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chapter 11

Technological Capacity as Fitness

An Evolutionary Model of Change in the International Political Economy

Sangbae Kim and Jeffrey A. Hart

INTRODUCTION

The resurgence of U.S. international competitiveness on the basis of its relative strength in the new leading sectors—computers and other information industries—has brought about a debate on adopting the U.S. model of business and industrial institutions among firms and governments in other countries. The United States is currently the most successful country in the world in adjusting to the so-called Information Revolution. The existence (or creation) of appropriate governance structures—industrial structures, government policies and institutions, and other institutional environments—explains the U.S. success in the computer and other information industries (Hart and Kim, 2000).

This is in a sharp contrast with the 1980s when the relative decline of U.S. international competitiveness was a major topic of debate. Then, American firms and governments were trying to learn from Japanese business practices and industrial institutions, especially the Toyota-style production system (also called "lean production"). Japanese international competitiveness in automobiles, consumer electronics, and computer hardware components could be explained by its unique form of industrial governance, which they created during the catch-up period of economic growth.

In this chapter, building on Borrus and Zysman's (1997) work, we attempt to understand the impact of governance structures in the United States on the computer industry by using the concept of *Wintelism,* a term derived from combining the *W* from Windows—Microsoft's popular operating system—and *Intel,* the world's leading producer of PC microprocessors. *Wintelism writ small* refers to the structural dominance of Microsoft and Intel in their respective parts of the global personal computer industry. *Wintelism writ large* signifies the transformation of the whole computer industry toward horizontal value-chain specialization, which gives rise to new governance structures (Kim and Hart, forthcoming).

In particular, we understand the rise of Wintelism both as a new mode of technological competition in the global computer industry and as a new *industrial paradigm* that we believe is of profound importance beyond the boundaries of the computer industry. Wintelism as a new industrial paradigm is potentially comparable to the British industrial model in the nineteenth century, Fordism in the early and mid twentieth century, and Japan's so-called Toyota production system of more recent vintage.

The idea of an industrial paradigm implies not only a set of new technological changes but also a set of practices and institutional arrangements that become increasingly important if not dominant in the global political economy. Much of the earlier literature on industrial paradigms contains debates about the ability of various social systems and political regions to adjust themselves to technological changes and the subsequent global impact of a shift in industrial paradigms. In this sense, the rise of Wintelism as a new industrial paradigm will present similar challenges of adjustment to firms and governments as did the rise of previous industrial paradigms.

In this chapter, we will focus on the question of the transition from earlier industrial paradigms to the Wintelist paradigm. What factors will influence the decision of firms and governments to switch over to the practices that are consistent with the new paradigm? What factors will permit some firms, regions, or countries to insulate themselves from the necessity of adjusting to the new global paradigm? Finally, what are the opportunity costs of not adjusting? By answering these questions, we aim to clarify the evolutionary and interactive dynamics of technological change and institutional adjustment in the International Political Economy (IPE), and to explain changes in international competitiveness in an industry as the consequence of technological versus institutional changes.

In particular, we offer a *theory of technological fitness.* In our theory, success or failure in industrial sectors depends not only on a *fit* between the properties of technology in individual sectors and types of governance structures in national institutions, but also on the abilities of nations to adjust their institutional capabilities to the given technological conditions. In other words, selection of industrial practices depends on the *fitness* of those practices with respect to a given economic environment. Fitness also depends on the degree to which a particular economic environment is insulated from global competition, whether by natural or man-made factors, and on the practices of both firms and governments that are appropriate in a given industry.

In subsequent sections of this chapter, after critically reviewing existing approaches to technology and institutions, we ask whether each technological system requires a particular governance structure. In particular, we will modify Herbert Kitschelt's (1991) framework on the fit between technological properties and governance structures to develop an evolutionary model of industrial paradigm change in the global political economy. We further examine the issue of technological fitness and institutional adjustment in an evolutionary context. Finally, we explain how nations can succeed or fail in adjusting to the rise of new technological systems, and how they may decide to specialize on particular industrial sectors through different industrial learning paths.

EXISTING APPROACHES TO TECHNOLOGY AND INSTITUTION

The prevailing neoinstitutional approaches to industrial innovation and competitiveness in the IPE are not adequate for conceptualizing the interactive dynamics of technological change and institutional adjustment. They mainly concern national variations of institutional capabilities for creating and diffusing technological innovations that influence the competitiveness of specific industries. These approaches describe national patterns of industrial performance in terms of the relationships among domestic institutions that specify the rules of interaction among actors—business, government, labor, and so forth. They then evaluate the extent to which each set of domestic arrangements helps or hinders nation-states in their attempts to achieve national economic performance goals (Katzenstein 1978, 1985; Zysman 1983; Zysman and Tyson, eds. 1983; Hall 1986; Hart 1992).

These national-level analyses can provide us with useful concepts to understand the impact of a nation's institutional inheritance on policy outcomes and national variations in innovative performance, but they do not provide the sector-specific understandings of industrial change that are often critical to capture the dynamics of policy responses. Scholars who rely on *sectoral analyses* criticize those using nation-wide approaches for conducting their analysis at too high a level of aggregation. Indeed, the description of sweeping aggregate national patterns may hide considerable policy variance across industrial sectors within each country (Kitschelt 1991). A national-level institutional framework that is hospitable to one set of technologies may not be to another. Many national-level analysts, however, provide categories of institutional conditions that they expect to be similar across sectors without closely examining the sectoral variations (Shafer 1994).

Sectoral approaches in contrast rely upon sector-specific properties and endowments—variously defined—to explain actor's behavior, and, in turn, political-economic outcomes (Kurth 1979; Rogowski 1989; Gourevitch 1986; Frieden 1991; Shafer 1994; Gilmore 1997). They use aspects of technology, markets, or other inputs—ownership or liquidity of capital, source of income, labor markets, and so forth—either alone or in combination as independent variables to determine the preferences of economic actors in a specific sector. Their research questions are primarily on how to explain cross-national and intranational variations in the capacity of states to implement policies to promote industrial competitiveness, to help firms adjust to technological change, and to seize opportunities in international markets, under the assumption that there will be sectoral variation.[1]

These studies have made major contributions to our thinking about the relevance of sector-specific policies and institutions. However, they tend to overlook the continued divergence in *national systems of innovation* across nations engaged in the same industry, and thus a major source of divergence in state capacities for restructuring and sustained innovation. In this sense, sectoral and national approaches are antithetical, as Gilmore (1997) points out. In particular, the two disagree over the primary determinants of individual action and collective outcomes, and how institutions originate and change. However, what we want to do here is not to decide which approach is best, sectoral or national, but rather to explore the ways in which sectoral and national structures interact in shaping industrial adjustment and restructuring.

Both sectoral and national analyses generally overlook the coevolving processes of technological and institutional change—the adjusting of existing institutions to new technologies that goes on at the same time that technological choices are made with an idea to their fit with existing institutions. Instead, they view the two types of change as relatively independent of one another. A coevolutionary perspective may help us better to explain both changes in both sectoral and national governance structure over time. There are at least three approaches that qualify as essentially coevolutionary: (1) the neo-Schumpeterian approach, (2) the flexible specialization approach, and (3) the regulation approach.

Evolutionary economics, based on the Schumpeterian intellectual tradition, is the first of these approaches. It experienced a particularly notable rise in popularity in recent years with the publication of Richard Nelson's and Sydney Winter's (1982) pioneering study, *An Evolutionary Theory of Economic Change.* That work challenged the static framework of neoclassical economics and set forth an evolutionary theory of the economy. It treated "technical advance as an evolutionary process, in which new technological alternatives compete with each other and with prevailing practice, with *ex post* selection determining the winners and losers, usually with considerable *ex ante* uncertainty regarding which the winner will be" (Nelson 1998: 322).

