3, written in conjunction with J. Lamar Pierce and Christopher S. Boerner for a conference in memory of Richard Cyert, highlights the major influence that Cyert and March’s *Behavioral Theory of the Firm* (1963) had on the “firm competence” and “dynamic capabilities” approaches to strategic management. Both theories build on the foundational concept of “standard operating procedures”, introduced by Cyert and March and called “routines” by Nelson and Winter (1982). Moreover, Cyert and March’s focus on the heterogeneity of firm characteristics is consistent with the development of the “firm competence” or resource-based theory of the firm. Cyert and March’s portrayal of the firm as an inherently rigid entity in a dynamic environment is a starting point for the “dynamic capabilities” theory, which seeks to explain the differential ability of firms to change with their environment. The dynamic capabilities approach recognizes certain rigidities but does not see them as completely beyond management ability to modify.

Chapter 4 in this volume, written with Mie Augier, discusses the important contribution that Edith Penrose’s work on *The Theory of the Growth of the Firm* (1959) made to the resource-based and “dynamic capabilities” theories of the firm. Penrose’s main contribution was defining the firm as an administrative framework for utilization of the firm’s “pool” of resources — a concept that substantially underpins the resource-based view of the firm. Penrose also recognized the fungibility of certain resources and the explicit role managers and entrepreneurs play in marshalling resources behind productive opportunities. Until the emergence of the “resources” and “dynamic capabilities” literatures, Penrose’s most recognized insight was the argument that the ability of firms to grow depends on the unused capacities of management. This insight, along with her concept of fungible resources, influenced my 1982 article on the multiproduct firm. However, the usefulness of Penrose’s theory for strategic management is limited in that she does not address how firms develop competitive advantage. She also sometimes underplays the importance of knowledge assets. Nevertheless, Penrose’s insights remain good starting points for developing a

theory of the firm and understanding the role of the manager. She highlights many important issues “swept under the rug” by others.

In Chapter 5, I attempt to elucidate the role of entrepreneurs and managers in a market economy, an issue left undeveloped by mainstream economic theory as well as by Cyert and March, and by Penrose. I analyze the essential role that managers play in orchestrating the deployment of assets in “thin” (illiquid) markets where the price mechanism does not work well. Because of “thin” markets, management plays a role in deciding to build assets rather than buy them, and in redeploying assets inside the firm (rather than selling them). The manager’s role in orchestrating the deployment of assets is particularly important when the property rights associated with assets have “fuzzy boundaries” (as with intangibles), suffer from appropriability concerns, and are highly co-specialized. This role is magnified further in “*n*-sided” markets (where demand for a product is driven by multiple, interdependent groups situated in separate but complementary markets) and in rapidly changing environments. Since managers play such an important role in these situations, understanding the role managers can play in creating value is a critical component of the “dynamic capabilities” approach to strategic management.

The chapters in Part II develop these foundational concepts in the context of intellectual capital, technology transfer and organizational learning.

Chapter 6, also written with Mie Augier, develops the notion of intellectual capital, the development, ownership and use of which is key to business performance in the economic system. The important role that intellectual — or knowledge — capital plays in the modern economy is increasingly being realized. However, although the early (classical) economists recognized the importance of innovation, the inherent limitations of neoclassical theorizing mean that mainstream economic theory has not been particularly insightful with respect to the causes and nature of technological progress and learning. This article surveys the valuable insights that have been generated by a few economists and social scientists who have investigated the phenomena of organizational learning and technological change more deeply. It also discusses the key features of intellectual capital that differentiate it from other forms of capital, and some of the issues involved in measuring intellectual capital.

Chapter 7 in this volume was written for a special issue of the *Journal of Technology Transfer* in memory of my distinguished thesis advisor, Edwin Mansfield. This paper highlights the influence that Edwin Mansfield had on my initial research into technology transfer and on understanding the role of the multinational corporation. Mansfield rejected the static analysis of mainstream

economic theory, and favored an interdisciplinary approach to understanding the role of technology and technological change. As a consequence, he was attuned to the costs of technology transfer, and encouraged me to empirically investigate what was then a virgin area of research. This work in turn laid the foundations for understanding the role of the multinational firm. When combined with Mansfield's work on spillovers and the high social rates of return to innovation, my work and Mansfield's strongly supports the thesis that the multinational firm is an instrument of economic development, rather than a tool for the extraction of monopoly rents and the amplification of poverty.

Chapter 8, an article I wrote with Gary Pisano in 1989, investigates the role that collaborative arrangements play in firm strategy for exploiting new technology in a dynamic technological environment. When technology is changing rapidly, the competitive advantage of an incumbent firm is continuously under threat. The firm faces important strategic decisions in choosing where to source new technology, and (if it sources that technology externally) what organizational mode it should adopt for commercializing that technology. The article discusses how the "location" of the invention, the ease of appropriability, and the "transaction costs" of writing and executing contractual relationships affect the technology sourcing strategies and the choice of organizational mode for external procurement. It also illustrates them in the context of the telecommunications equipment industry. These decisions are important strategic choices made by managers and entrepreneurs. The ability to match correctly the strategy to the environment — key elements of a firm's business model — is a key element of the dynamic capabilities of the firm.

