National Specificities and the Context of Change: The Coevolution of Organization and Technology

GIOVANNI DOSI
BRUCE KOGUT

The chapters in this book present a wide range of evidence that the organizing of work varies considerably among countries. Country variations are historically persistent; in the language of Midler and Charue (Chap. 9), they have the characteristic of "irreversibility." The challenge posed by these studies is to understand to what extent the historical persistence in the variation of national organizing principles explains the long-term differentials in the income and growth of countries.

Whereas differences in organizing principles among countries tend to persist for long periods of time, economic leadership has proven to be historically cyclical. To a large extent, the chapters in this book are a discussion of the relative decline of the United States and the organizing principles of mass production, and the rise of Japan and Germany that are advancing on the strengths of quality production. The historical record suggests a cycle of divergence in the performance of countries due to the introduction of new organizing heuristics, followed by a gradual convergence due to the diffusion of these heuristics across borders (Boyer 1988; Kogut 1991).

What we are currently witnessing is a period of divergence resulting from the expansion of new techniques of organization in a few countries. These new techniques do not spring up uniformly from the soil of a nation. Rather, as the chapters by Midler and Charue (Chap. 9) and Kern and Schumann (Chap. 5) show, there is substantial variation within a country. Certain sectors, such as machine-tools or autos, may lead in advance of other industries. The study by Fruin and Nishiguchi (Chap. 12) suggests that many new practices in Japan are still in development and that their diffusion across sectors, and even within the lead automobile industry, is still very much in progress. Despite the discussion in the chapters by Webster
(Chap. 8), Jürgens (Chap. 6), and Dunning (Chap. 11) on the diffusion of Japanese techniques, the impression left by these studies is that the adoption of flexible work roles and subcontracting systems is substantially slower in the United States, the United Kingdom, France, and, perhaps to a lesser extent, Germany.

One way to understand national patterns in organizing is to identify, along the lines of Herrigel (Chap. 1), Lincoln (Chap. 3), and Westney (Chap. 2), the roles that larger institutions play inside a country. Since schools, technical training facilities, unions, and government agencies are regional and national institutions, they generate what Dimaggio and Powell (1983) have labelled "isomorphic pressures" that drive firms toward adopting similar practices. Firms in the same country draw, for example, from a pool of workers who have been trained in similar educational institutions and whose responsibilities and rights are defined under a common body of law.

It is the absence of international institutions, on the other hand, that accounts for why these pressures do not act similarly on firms located in different countries. Unions do not effectively span borders. Though the education of white-collar workers has been influenced by an international ideology of business education (witness the diffusion of American business schools among countries), workers are, by and large, trained in uniquely different educational systems.

If there is a factor that cuts across countries, it is the role played by competition in international markets. The reason why national variations in the organizing of work become important at particular historical junctures is because international competition is, at these times, driven by technological and organizational innovations that have not diffused across the borders of countries. International competition causes not only a fundamental challenge to firms losing market share, but to the very educational, labor, and legal institutions prevailing among countries.

The force of international competition drives the nature of adjustment to four distinct, though not exclusive, outcomes. The first is that a country with inferior practices may simply withdraw from the world market; autarkic policies, such as raising tariffs or forbidding trade, are historically quite significant. Indeed, the current era of relatively free flows of international trade and investment is the exception, but the longevity of this political order is clearly in question.

Second, the inferiority of organizing practices, which is revealed in relative productivity rates, is compensated by lower wages. According to numerous recent estimates, wage rates in the United States relative to Japan and Germany have rapidly deteriorated since the 1980s. Whittaker's description (Chap. 7) of the inability of British firms to match the Japanese practice of using a single employee for the integration of programming and operating tasks subtly suggests that lower efficiency is offset by the significantly lower wage rates in the United Kingdom.

Third, the analysis by Sorge and Maurice of the machine-tool industry in France and Germany (Chap. 4) shows that adjustment may also occur through market differentiation. Over time, French producers lost market share to both Japanese and German firms, with the surviving French firms focusing on specialized markets. Even with the expansion of mass produced automobiles in the first half of this century, there remained many producers of cars who specialized in low volume, customized production. Whether this outcome generates similar levels of income and wealth across countries is problematic, but it would seem to be an unlikely event.

The fourth mechanism of adjustment is the international diffusion and adoption of best practices. Many of the chapters in this book are analyses of the process by which new principles of organization are adopted. The composition of these practices, as the divergent cases of Japan and Germany suggest, need not be the same, but the direction of development should reflect a basic convergence in the design of tasks and organizing principles.