In the same Schumpeterian tradition, Giovanni Dosi's concept of *technological paradigm* and Christopher Freeman's and Carlota Perez's concept of *techno-economic paradigm* provide useful frameworks for understanding the coevolution of technologies and institutions (Dosi 1982; Dosi et al. 1988; Freeman and Perez 1988). According to Freeman and Perez, for example, changes in technological paradigms

> have such widespread consequences for all sectors of the economy that their diffusion is accompanied by a major structural crisis of adjustment, in which social and institutional changes are necessary to bring about a better *match* between the new technology and the system of social management of the economy. (1988: 38)

Therefore, the definition of innovation should not be confined narrowly to a range of new products or industrial processes. Innovation includes new forms of work organization and management, new high growth sectors, new transport and communications technologies, new geographies of location, and so on. It is in this context that

> the computer revolution, which was accelerated by the microprocessor in the 1970s, has been followed by a growing recognition of the importance of organizational and managerial changes (*multi-skilling, lean production systems, downsizing, just-in-time,* stock control, worker participation in technical change, quality circles, continuous learning). The diffusion of a new techno-economic paradigm is a trial and error process involving great institutional variety. (Freeman and Soete 1997: 312).

Despite this apparent sensitivity to the contextual environment, in this view, the history of capitalism remains one in which new techno-economic forces always do the initial acting and old socioinstitutional frameworks the eventual reacting. The socioinstitutional context is clearly subordinate to the technoeconomical and its autonomy is strictly bounded.

The flexible specialization approach predicated on the neo-Smithian perspective is also useful for analyzing technological and institutional changes. (Sabel 1982; Piore and Sabel 1984; Sabel and Zeitlin 1985; Hirst and Zeitlin 1989, 1991) Michael Piore and Charles Sabel (1984) base their argument on a simple conceptual distinction between two ideal types of industrial production: mass production and flexible specialization. The type of industrial production affects the nature of institutions and governance structures. Piore and Sabel argue that craft production involves the use of general-purpose machinery and skilled labor, has low-fixed capital costs, and therefore promotes small firms in associative networks of exchange and reciprocity. In contrast, mass production utilizes dedicated (specialized) machinery and unskilled labor, has high-fixed costs, and fosters large integrated corporations in imperfectly competitive or oligopolistic markets.

However, Piore and Sabel argue further that technological choice must be endogenized within a sociocultural process. The emphasis is very much on social innovation and only secondarily on embodied technology. Central to this choice are the policy decisions taken by different actors that influence the diffusion of one or the other paradigm. Institutions are created in a context of conflict and rivalry. At rare historical turning points, or *industrial divides,* active choices taken in one direction or the other tend to consolidate into an epoch-making standard favoring either mass production or flexible specialization. "Thus one paradigm suffers because of the absence of supporting structures, while the other, it seems, gains in strength, because it comes to be seen as 'best practice' by industry, government and other institutions" (Amin 1994: 13–15).

As Herbert Kitschelt points out, Piore and Sabel's model places less emphasis on technological versus socioinstitutional factors as compared with that of the neo-Schumpeterians. Their model stands on two implicit premises: "The first is that technological systems, taken by themselves, do not determine which governance structures are efficient, and the second is that institutions are not adopted in a process of rational choice or evolutionary selection on the basis of their efficiency in delivering desired services" (Kitschelt 1991: 459). Indeed, Piore and Sable understand that a sociocultural process is relatively autonomous, and sociocultural models alone, not technology and efficiency, shape governance structure. In their view, governance structures are politically created and do not simply unfold according to an interior technological logic.

The third approach, the so-called *regulation school*, is consistent with the neo-Marxist tradition (Aglietta 1979; Lipietz 1987; Boyer 1988, 1990). In order to articulate and explain the systemic coherence of individual phases of capitalist development, regulation theory draws on two key concepts. One is the *regime of accumulation*, a "set of regularities at the level of the whole economy, enabling a more or less coherent process of capital accumulation." The other is the *mode of regulation*, "the institutional ensemble (laws, agreements, and so forth) and the complex of cultural habits and norms, which secures capitalist reproduction as such" (Nielsen 1991: 22). According to the regulation school, these two basic dynamics emerge out of the bedrock of capitalist social relations.

The regulation school's idea of a post-Fordist era of capitalism is a case in point. For them, Post-Fordism emerges from an interaction between technological transformations (a new regime of accumulation) and institutional transformations (a new mode of regulation). In their view, each particular mode of regulation is designed to control and stabilize a particular phase of capitalist growth, differing in important respects from the preceding phase. Institutional forms differ considerably between the regimes of early and mature *competition regulation* in the nineteenth century and the *monopolistic* (or Fordist) mode of regulation in the period since the Second World War.

According to Elam (1994), the regulation approach sharply contrasts against the other two approaches. In contrast to the neo-Schumpeterian perspective that subjugates a diffuse and unspecified *socioinstitutional* framework to an irresistible and relatively articulate *techno-economic paradigm*, the regulation perspective pays more attention to autonomous institutional forms that fill the gap between technological and institutional spheres. In contrast to the neo-Smithian perspective that subjugates politics and institutional arrangements to the invisible hand of the market, the regulation perspective sees markets as institutions usually encompassed by other institutions, which guarantee social cohesion through the coordination of private activities (Elam 1994: 57).

These evolutionary approaches may be more useful for explaining dynamics of technological and institutional changes than the sectoral and neoinstitutional approaches discussed earlier. However, all of them still lack an analytic method for describing the range of technologies and associated governance structures and for predicting the relationship between successful innovations and supporting institutional conditions. In particular, they have done little to develop theoretical tools that would enable us to understand the *selection mechanism* for determining the

fitness of governance structures in relation to underlying technological conditions. Without such an analytic scheme, success or failure in adapting to coevolving technological and institutional changes cannot be explained.[2]

THEORETICAL FRAMEWORKS FOR EXPLAINING INSTITUTIONAL FITNESS

To develop a theoretical framework of institutional fitness for technological systems, we need to outline analytic types of technological systems and to distinguish types of governance structures to which they are expected to relate. Thus, we first rely on Herbert Kitschelt's (1991) theoretical framework for dealing with technological systems because, unlike the approaches discussed above, it makes predictions about the fitness of associated governance structures for various types of technological systems. We also draw upon neoinstitutional approaches to industrial change and international competitiveness in order to distinguish types of governance structures in national institutions that match each technological system. These theoretical resources help us to identify the mechanisms that establish the correspondence between technological systems and governance structures, and the interplay between sectoral and national conditions.

Kitschelt's Frameworks for Technological System

A definition of industrial sectors should be based on technological systems in order to develop a theory of the technological determinants of industrial governance structures. In this research, we adopt Herbert Kitschelt's definition of an industrial sector. He puts it this way:

> [An] industrial sector is often defined exclusively in terms of market conditions. But similar products and services may be delivered with different techniques and factors inputs. For this reason, I conceptualize a sector as a technological system within a particular market segment (1991: 460)

To distinguish analytic types of technological systems as industrial sectors, Kitschelt draws on recent contributions to organizational theory in sociology, economics, and business history. In particular, he relies on two main theoretical sources: Charles Perrow (1984) on technology and organization and Oliver Williamson (1985) on technological systems and governance structures. Kitschelt argues that any technology has two important dimensions that influence the choice of governance structures: One is the *degree of coupling* in the elements of a technological system, and the other is the *complexity of causal interactions* among production stages.