Chapter 9 of this volume extends the research of firm capabilities to economic development and highlights the role of the firm as a central agent of economic development. While the differences in institutional context mean that much of the mainstream economic analysis of industrial organization and regulation is irrelevant for newly industrialized economies, firms in developing economies face very similar problems to those in advanced industrial countries in trying to leverage existing assets into new and/or related business. Hence, the insights gained from research on the basic processes of organizational learning and advancement can more plausibly be extended to the developing-country context. Moreover, firms in newly industrialized economies can take advantage of the institutional context of developed countries (particularly, the open intermediate product markets and international market for know-how) to access the complementary assets and technology developed elsewhere.

Chapter 10 was originally written with Christopher S. Boerner and Jeffrey T. Macher for the *Handbook of Organizational Learning and Knowledge*. It reviews the research in economics that speaks to the critical phenomena of organizational learning. The ability of mainstream economic theory to inform organizational learning is limited by the highly stylized set of assumptions about the behavior of managerial and economic decision-makers. Insights into organizational learning have been generated by modifying some of the behavioral, institutional and equilibrium assumptions of the neoclassical economic model. Even more significant insights into learning have come from scholars analyzing the economics of innovation and the theory of the firm. They have relaxed many of the strict assumptions used by many economic theorists.

Scholars of innovation, for whom the processes by which firms acquire new knowledge is a central concern, have identified the different learning processes that apply to internal sources of knowledge, and recognized that the unique trajectories of incremental and cumulative technological innovation are a consequence of the existing pool of knowledge capital and specific learning processes. Meanwhile, economic researchers studying the theory of the firm, who seek to understand how firms adapt to changing circumstances, have elucidated the limitations and possibilities for learning associated with different forms of organization, the crucial dimensions along which firms vary in their ability to acquire and exploit knowledge, and the processes and mechanisms that firms employ to create new knowledge. The insights from these two strands of literature form the basis for the “dynamic capabilities” approach to strategic management.

Chapter 11, written with Ikujiro Nonaka, presents some suggested directions for research in knowledge management that evolved out of the U.C. Berkeley Forum on Knowledge and the Firm. This advice is still very pertinent today. In this chapter, we urge that research in this area be conducted in a transdisciplinary fashion — that is, integrating the existing approaches from different disciplines and creating a new, multifaceted view of human behavior. A key proposition of the knowledge management literature is that firm-level competitive advantage in open economies follows from creating, protecting and using difficult-to-replicate knowledge assets. However, establishing this proposition quantitatively is quite challenging methodologically because in order to do so, one needs to establish measures for intangible assets as well as dynamic capabilities. Therefore, careful efforts to quantify the value of intangible assets and to understand how they feed into profitability are highly desirable.

Part III contains three articles that apply the concepts developed in Parts I and II to address several key strategic issues faced by firms in innovative industries.

Chapter 12, originally published in 1988, outlines a framework for analyzing how an innovator captures value from its innovation. The chapter introduces three concepts — the appropriability regime, the notion of complementary assets, and the dominant design paradigm — that are useful in determining the optimal strategy of a firm commercializing a new technology, and understanding why imitators sometimes can capture more value from innovation than its inventor. The key insight is that in weaker appropriability regimes, the control of complementary assets becomes critical to enterprise profitability once the market settles on a dominant design.

Chapter 13, written with Peter C. Grindley for the *California Management Review*, discusses intellectual property (IP) management and licensing strategies in the context of the history of the semiconductor and electronics industries. The evolution of licensing practices within these industries highlights how optimal strategies change with the increasing importance of intellectual capital. Although royalty-free cross-licensing initially evolved as a response to regulatory and judicial constraints in the early days of the industry, amplified by the consent decrees signed as a solution to AT&T and IBM's antitrust problems, this strategy became inappropriate as the regulatory environment changed, global competition sharpened, and the value of intellectual capital increased. In recent years, IP owners have begun to enforce their intellectual property rights more aggressively. This article highlights the importance of intellectual property and intellectual capital in the current environment. It also provides lessons for managing intellectual capital.

The final chapter, a recent paper co-authored with Deepak Somaya, builds on the discussion of IP management of semiconductors and electronics in Chapter 13 and the organizational modes discussed in Chapter 12 to describe how entrepreneurs can effectuate and capture value from innovation in multi-invention contexts. The chapter also introduces the various patent strategies available to entrepreneurs to support their choice of organizational mode, and discusses which business models and patent strategies are most appropriate in different situations.

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