A comparison of these alternatives would certainly imply, from an economic perspective, that the fourth outcome of adopting a variant on new organizing principles would be the most appealing. Yet, the historical record, as outlined for Taylorism in the chapter by Kogut and Parkinson (Chap. 10), indicates that convergence is slow and only approximate. Moreover, the degree of convergence varies substantially by country.

These considerations raise a few fundamental questions. Can one identify a unifying and historical logic that shapes the development of distinct national technological and organizational trajectories? If different organizational features of firms matter in terms of national economic performance, why should particular countries "lock-in" within seemingly "inferior" organizational forms? The first question is a more general way of investigating why certain countries display historically bounded leadership. The second directs attention to why such leadership appears to be cyclical; convergence is not rapid, but economic leadership is also not enduring.

The kind of unified explanation required to address these diverse observations should provide an account of (1) the coevolution of firm-specific and country-specific technological and organizational capabilities, and (2) the implications for economic performance regarding trade, investment, and growth. To be historically realistic, this explanation must provide an argument by which firms and countries reproduce over time particular technological and organizing characteristics, even when these characteristics are inferior, in terms of efficiency, to existing forms of best practice.

Though these are large questions, there has been considerable agreement that their answers require a formulation sensitive to historical events, social institutions, and the cumulative growth of knowledge specific to firms and countries. No existing theory is near the full realization of the task of combining these elements to explain why firms and countries reproduce over time particular organizational and technological characteristics. But we can suggest, as a way of commenting on the contributions to this book, an outline of what such a theory would look like.

Coevolution of Organization and Technology

There are, in our view, three central elements to the sort of story of the coevolution of organization and technology we would like to develop regarding country cycles in economic leadership. These elements are expressions, in the language of Campbell (1969), of the three fundamental social processes of variation, retention, and
selection (see also Aldrich 1979). The first element is that major innovations evolve at particular periods of time that alter, fundamentally, the way work is organized in specific locations. The second element is that firms and organizations retain new knowledge in the form of institutionalized rules and heuristics of search and decision. Because new knowledge builds on old knowledge embedded in institutionalized patterns of social action, innovations evolve and diffuse in a cumulative manner, with incremental learning being a driving factor in growth. Finally, these new practices must be in some sense selected by the environment; governments may subsidize their use, or consumers may favor the derived goods for reasons of price and quality (Nelson and Winter 1982; Dosi 1982, 1988; Silverberg, Dosi, and Orsenigo 1988).

The consequence of these three processes is that economic change is spatially and temporally bounded and is evolutionary. There are many ways to explore these issues, from historical and social analysis to more formal models. Yet, the underlying ideas are the same. The economic and social history shows that change tends to be ordered, complex, and irreversible. There are, in effect, self-organizing forces capable of generating multiple but finite number of historical outcomes.

Let us take a concrete example. The decision to organize a factory by mass production has several immediate effects. First, it is a destruction of the existing knowledge on how to organize a factory by alternative methods; a return to the old organization cannot instantaneously recover previous levels of productivity. Second, the knowledge gained in organizing a mass production system in one factory may suggest the application of similar methods (that is, problem-solving heuristics) to other factories or activities. Some of these activities may be quite distant from a manufacturing facility; witness the growth of mass production in higher educational systems. Third, the change in organization makes it more attractive to develop new capital equipment and technologies to facilitate mass production. Some of the new capital equipment may be bought from outside of the firm.

Technology and organization tend to coevolve with each other. Adam Smith noted this relationship when he attributed the organizing principle of the division of labor as linked to the invention of specialized machinery (Smith 1770, p. 112). Over time, the reciprocal effect of technology and organizing principles on each other creates what Hughes (1983) has called a technological system in which the efficiency of individual parts and firms depend on the whole.

To continue the example, the diffusion of mass production is, in principle, the ordered replication of a method of organization that progressively diffuses in an economy. This process of diffusion is self-reinforcing due to the accumulation of learning on how to do such mass production in better ways and due to the coevolution of technologies. As long as the social environment favors the relative growth of mass production, these techniques, once they have begun to expand, will diffuse either by the elimination of, or their imitation by, firms using older techniques.

This process of coevolution of technology and organization is described by a variant on the schema used in sociobiology (Durham 1991, pp. 182, 186). Initially, there are a finite number of types of technologies and ways by which work is organized that approximate the role played by genes in biological evolution.1 By the tendency of firms to search locally for new ways of doing things that are similar to current practice, these technologies and organizing principles may be incrementally and interactively adapted and changed. Simultaneously, the technological and organizational attributes of a firm are subject to selection pressures. The joint process of learning and selection generates, in turn, a new frequency of technologies and organizing principles.