First, the tightness of coupling refers to the requirement for spatial or temporal links between different production steps. In tightly coupled systems, there are close spatial and temporal links between production steps. Thus, the production steps must be done at the same location or at the same time. In loosely coupled systems, however, each step or component of production is separated from every other step in space and time. Thus the production steps can be done in any sequence at any location. Tight coupling requires close supervision in order to contain problems that might otherwise spread quickly to other processes, but loose coupling permits less-centralized control because errors in system components do not easily affect the entire system. In short, the tighter technological elements are coupled, the more control needs to be centralized.[3]

This concept of coupling is closely related to the scale of the economy: the amount of capital investment required, the size of firms and individual production facilities, and so forth. If a technological system is tightly coupled, it generally requires a large economy with high levels of capital investment for local firms to be successful. However, if the technological system is loosely coupled, just the opposite holds. Kitschelt also relates the tightness of coupling to the organizational pattern of research and development research and development (R&D): "Tightly coupled systems require 'global' learning in which innovation addresses the mutual fit of all system components. Loosely coupled systems, in contrast, can afford more 'local' learning through improvement of individual system components" (Kitschelt 1991: 462).

Second, the complexity of causal interaction refers to the importance of feedback among production stages that is required to keep the whole process on track. In systems with complex interaction, elements influence each other mutually and engage in circular causal interaction. Thus, complex systems have large information requirements to manage the intricate flow of connections across processes. In systems with linear interaction that proceed from one stage to the next without feedback, the causality between elements is not complex. Thus, linear systems have fewer information requirements. In complex interactive systems, the monitoring, analysis, and correction of production processes take place in decentralized organizational units, because a centralized control would be quickly overloaded. In contrast, less complex systems with linear causality among the components are more amenable to centralized control because the straightforward intelligibility of systemic interactions reduces the probability that centralized control units will be overloaded with information processing.[4]

This concept of causal complexity is closely related to types of problem solving in R&D. If a technological process is in complex causal interaction, then its trajectories involve greater uncertainty in the interplay of system components, and are not readily predictable. Thus technological innovations have to be explored by trial and error, yielding fast-paced technological change with major breakthroughs followed by small incremental improvements. However, if the technological process is in causally linear systems, then its trajectories are predictable and production advances in continuous, incremental steps. These trajectories are associated with low levels of uncertainty and risk, thus facilitating programmed, incremental strategies of problem solving.

Based on his two criteria of technological systems—coupling and complexity, Kitschelt distinguishes five technological clusters from Mark I to Mark V technology, and matches them to possible efficient governance structures or favored institutional arrangements. In this research, we modify his categorization by reinterpreting Kitschelt's Mark III and Mark V categories. We divide his Mark III into two distinct technological clusters, Type 3 and Type 5a, and rename his Mark V as Type 5b.[5] Thus we create six types of distinct technological systems in all. (See Figure 11.1) These six types of technologies correspond to the empirical presence of *the leading sectors*—or the cyclical development of technological innovations—in the history of industrialization as described below.[6]

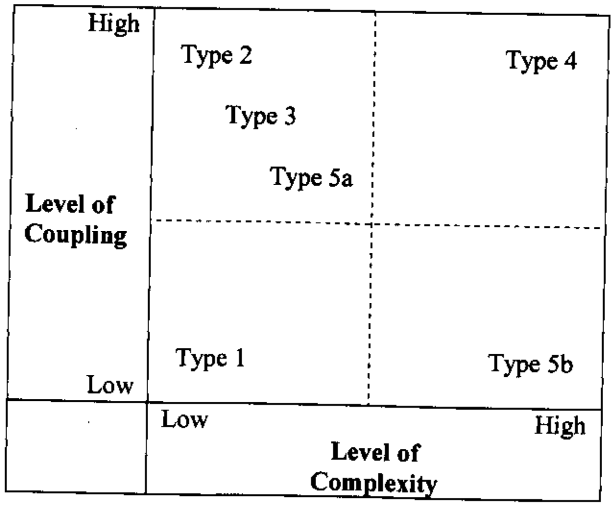

Figure 11.1 Analytic Types of Technological Systems

Sources: Modified from Kitschelt (1991) pp. 468–75, and Golden (1994) p. 129.

- *Type 1 technology* is a loosely coupled technological system with linear interaction among its components. Concentrated ownership is not necessary, nor are there important economies of scale. Because knowledge intensity is quite low, technological trajectories in this case are readily predictable. Therefore, new technologies are incrementally innovated. Consumer goods, light machine tools, and textiles belong to this type.
- *Type 2 technology* is a tightly coupled technological system with linear causal complexity. Because knowledge intensity remains fairly low, advances in product technologies are made incrementally along predictable trajectories. But, this type of technology requires large capital investments, and economies of scale increase rapidly over time. The heavy industries, such as iron, steel, and railroads, belong to this type.
- *Type 3 technology* is a considerably tight-coupled technological system with moderately low causal complexity. This type of technological system involves moderate knowledge intensity, and technological trajectories are readily predictable. Thus, product advances are made incrementally, but capital requirements are considerably high, and economies of scale are considerable. Chemical production, electrical engineering, consumer-durable goods, and automobiles belong to this type.
- *Type 4 technology* is a tightly coupled technological system with high causal complexity. Because this type of technology requires intensive knowledge, its trajectory is quite unpredictable. Advances in product technologies are made by leaps, not incrementally. Economies of scale are very large, and investment risks are very high. Representatives of this type of industry include nuclear power, aerospace, and large-scale computer and telecommunication systems.
- *Type 5a technology* is a relatively tight-coupled technological system with moderately low causal complexity. Because this type of technological system involves moderate knowledge intensity, the technological trajectories are generally predictable, and product advances are usually made in incremental steps with some breakthroughs. These are capital-intensive and high-volume industries that operate in commodity-like markets. Economies of scale are initially high, but decrease over time. Examples include consumer electronics and computer hardware components such as dynamic random access memories (DRAMs) and flat panel displays (FPDs).
- *Type 5b technology* is a loosely coupled technological system with high causal complexity. Because this type of technological system involves high intensity of knowledge, the technological trajectories are highly unpredictable. Problem solving for this type of technology is not readily predictable in time, cost, or in final results. Thus, innovations occur in these technological systems as a process of localized trial-end-error learning, often in interaction with customers. The economies of scale are initially moderate, but increase over time. Examples of this type of technology are computer software, microprocessors, and biotechnology.

Kitschelt's idea of analyzing the degree of coupling and the complexity of causal interactions is very useful in distinguishing types of technological systems and in predicting how well each type of technological system will fit a particular governance structure. Kitschelt hypothesizes that each technological system requires a distinct governance structure for maximum performance. Although the combination of coupling and complexity of a technological system do not determine a uniquely optimal governance structure, they do at least constrain the efficient possibilities. What types of governance structures match each technological system?

Neoinstitutional Frameworks of Governance Structure

To understand the potential *match* between technological systems and governance structures, it is necessary first to distinguish analytic types of governance structures. Although Kitschelt presents a framework for distinguishing types of appropriate governance structures, his framework is somewhat inadequate. Relying on Perrow's approach, Kitschelt's framework is mainly based on the distinction between *centralized* and *decentralized* governance structures. He relies on Williamson's work in order to add two more types—*market-oriented* governance structures, and *mixed* private and public networks—somewhere in between the centralized and decentralized extremes.

Kitschelt's typology of governance structures, therefore, is too one-dimensional—centralized and decentralized governance structures mark the endpoints on a continuum, whereas his typology of technological systems is obviously two-dimensional: with coupling and complexity forming the two dimensions. We thought it might be useful to match the two-dimensional categorization of technological systems with a two-dimensional categorization of governance structures.

As discussed earlier, some neoinstitutional approaches try to explain why and how particular types of domestic institutional arrangements—national-level governance structures—have succeeded in creating innovations, and in diffusing new technologies, while other types have had difficulties.[7] They attempt to show that variations in national institutions explain why similar sectors in different countries are associated with varying governance structures, and why different sectors in the same country develop similar governance structures. Among the institutional elements that account for sectoral variations, two key variables have gained special attention by neoinstitutional scholars on industrial innovations and competitiveness: (1) the organizing principle (or the pattern of integration) of corporate and industrial structure and (2) the industrial role of the state in relation to the societal sector (Fong 1990).

Analytic types of *industrial governance* can be distinguished by observing the characteristics of the industries and their firms that affect their economic behavior and impact upon government policy (Chandler 1977 1990; Aoki 1986; Utterback and Suarez 1990; Lazonick 1991; Grove 1996; Fransman 1999). Such industry characteristics include the size of the industry, the organizational structure of firms, the degree of concentration of ownership, the level of interfirm coordination, the degree to which user-producer (or manufacturer-supplier) links are utilized by firms in the industry, the presence of national or cross-national production and distribution networks, and the corporate and managerial cultures of firms and industries.

For the purpose of this research, we will categorize industrial governance into three main types of integration: *vertical, networked,* and *horizontal.* The more vertically integrated corporate or industry structure is, the more centralized industrial governance is expected to be; the more horizontally integrated it is, the less centralized industrial governance is expected to be.

- *Vertical Integration:* The industry's organizing principle is based on hierarchical control, and the degree of integration among industrial units is tight or closed. For example, inputs, assembly, and distribution are vertically integrated. The firms rely far less on outside suppliers than other types, tending to be far more self-sufficient in producing or procuring parts. Corporate and industry structure among the minicomputer firms along Route 128 near Boston and large American computer and communication companies, such as IBM and AT&T, are considered to belong to this type of industrial governance.
- *Horizontal Integration:* The industry's organizing principle is based on horizontal coordination, and the degree of integration among industrial units is loose or fragmented. For example, inputs, assembly, and distribution are horizontally integrated. The firms rely far more on outside suppliers than other types, tending to be far more interdependent in procuring parts. The semiconductor industry in Silicon Valley in California is a prime example of this type of industrial governance.
- *Networked Integration:* This type is located somewhere between vertical and horizontal integration. Japanese industrial organizations, as typified by interlocking business ties within *keiretsu* industrial groups, are examples.

Analytic types of *state governance* can be distinguished by observing the industrial role of the state or the patterns of industrial policy (Evans, Reuschemeyer and Skocpol 1985; Krasner 1984; Nordlinger 1981). The so-called *strength of the state*—the capabilities of government agencies and other national political institutions in relation to the business sector, including mechanisms of state penetration into society—or *state-societal arrangements*—defined in terms of the distribution of power among the state, the private business sector, and organized labor—is often considered to be a critical factor for understanding the nature of state governance (Hart 1992). More specifically, the industrial role of the state is embodied as industrial policy, which refers to the deliberate attempt by the government through a range of specific policies such as financial subsidies, trade protectionism, promotion of research and development, and procurement to determine the structure of

the economy. Although we are mostly interested in these *micro* aspects of industrial policy popularly known as *industrial targeting,* we also take into account the effects of more generic, *macro* policies that differentially affect specific industries or create capabilities relevant to specific industries, such as antitrust policies, intellectual property protection policy, and educational policies.

For the purpose of this research, we will categorize state governance into three types: *interventionist, developmental,* and *regulatory.* The more interventionist the state is, the more centralized state governance is expected to be; the more regulatory the state is, the less centralized state governance is expected to be.[8]

- *The Interventionist State:* The role of the state is intrusive and interventionist in the economy. The *strong* state is largely autonomous from society and can direct economic activities in directions it considers socially or politically desirable. This type of governance involves a vertically coordinated and tightly controlled bureaucracy. The communist or fascist ideal of the state belongs to this type.
- *The Regulatory State:* The role of the state tends to be a minimal one. The predominant responsibility of the state is to correct market failures and provide public goods. That is to say, the state has principally a regulatory and facilitating role. These *weak* states frequently become the captives of interest groups. This type of governance is horizontally coordinated and loosely controlled. The so-called *liberal state* belongs to this type.
- *The Developmental State:* This type is located somewhere between the interventionist and the regulatory. The contemporary Japanese state, with its close cooperation between the state and business, is an example.

The neoinstitutional framework of industrial and state governance provides us with a useful guideline to distinguish types of governance structures at both the national and sectoral levels. In particular, Kitschelt's one-dimensional typology of governance structures—from centralized to decentralized structures—is obviously enriched by our two dimensional modification. Indeed, these principal components of national governance most directly affect industrial innovations and an economy's international competitiveness, and differentiate their systems of political economy in the contemporary world.

Institutional Fits for Technological Systems

How are these types of governance structures expected to relate to analytic types of technological systems identified above according to properties of technology? How do we relate each sector to a predicted governance structure? Efficient national governance structures shaped by properties of associated technological systems—from Type 1 to Type 5b technology—can ideally be described as follows (See Figure 11.2).

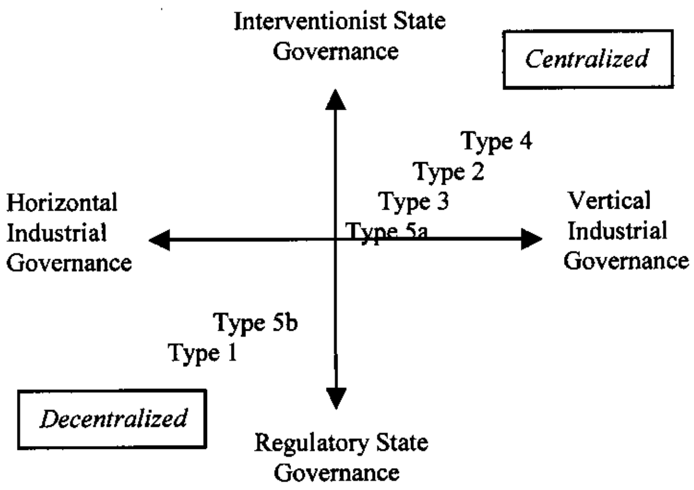

Figure 11.2 Institutionalized Fits for Technological Systems

- Governance structures for *Type 1 technology* (loose coupling and linear causal complexity) match a combination of *horizontal* industrial governance and *regulatory* state governance. This is *highly decentralized* market-oriented governance with a *weak* state and *strong* business. As Kitschelt (1991: 466) argues, "innovation in these systems stems from the disjointed, local, and incremental process of *learning by doing*, rather than from systematic research organization." Therefore, centralized involvement in technology development is often inefficient.
- Governance structures for *Type 2 technology* (tight coupling and linear causal complexity) generally match a combination of *vertical* industrial governance and *interventionist* state governance. This is basically a *centralized* government-guided governance model witnessed in the industrializing countries with *strong* state intervention during the early stages of industrial catching-up. As Kitschelt (1991: 466, 471) argues, "the domestic structures that gained advantage were those which facilitate industrial centralization, state involvement in industrial development, or a combination of both."
- Governance structures for *Type 3 technology* (considerably tight-coupling and moderately low-causal complexity) primarily match a combination of *networked* or *vertical* industrial governance and *developmental* or *interventionist* state governance. However, the increasing tightness and scale of the economy require this governance structure to bring about a *relatively centralized* mass-production model: high-volume production of mass-produced standardized goods or intermediate products using standardized machinery. The markets of Type 3 technologies shift from initially competitive to imperfectly competitive markets, and firm governance becomes increasingly vertical.