There are two important complications in this process by which new techniques of production and technology coevolve within an economy. The first is that the evolution of a new heuristic is characterized initially by increasing benefit. Eventually, however, declining gains from further development sets in. The early decades of mass production showed considerable investment in exploring new methods, but as the most fertile ground for incremental innovation is explored and exhausted, the benefits of further search decline.

Second, the new techniques will not fully diffuse in an environment. A residual demand may persist for products built on alternative systems. But also the heterogeneity in social institutions will maintain a heterogeneity in organization; factories in the American south differed substantially from the factories in Philadelphia and Boston regions where Taylorism was first introduced.

Nevertheless, competition within a fairly homogeneous national environment favors over time the expansion of particular techniques. From the perspective of history, these techniques are unlikely to be the "best." By the accident of war or social conflict, one technique may have been initially favored, which, due to learning and coevolutionary economies, locked a country into a particular and irreversible developmental path.2 In all European countries, the demand of military production in World War I was a major impetus toward the introduction of principles of standardization of work. This change caused an irreversible departure from the old system in many of these countries. The impact of the war on the organization of work varied by nation.

Of course, these abstract statements do not do justice to the institutional richness of the social process of change and development. The decision to introduce mass production is itself embedded in a wider social context. Many suggestions (e.g., Lazonick 1990) have been made for the leadership of the United States in the development of systems of standardization and mass production, from the scarcity of labor and the task of training immigrant workers, to the pull of a mass market for the new household and construction goods to build the new frontier. As suggested by Kogut and Parkinson (Chap. 10), the absence of an embedded craft and guild tradition certainly abetted the diffusion of Taylorist ideas in the United States, while these very traditions slowed the adoption of work changes in the United Kingdom.

In this sense, coevolution takes on a wider meaning than just the positive externalities between certain kinds of organization and technologies. Rather, coevolution also tends to promote the mutual expansion of complementary social institutions.3 A system of mass production and standardization of work encourages the development of labor unions concerned about job definitions and rules by which workers are laid off in cyclical downswings. Social institutions tend to coalesce around the principles by which work and human activities are organized.

These issues are old, but unsettled, themes in organizational theory. Webster's
social context strongly conditions the nature of the relationship of technology and organization, but this relationship must still conform to the broad technical constraints discovered in implementation.

Specificities in national principles of organization are sensitive, consequently, to the coincidence of unique historical events and the prevailing social order. In a broad sense, the coevolution of technologies and organization are constrained to reveal a pattern of convergence among countries. International competition, among other forces, motivates countries toward adopting the apparent best practices by which technology and organization are structured. Yet, the specific structures revealed over time are tempered by the national contexts and initial conditions.

Costs of Change

To complete the analysis of why coevolution carries significant implications for the economic performance of countries, it is essential to examine why these country-specific principles of organizing may be reproduced despite the selective pressures of international competition. The difficulty with the question is not the lack but, rather, the plethora of answers. The challenge to the existing economic and political order, the inability to identify the need for change, or the noncomprehension of the changes required are all viable candidates for explaining why new practices are not quickly diffused across the borders of a country.

Despite this embarrassment of riches, the condition of being locked into inferior practices even when better practices are identified can be explained in terms of three kinds of three factors that influence costs: switching, learning, and hysteresis. We abstract from two important considerations. First, the process by which organizations and institutions in one country come to make comparisons between the existing order and new ways of organizing differs substantially from this stylized description of these three factors that determine a condition of "lock-in." Second, these costs are not the same for all actors in a country; entrenched powers (e.g., incumbent firms or organized labor) may attach a greater cost to switching to a new system than might start-up companies or workers entering the labor force.

In Figure 13.1, these three kinds of costs are described. There are two distinct ways of organizing activities, A and B. In each case, B is revealed as a less costly way of accomplishing a given task.

Figure 13.1.4 depicts the simple case where the costs of switching between organizing principles A and B are greater than the benefits. An obvious example is the continued use of a nonmetric system of measurement in the United States. The incremental benefits of using a metric system are offset by the large costs of changing all the existing standards and measurements.

One of the most complex considerations is that the desirability of switching increases with the number of institutions and firms which find it advantageous to adopt the metric system. The dependence of any one firm in a larger technological system means that the costs of switching vary depending on the decisions of other actors in the country. Overcoming the effects of history requires a collective choice.
One way to break out of the vicious circle is to adopt technique B and finance the losses by lower returns to either capital or labor. If capital is mobile and can easily flow to foreign countries, then the costs of adjustment will fall on workers’ wages. Of course, by staying with technique A, wages also will eventually fall in any event as competitors gain further experience with the superior technique. The flexibility in labor and social institutions that will govern this period of adjustment rests largely on the strength of the political order in managing this critical juncture.