- Governance structures for *Type 4 technology* (tight coupling and high causal complexity) match a combination of and *vertical* industrial governance and *interventionist* state governance. This is *highly centralized* governance requiring *strong* state involvement, which often puts the burden of investment risks on public agencies, even in cases where the technologies could be developed or produced in privately owned facilities. According to Kitschelt (1991: 467–68), "because an efficient form of governance appears to be difficult to establish, (technologies of Type 4 develop) only under the tutelage of national governments, with private investors relieved from all or most of the investment risks through cost-plus contracts, favorable regulation, or outright public entrepreneurship."
- Governance structures for *Type 5a technology* (relatively tight-coupling and moderately low-causal complexity) primarily match a combination of *networked* or *vertical* industrial governance and *developmental* or *interventionist* state governance. In contrast to governance structures appropriate for Type 3 technologies, the role of state here is more limited and the pattern of industrial governance less vertical. This is a *cooperative* governance model between the state and other societal actors, infusing an element of flexibility into production systems and reducing the risks for individual firms of investing in new technologies. According to Kitschelt (1991: 472), this kind of governance structure "fostered networks of medium-sized companies with close linkages between customers and suppliers and close interaction with a nonprofit research infrastructure of universities and laboratories."
- Governance structures for *Type 5b technology* (loose coupling and high causal complexity) match a combination of a *horizontal* industrial governance and *regulatory* state governance. This is basically *decentralized* market-oriented governance. However, in contrast to the similar governance structure for Type 1 technology, this type requires more *sophisticated* institutional arrangements. The rise of clan-like and collegial groups, such as start-up firms with an entrepreneurship, are primarily expected; and small venture capitalists invest in the nodes of the network in which causal relations are sufficiently well understood. However, in cases where R&D uncertainties are substantial and markets for venture capital remain underdeveloped, a governance structure with mixed private and public R&D supports is required. Large corporations with decentralized structures or intercorporate alliances of various sorts are needed in order to provide necessary R&D costs. Moreover, a comprehensive public and semipublic infrastructure of technological development through universities, professional associations, and

research centers can further R&D efforts. The regulatory role of the state to promote start-up firms and private investment like venture capital is also considered to be important.

The framework of technological and institutional fit, as outlined above, tells us that *industrial learning* about the technological fit of governance structures likely occurs in a particular sector, and the fit determines the outcomes. That framework, however, does not specify *how* industrial learning occurs. To account for the process of industrial learning, we must therefore further explore how sectoral (or technological) and national (or institutional) conditions interact to produce successful or unsuccessful outcomes of institutional adjustment, to what degree industrial learning occurs, and in what feedback process the adjustment strategy corrects itself. Moreover, we must answer what factors—incentives or obstacles—should be considered for the successful adjustment This must be related to the question that is probably the most interesting one from the national policy perspective: What strategies are needed for the countries to create—or emulate—efficient governance structures for a new technological system?

AN EVOLUTIONARY MODEL OF INSTITUTIONAL ADJUSTMENT

Now we apply the theoretical framework discussed above to explain the rise of technological systems and responses of the form of institutional adjustments as parts of an evolutionary model of technological fitness. This evolutionary model will help us understand the rise and fall of industrial paradigms in *leading sectors* of the global political economy, and further provide an explanatory framework for understanding the persistence of national institutional diversity.

Technological Fitness in the Evolutionary Context

As in any evolutionary analysis, we need to examine four basic mechanisms: variation, selection, amplification, and cooperation. Because our subject is the evolution of a set of social institutions and practices possibly modified by institutional adjustment strategies, the causes of variation, selection, amplification, and cooperation will be social rather than natural. Large changes, therefore, can be expected to occur over shorter time periods than they do in nature (Modelski and Poznanski 1996). Figure 11.3 provides a brief analytic summary of the hypothesized interactions between technological systems, national governance structures, and institutional adjustment in contributing to success or failure in industrial sectors.

The ultimate source of *variation* in industrial practices is technological change—that is, technological innovation in products and processes at the level of the firms or research laboratories. Occasionally technological innovations give rise

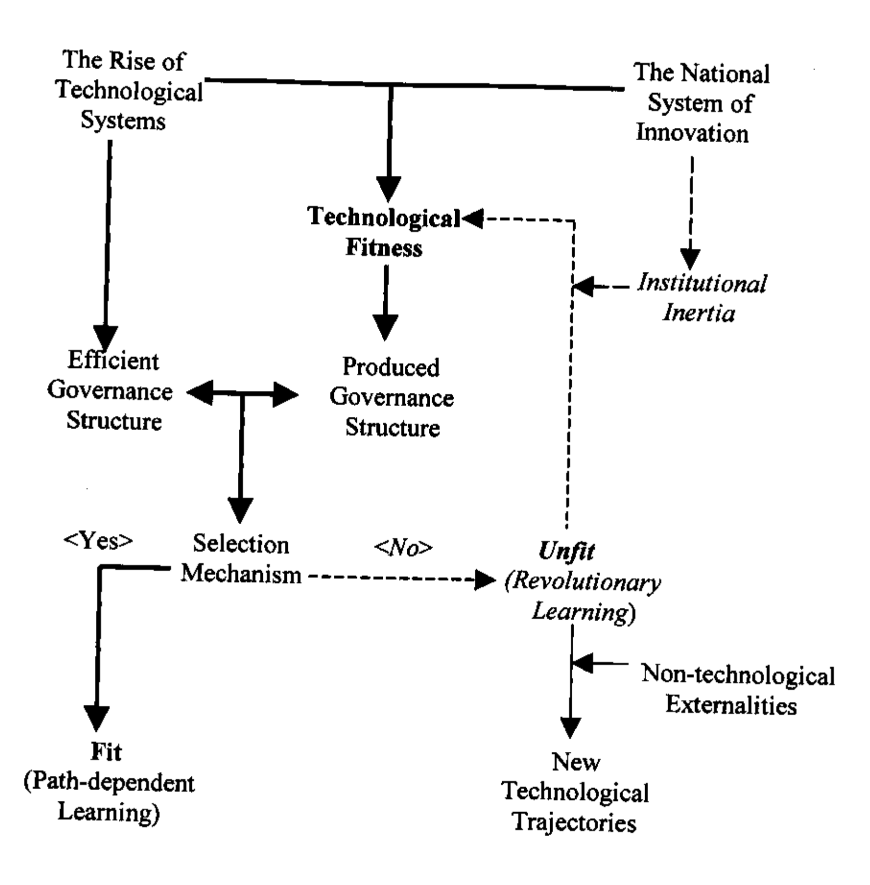

Figure 11.3 An Evolutionary Model of Institutional Adjustment

to a new technological system, or, as evolutionary economists call it, a *technological paradigm shift* (Dosi 1982; Freeman and Perez 1988). Since industrial sectors are defined by their underlying technological conditions, the rise of a technological system alters fundamental conditions within specific industrial sectors.

Technological innovations very often transform the economic characteristics of industries, the basic direction (and structure) of markets, the nature of opportunities and risks in those markets, the mode of competition, and the range of competitive strategies available to firms. The rise of new technological systems also transforms the institutional characteristics of industries. Because a new technological system often requires new governance structures for best performance, when a new technological system arises, institutional requirements for successful innovation and productive efficiency in those sectors also change. In the face of technological change, therefore, established firms have to make adjustments to handle new competitive conditions and states have to create new policy tools and adjust national institutional arrangements in order to be able to assist firms in dealing with technological change.