Given the complexity of these issues, the benefits of switching are clearly uncertain. This uncertainty itself has fundamental consequences for why a social system should, on rational grounds, persist in its prevailing form. The sources of the uncertainty are several; the degree of social unrest and the costs of investing in the new technology are two sources previously stressed. But there may even be doubts about the benefits of the technology. Flexible manufacturing is less valuable in a stable environment regarding the value of flexibility in the future.

The implications of uncertainty on the decision to switch results in what is described as hysteresis. In Figure 13.1C the costs of techniques A and B are probabilistic. Though the mean costs differ, there remains the possibility that A may prove to be better than B. If there were no costs to switching, then a firm and country could simply switch from technique A to B, and back again. As shown earlier, one-time (or static) switching costs may render such change economically unattractive. These static costs understate, however, the unattractiveness of switching once uncertainty has been considered. Since costs are incurred and since the future best technique is uncertain, switching will not occur as frequently. After all, it may be advisable to switch back in the near future. The effect of uncertainty is to increase the perceived dynamic (i.e., over-time) costs of switching compared to the static costs described in Figure 13.2A. Only a large disparity in the benefits of A and B will induce a switch.

The impact of uncertainty, therefore, is to heighten the persistence of history. It is easy to underestimate the importance of hysteresis. And yet rather small degrees of uncertainty over the future benefits can result in a substantial tendency toward inertia (see, e.g., Dixit 1989, and Kogut and Kulatilaka 1992). In retrospect, it is obvious to conclude that one way of doing something is superior to another. At prevailing prices of petroleum, the era of gas-guzzling autos is clearly at an end, but the volatility in oil prices in the 1970s rendered such forecasting more hazardous. The costs of scrapping decades of experience in the production of large car manufacture and of investment in new plants and tooling for fuel efficient cars have proven to be astronomical. Small amounts of uncertainty over the direction of future demand can have a powerful influence on sustaining current capabilities and methods of organization.

Some Theoretical and Normative Conclusions

There is a troubling conclusion to this consideration of the costs of switching to new practices. No matter what choice a country makes, a fall in wages relative to foreign wages would appear to be unavoidable. If best practices are not adopted, lower wages is a permanent state; if a decision is made to switch, the costs incurred during the
The variations in the micro rules that prevail in a society can generate significant differences in the macro performance of an economy. In this respect, Aoki's comparison between two "ideal" types—the "Japanese firm" and the "American firm"—is a good example: different internal governance structures affect learning and performance, despite identical economic opportunities (Aoki 1988). In an exploratory attempt to model and simulate the relationship between behavioral norms and patterns of growth, Chiaromonte, Dosi, and Orsenigo (1992) have shown how economic dynamics widely differ when simple alterations are made to behavioral rules (e.g., how adjustment occurs in labor markets), even when other system parameters, such as technological opportunities, are left unchanged.

It would follow from this discussion that the influence of history on restricting an economy's ability to transform itself radically can only be overcome by changing the expectations that inform the choices of firms, workers, and institutions. These expectations, or what can be called "notional" possibilities, concern the identity of available technologies and organizing heuristics (i.e., micro rules). Because of the dependency of parts on the whole, however, these expectations consist also of anticipations regarding what other actors in the system will decide.

Several of the chapters in this volume comment directly on the process by which explicit public policies have influenced the notional set of technological and organizational opportunities. Herrigel (Chap. 1), in particular, describes the success of the government and public institutions of Baden Württemberg in providing institutional support by which new practices were diffused in the region. Similarly, Sorge and Maurice (Chap. 4) find French government policies to have been far less successful than the German in reorienting the machine-tool industry toward more flexible manufacturing technologies.

Kern and Schumann (Chap. 5) suggest a far more subtle dynamic in their study. The German economy, as argued by their original studies, was at a crossroad in the late 1960s. Rising wages threatened the export viability of mass production, and the importation of competing goods, when not prohibited by quotas or tariffs, rose in a number of sectors. Indeed, one would have been hard pressed to predict the high performance of the German economy in the 1980s in the context of the high unemployment of the 1970s. But what eventually caused a few sectors in the German economy to switch to new practices stressing flexibility and worker autonomy was the combination of a highly trained work force and the severe restraints on German firms to cut wages or to move production outside of the country. In other words, German firms were forced to search for new practices because the wage constraints ruled out persisting with traditional work methods.