In the theory presented above, the outcomes of these adjustments depend on whether they can produce new governance structures that fit the new technological system. Kitschelt (1991: 480) amplifies on this point by saying that,

> ... success or failure depends not only on a match between the properties of technology in individual sectors and the national institutional capabilities but also on the abilities to translate these properties and capabilities into efficient sectoral governance structures.

We will refer to the closeness of the match between governance structures and technological systems as *technological fitness*. We will distinguish between short-term technological fitness that arises almost accidentally from a close fit between national governance structures and a new technological system and the long-term fitness that arises out of conscious efforts on the part of the state and other institutions to adjust to the new technological system.

Institutional adjustment is a critical factor in the success of firms in new industrial sectors over the long term. We focus here on adjustments in two key types of national governance structures—industry structures and the industrial role of the state. In this sense, we distinguish institutional adjustment from related terms in IPE such as *structural adjustment, industrial adjustment*, and *economic adjustment*, which define various forms of policy coordination for coping with structural changes in macroeconomic conditions or overall comparative advantage, but which do not necessarily focus on the fit between governance structures and technological systems.

To summarize, technological fitness works as a *selection mechanism* in the coevolution of technological change and institutional adjustment. The more a nation can develop technological fitness, the more it will succeed in an industrial sector. Over time, *selection* should yield nearly identical (or at least similar) governance structures in identical sectors, regardless of national differences in other areas. If the governance structures of a particular nation diverge from the structure needed to foster growth in a given technology, industries associated with that technology will not grow as rapidly in that country.

Path-Dependent Learning and Industrial Paradigms

Every nation has different institutions. All, without exception, have strengths and weaknesses for the development of particular industrial sectors. Thus, major technological changes tend to benefit some nations more than others. As Kitschelt (1991: 468–69) argues,

> ... countries will successfully innovate in those new sectors in which their prior institutional endowments are conducive to the emergence of governance structures optimal in those sectors. Under these circumstances, the cost of learning to master a new technological trajectory is quite modest and sectors will seize new opportunities quickly.

If a nation adopts a new technological system that fits an already existing pattern of governance, that nation can achieve success within a framework of *path-dependent learning* (following the **bold** line in Figure 11.3). Usually one or two nations—mostly through path-dependent learning—survive and prosper from the initial transition to a new industrial paradigm. Subsequent moves toward fitness in other countries/regions are primarily the result of conscious sociocultural change. Only through the process of adjusting national institutions to technological change, can they adapt to a new industrial paradigm. Occasionally, however, a new industrial paradigm emerges from an attempt on the part of a given nation (or region) to partially adapt its institutions to earlier technological changes. The new institutions still do not fit the dominant technological system but they are well suited to still newer technological systems that have the potential to create a new industrial paradigm of their own.[9]

Now, we present brief descriptions of six distinct industrial paradigms that have been created (or is being created) in leading sectors. (See Table 11.1) Each industrial paradigm emerges from a particular moment in industrial history and from a specific nation that benefits from an initial advantage in fitness and from cheaper path-dependent learning.

Table 11.1 Leading Sectors versus Industrial Paradigms

	Leading Sectors	Industrial Paradigms	The Fittest
Type 1	Consumer Goods, Light Machine, Textiles	The British Model	Britain
Type 2	Iron, Steel, Railroads	The Late-Industrializer Model	Germany
Type 3	Chemicals, Electrical Engineering, Consumer-Durables, Automobiles	Fordism	The United States
Type 4	Nuclear Power, Aerospace, Large-scale Computer, and Communication Systems	The Manhattan Project Model	The United States
Type 5a	Consumer Electronics, Computer Hardware Components	The Japanese Model	Japan
Type 5b	Computer Software, Microprocessor, Biotechnology	Wintelism	The United States

- *The British Model* in the late-eighteenth and early-nineteenth centuries: The *light industry-production* model supported free markets and the *liberal state*—noninterventionist and nonauthoritarian state governance combined with parliamentary supremacy and property suffrage—emerged during the textile industrialization in Britain. It matches *highly decentralized* governance in Type 1 technologies, such as consumer goods, light machine tools, and textiles (Kurth 1979).
- *The Late-industrializer Model* in the mid to late nineteenth century: The *heavy industry-production* model supported by oligopolistic markets and *authoritarian states*—along with large investment banks—which undertook large capital costs, emerged in the late industrializers, particularly Germany, Austria-Hungary, Italy, and Russia. It matches *centralized, government-guided* governance in Type 2 technologies, such as iron, steel, and railroads (Gerschenkron 1962).
- *Fordism* in the late-nineteenth and the twentieth centuries: The *mass production* model supported by large corporations and the *welfare state* emerged in the United States, and then became the model of industrial development in the years after World War II. It matches *relatively centralized* governance in Type 3 technologies, such as chemical production, electrical engineering, consumer-durable goods, and automobiles (Amin 1994; Bakker and Miller 1996).
- *The Manhattan Project Model* in the mid-twentieth century: The *megaproject* production model supported by the military like the *strong state's* capabilities expending very large, highly engineered military R&D projects emerged in the United States century particularly during the Cold War period. It matches *highly centralized* governance in Type 4 technologies such as nuclear power, aerospace, and large-scale computer and telecommunication systems (Ferguson and Morris 1994: 172).
- *The Japanese Model* in the late-twentieth century century: The lean production model[10] supported by a cooperative, sometimes networked social structure of firms—the so-called *keiretsu* system—and the *developmental* state—a cooperative network between the state and other societal actors—emerged in postwar Japan. It matches *moderately centralized* governance in Type 5a technologies such as consumer electronics and computer hardware components (Kitschelt 1991).
- *Wintelism* in the latter part of the twentieth century (and possibly into the twenty-first century): The so-called Silicon Valley model supported by *horizontally segmented* industrial structures combined with a *regulatory* state is emerging as an industrial paradigm in the United States. It matches *sophisticated decentralized* governance in Type 5b technologies such as computer software, microprocessors, and biotechnology (Ferguson and Morris 1994; Borrus and Zysman 1997).

A new industrial paradigm created in a specific nation tends to become more general and diffuses to other nations over time. Once a nation succeeds in establishing an industrial paradigm in a leading sector, it is likely that other nations will try to copy it. In both cases of the British model and the American Fordism, for example, a single dominant style of production organization spread out from a single dominant core country—Britain in the former case, the United States in the latter. In the similar vein, since the early 1980s, Japanese management and production systems have attracted worldwide attention because they offer techniques and methods of production that outperformed existing U.S. and European systems. In this way, a successful model of industrial paradigm tends to diffuse across national boundaries.

Revolutionary Learning and Institutional Inertia

Those nations whose prevailing national governance structures do not match the institutional requirements of a new technological system—and whose weaknesses in institutional capabilities are critical obstacles for success—have fewer possibilities to be successful in the sector unless they deliberately attempt to create new governance structures. In this case, therefore, an alternative possibility is that nations will promote their technological fitness through *revolutionary learning*—involving a major break with past practices, as seen Figure 11.3, following the *dotted* line.

In the case of revolutionary learning, the task of institutional adjustment is more complicated because it requires adjusting not only industrial structures and industrial policies but also deeper aspects of the national system of innovation. Moreover, institutional adjustment through revolutionary learning may involve changing deeply rooted institutions such as educational systems or labor-management systems.