Is there a lesson, then, in the ability of German firms to adapt to the pressures of international competition? Herrigel (Chap. 1) intimates that leaders have the capacity to lead by changing the notional possibilities understood by workers and managers. Kern and Schumann (Chap. 5) suggest that, by placing severe constraints on management and by empowering workers at the workplace, firms are forced to invest in searching and implementing new methods of organizing. Better practices evolve, they appear to suggest, when the attractiveness of short-term adjustment by cutting wages is eliminated.

But the complexity of the interdependence of institutional elements makes it
CONCLUDING NOTES

difficult to extrapolate from one country's experience. Would raising minimum wages in the United States also evoke a similar response given high heterogeneity in labor training and skills? Should restrictions on outward flows of direct investment also be required, or should laws require the representation of labor on boards of directors and the formation of work councils?

These are difficult questions to address, and this difficulty is, in fact, the clue to answers. The causality between action and outcome is highly dependent on the institutional context. National specifics in organization persist because knowledge of the causal relationships between practice and performance is gained only incrementally. The chapters in this book, by and large, agree that the direction of change is toward greater worker autonomy and reliance on skilled employees. Within this broad notion of convergence, there remains considerable play for the persistence in the variations of national principles by which work is organized.

Notes

1. There has been a growing literature in sociobiology on how to analyze culture in ways analogous to genes. See the discussion in Winter (1990) who identifies the genetic analogue with methods of organization.

2. For a discussion of historical accident and lock-in, see David (1985) and Arthur (1988).

3. This meaning is closer to the original use of coevolution in biology as the coadaptation of two species. The growth of the school stressing the population dynamics of genes, best known through the popular writings of Richard Dawkins, is closer to our discussion of the evolution of techniques. See Durham (1991, 166n).

4. These concerns raise important issues of public choice and property rights. For applications to understanding cycles in country leadership, see Olson (1982) and North (1981).

5. See the discussion in Kogut (1990) on why practices may be more difficult to identify and adopt across borders.


References


Lawrence, Paul, and Jay Lorsch. 1967. Organization and Environment: Managing Differentiation and Integration. Boston: Division of Research, Graduate School of Business and Administration, Harvard University.


Index

Aix Group, 75–76
American organizing principles in Europe, 179–99
American organizing principles, 181–87
multidivisional structure, 187–96
American organizing principles of work, 181–87
American system of manufactures, 181–82
diffusion to continental Europe, 184–86
diffusion to United Kingdom, 183–84
American Production and Inventory Control Society (APICS), 143
Assembly line, 109, 115, 161, 184
cycle times, 118
Aston centralization scale, 60, 63–64
Asymmetrical, bilateral relations (arms-length), 231
Autarkic polices, 250
Automated transfer lines, 116
Automation in car industry, 113–16
substitution of human labor with, 109
Automobile body shop robotization, 156–74
automatic line control, 162
chain of command hierarchy, 164
design of organizational objectives, 163
diversity as result of irreversible learning processes, 167–68
diversity of production patterns, 163–64
flexibility and production capacities, 160–61
importance of technological obsolescence, 172–73
inadequacy of traditional working systems, 162
labor organizations and, 170–71
line controller, 163–65
management models, 166
new industrial doctrine, 164–65
plant layout and human-machine relationships, 160
production flow constraints, 160
restructuring labor force, 168–70
role of management in, 171–72
stability of organized models versus dynamic process of job development, 173–74
stabilization via increased production volume, 173
three typical robotization models, 165–67
transformation of production supervisors, 170
Automobile industry. See Car industry

Babbage principles, 129
Baden Württemberg, 15–32
banks in, 19
chambers of commerce in, 18–19
decentralization in, 22–24
decentralized production among small and medium-size firms, 16–22
education institutions in, 17–18
industrial adjustment in, 15
large firms and capital mobility, 28–32
large firms and decentralized small and medium-sized production, 25–32
mutual convergence, 16
number of small and medium-size firms, 16
openness in, 20–22
organizations, 17–20
origins of decentralized system and role of large firms, 22–25
portable inheritance in, 22–23
power imbalances in contracting in, 26–28
redundancy in, 20
regional government and, 19–20, 29–30
risk socializing system in, 22
role of large firms in, 23–25
self-policing through fear in, 21–22
small and medium-sized firms and mass production in post-war Germany, 24–25
success of small and medium-size firms, 16–17
technology subsidy programs in, 20
trade associations in, 18–19
Banks in Baden Württemberg, 19
Bedaux system, 184, 185, 186
"Best practice" techniques, 218
as term, 111
Bicycle industry, 183