To conceptualize the deeper aspects of a social system relating to technological innovation, evolutionary economists adopt the concept of *national systems of innovation*—the "network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman 1987: 1). In the very similar context, Margaret Sharp (1997) adopts the concept of *science and technology* (S&T) *infrastructure* to describe the deeper aspects of a national system of innovation. According to Sharp (1997: 101), S&T infrastructure involves high quality secondary education, a good vocational training system, a strong university sector, a well-found academic research base with a major postgraduate component, university-industry linkage, research associations that support technology dissemination to small and medium-sized business, and the encouragement of regional initiatives bringing together firms, universities, and research institutions.

S&T infrastructures differ markedly across nations. One major cleavage is between the S&T infrastructures of technological leaders and followers. S&T infrastructure in technological leaders tends to be *macroscopic*, providing a broadly based capacity for original thinkers to create new knowledge. General emphases are on enhancing human resources in basic research, creating and maintaining a strong university participation in R&D, and nourishing a *liberal* tradition in postgraduate educational institutions. In contrast, S&T infrastructure in catch-up or follower countries tends to be *microscopic*, implementing specific tasks necessary for catching up with the leaders. Thus, general emphases are on enhancing human resources in applied engineering, corporate initiatives in R&D, and nourishing a *developmental* tradition in both educational institutions and state bureaucracies.

When a nation has an already well-established national system of innovation or S&T infrastructure, it is much more difficult to achieve the goal of adjustment through revolutionary learning. This is because there is *institutional inertia.* Institutional inertia usually comes from an unwillingness to try new techniques when old ones have proven to be successful in the past. With regard to the institutional inertia, Robert Gilpin (1996: 413) convincingly holds,

> . . . past success itself can become an obstacle to further innovation and adaptation to a changed environment; a society can become locked into economic practices and institutions that in the past were congruent with successful innovation but which are no longer congruent in the changed circumstances. Powerful vested interests resist change, and it is very difficult to convince a society that what has worked so well in the past may not work in an unknown future. Thus, a national system of political economy that was most fit and efficient in one area of technology and market demand is very likely to be unfit in a succeeding age of new technologies and new demands.

Failures to adjust the system are caused mainly by assuming that the future will be like the past and that what was done in the past will work in the future. More importantly, however, failures are also caused by the continuing political strength of interests strongly associated with the methods and results of past successes. The system will not change as long as those established political forces successfully resist changes in the system and ignore the need for reforms.

Such institutional inertia often prevails when a nation attempts to adopt or emulate a new industrial paradigm of foreign origins. The new industrial paradigm is often embedded in a web of interrelated social institutions in the nation of origin that cannot easily be copied or adapted.

Much of the earlier literature on industrial paradigms contains debates about the ability and/or necessity of various social systems and political regions to insulate themselves from the global impact of a shift in industrial paradigms. For example, many countries in Western Europe had difficulties in adjusting to the American mass-production techniques typical of the Fordist industrial paradigm. Rather, they attempted to preserve the institutions that were compatible with traditional family-owned businesses with their smaller-scale and craft-related production.

Similarly, there is a more recent debate about the ability and/or necessity of both American and European firms and governments to adopt the practices associated with the Toyotaist industrial paradigm. Toyotaism requires a commitment

by suppliers and assemblers to cooperate that is easier to obtain in national systems that encourage vertical integration of firms than in systems that discourage it. Countries with strong organized labor may have difficulties changing labor-management relationships to accommodate lean production practices like *just-in-time* delivery of components.[11] Without careful consideration of these cross-national differences in antitrust enforcement and labor-management relations, importing Toyotaist practices may not have the desired effects (Abo 1996).

Japan's difficulties in the computer software industry can be understood in the same context. Recently, Japan has been trying to adjust its system to adopt the so-called Silicon Valley model—or Wintelism—as an institutional solution for the computer industry. Wintelism is consistent with the existing cultural and institutional environment of the American system. However, the corporate cultures, educational system and other social institutions in Japan are not consistent with Wintelism even though they were supportive of past industrial success (Kim 2000).

In our theory, the inability or unwillingness to change out-dated systems due to institutional inertia lies at the heart of industrial failures. Unless they can find some other ways to compete in new industrial sectors—through revolutionary learning or path-dependent learning that encourages the rise of new industrial paradigms—then countries with such systems will suffer relative economic decline. If a nation cannot successfully establish appropriate governance structures in the industrial sector, technological leadership may pass to other countries better able to make the necessary institutional adjustments in new sectors, as seen in Table 11.1.

Before concluding, we call attention to the possibility of revolutionary learning by *non-technological externalities* as seen in Figure 11.3. This point is closely related to the argument contained in Modelski and Thompson's theories on long waves and the long cycle in global politics (Modelski and Thompson 1996; Thompson 1990). During international crises or wars, learning may sharply diverge from the path-dependent learning usually witnessed in governance structures. Victory or loss in a major war or a fundamental change in a country's position in the international system can serve as a motivating factor for revolutionary learning. The success of Type 4 technology and the emergence of the Manhattan Project model in the United States (and partially in France), for example, were obviously affected by the exigencies of World War II and the Cold War.

CONCLUSIONS: THE GLOBAL POLITICS OF INDUSTRIAL SPECIALIZATION

Even in an increasingly globalized world economy, nations tend to display very different institutional responses in adjusting to technological changes. Variations in national circumstances may often lead to diverse paths of institutional solutions, and result in diverse industrial outcomes. We cannot imagine the adoption of a single best solution for a technological system by every society. Likewise, we cannot posit that the adoption or emulation of a given industrial paradigm will always yield identical governance structures in identical sectors across national boundaries guaranteeing identical successes.

Given limited national resources and institutional capabilities, it is exceedingly unlikely that every country will succeed in creating or emulating all new industrial paradigms as they arise. Countries may choose (or may be forced to choose) to specialize (or *cooperate*) in particular sectors, in which they have advantages, rather than to invest in all industrial sectors. As a result, they may choose to continue to occupy sheltered *niche markets* within a larger economic environment. Usually, countries will choose those technologies and governance structures that *minimize* any possible adjustment costs. In other words, nations may choose only to emulate industrial paradigms that are located close to existing institutional arrangements (Kitschelt 1991: 470).

As a result, there will be always be some tendency toward specialization, even in the three major industrial regions—Western Europe, Japan and the United States. In Western Europe, for example, Germany specializes in engineering, chemicals, high-quality machinery, and intermediate equipment goods (Type 2 or Type 3); France in nuclear power and high-speed trains (Type 4); and the United Kingdom in finance and pharmaceutical (Type 1 or Type 5b). Japan continues to specialize in automobiles (Type 3), consumer electronics and electronic components (Type 5a). And, the United States specializes in aerospace (Type 4) and biotechnology, microprocessors and computer software (Type 5b).

In this process of industrial specialization, each country enters new industries under a different set of initial conditions affected by a different set of decisions and events; therefore, each nation followed its own path to its present position. Some pre-existing conditions worked well, while others did not. Countries succeed in one new industry, but not in others. Each country uses its national repertoire of strategies to take advantage of strengths built up in specific areas over decades of pursuing a specific institutional capability. For example, Germany takes advantage of the richness and quality of the skills of German workers, Japan takes advantage of its system of large firms and stable subcontractors, and the United States relies on the excellence of university research and the easy availability of venture capital (Boyer 1996: 52–53).

In fact, a new conceptualization of industrial specialization among nations is not based on different resource endowments, as understood in neoclassical theories of comparative advantage, but on varied institutional capabilities in relation to technological changes. In other words, specialization will be based on important differences among the countries in terms of *technological fitness* in a general context of institutional inertia. Nations will succeed in new industrial sectors when their existing industrial governance structures fit the institutional requirements of the new technological system. Also, nations will succeed in the new industries if they can successfully adjust their existing institutional capabilities to the requisite properties of the new sector.

Two further points about specialization can be made. The ability to support diverse industrial and state governance structures across industries will be a great advantage to any nation that aspires to be a major industrial power with competitive strengths in a broad range of industries. Second, a nation can partially compensate for its inability to adjust domestically by encouraging domestic firms to partner with foreign firms and by encouraging inward foreign investment on the part of foreign firms from countries with higher technological fitness. These options become less expensive as the world economy becomes more global.

When the firms of nations that have technological fitness in leading sectors dominate the most profitable businesses, the long-term consequences of global industrial specialization might be to increase the level of global economic inequality. Thus, there is a strong incentive for nations to develop institutional arrangements that permit multiple forms of industrial and state governance to coexist domestically. There is also some incentive for contemporary nations to support the continuation of trends toward economic globalization as a way of stemming increases in global economic inequality. There is much evidence from the past, that this is not an easy task. George Modelski and William Thompson (1996), for example, hold in their empirical research that rises and declines in leading sectors in the global economy—connected with the so-called Kondratieff waves—were linked to the rise and decline of world powers in what they call the long cycle of global politics. The world powers listed in Table 11.1 were countries that had technological fitness in leading sectors, and thus were able to define new industrial paradigms, but only for a limited time. The uncertainty about maintaining top-dog status in an environment of rapid technological change creates a new logic of international competition where the need to foster multiple forms of technological fitness simultaneously may overwhelm the tendency toward domestic institutional inertia.

NOTES

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1. In his seminal work Michael Porter (1990) explores a similar question on nations' industrial performances not only across nations and across industries within the same nation, but even within the same nation and industry over time.
2. Presenting an advanced version of sectoral analysis, Gilmore tries to offer an explanation of the selection mechanism. He hypothesizes, "a state is more likely to facilitate innovation in those sectors in which institutional endowments and policy choices are conductive to both the pursuit of viable market strategies, and unfettered domestic rivalry." In his theory, "institutions and policies must *fit* the requisites of competition in global markets. Only then will policy makers enjoy the autonomy and relative capacity to effectively formulate and implement technology policy" (emphasis added) (Gilmore 1997: 41). However, his analytic framework of the *fit* between market condition and institutions is still inadequate to understand the dynamics of technological factors.

3. According to Kitschelt, Perrow's concept of coupling is in the same context as Williamson's concept of *asset specificity*. "Assets are considered highly specific if they are committed to a particular location, production process, or customer. In other words, high asset specificity establishes *tight linkages* (in Perrow's sense) between different elements and stages in the production process, whether it is based on purely technical or purely economic conditions, whereas low asset specificity established *loose linkage*" (emphasis added) (Kitschelt 1991: 464).
4. Kitschelt also places Williamson's concepts of *uncertainty* and *frequency of interaction between suppliers and customers* in the same context as Perrow's concept of *causal complexity*. "Uncertainty in contractual linkages has a technical and an economic face. High uncertainty often stems from the *complex causal interaction* among agents and techniques involved in the production process and requires, in Perrow's sense, decentralized intelligence and the autonomy of professionals. Conversely, low uncertainty is generally associated with *linear causal linkage*. In complex interactive production processes, it is difficult to specify contracts fully in advance and hence to enforce them. These circumstances also enable self-interested actors to take advantage of underspecified contracts by opportunistic behavior" (emphasis added) (Kitschelt 1991: 464).
5. There are two reasons we present type 5a and type 5b, instead of type 5 and type 6. On the one hand, it is still hard to distinguish clearly the two types of interrelated technological systems, which keep transforming; on the other hand, it is the critical part of our research design to contrast these two types of technologies, thus we use a set of paired labels: type 5a and type 5b.
6. Among various industrial sectors growing at different rates, *leading sectors* are expanding rapidly, and thus drive the rest of the economy. The leading sector is characterized by quantitative increases in output and qualitative improvements in the basic technology, and thus is a generator of high rates of profits, wages, and employment. From this leading sector, secondary and tertiary industries are spun off and radiate growth throughout the economy (Modelski and Thompson 1996).
7. In a similar vein, to explore these similarities and differences among nation-states, evolutionary economists adopt the concept of *national systems of innovation*—the "network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman 1987; Freeman and Perez 1988; Lundvall 1992; Nelson 1993; Freeman and Soete 1997).
8. This categorization of state governance is usually based on the scale of technological systems—in Kitschelt's terms, the tightness of coupling. Some scholars have previously dealt with the relationship between governance structures and new technologies. For example, when Kurth (1979) argued that countries in which industrialization was driven by light consumer goods, rather than by heavy industry, were likely to end up as liberal democracies, one of his independent variables was the 'scale' of individual technological systems. See Kitschelt (1991: 457–58).
9. The concept of production systems—such as Fordism, Post-Fordism, or Toyotaism (the lean production model)—has been used primarily by the Regulation School to describe the range of particular methods of procuring and combining various inputs and managing the whole manufacturing process at the level of the workplace. An industrial paradigm is a broader concept that includes within it a production system—but goes beyond it to also include a set of institutional arrangements that fit that production system.
10. Origins of the Japanese lean production model are from the automobile industry such as Toyota and other Japanese auto companies. However, electronics producers like Matsushita and Hitachi applied this lean production principles in order to innovate in traditional consumer electronics products with all solid-state televisions. As in autos, adoption of lean production techniques enabled Japanese electronics firms to create new and distinctive market segments by the late 1970s with the Walkman, VCR, and Camcorder, and by the early 1980s, to challenge U.S. leadership in semiconductors. In many respect, this model is the *Japanese-style Post Fordism*.

12. Scholars like Wolfgang Streeck argue that Toyotaism is inconsistent with the German model of labor-management relations, and that German auto firms will therefore have to find some other way to compete with Japanese auto firms in their main markets (Streeck 1996).

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chapter 12

Continuity versus Evolutionary Shift
Global Financial Expansion and the State

Brian M. Pollins

> The notion that something fundamental is happening, or indeed has happened, to the global economy is now increasingly accepted . . . we live in a period of major economic change; an era of turbulence and volatility in which economic life is being restructured and reorganized both rapidly and fundamentally.
>
> —Peter Dicken (1992)

> The economic changes that have occurred during the last quarter of a century . . . have unquestionably been more important and varied than during any former corresponding period of the world's history.
>
> —David A. Wells (1890)

Comments like Peter Dicken's cited above were found easily during the 1990s. Many aspects of global economic life are, indeed, changing, and several observers have succumbed already to the temptation to declare the arrival of the millennium. Not unlike early writers in the "interdependence" school thirty years ago, some major commentators today tell us the nation-state is obsolete, peace is at hand, and world politics is being transformed.[1] But this is hardly the first time that the world has experienced rapid change, as the above quotation from David Wells—made just over one hundred years ago—would suggest.[2] Recent developments must be considered in historical context if we are to assess their implications accurately. In my judgment, the current boom in international capital flows is the single most important feature among many changes in today's global economy. For this reason, I have chosen to focus on a study of capital flows in this chapter.

There is neither any doubt that capital flows are presently growing at breathtaking rates, nor is there any doubt that these flows are having important economic and political impacts as they expand. It is not yet clear, however, that the growth in volume is unprecedented in history, especially when compared to broad indicators of economic activity such as total investment or national product. The purpose of this chapter is to provide a longer historical view, and improve our understanding of recent developments by placing them in historical context.

International banking and finance have existed even longer than the state system itself. Feudal monarchs often financed public works, armies and navies, as