COMPLEMENTARITIES AND SYSTEMS: UNDERSTANDING JAPANESE ECONOMIC ORGANIZATION*

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Resumen: El comportamiento de la economía japonesa en los últimos cuarenta y cinco años es un caso sin precedente en la historia de la humanidad, al pasar del colapso inminente de la posguerra a ser una de las más ricas y productivas del mundo. El propósito del presente trabajo es interpretar, tanto los rasgos característicos de la organización económica de Japón en términos de complementariedad, como algunos desarrollos recientes de su economía. Esto último nos permitirá especular con respecto al futuro de la misma.

Abstract: The performance of the Japanese economy in the last forty-five years, during which it has gone from post-war destitution and near collapse to one of the richest and most productive in the world is unmatched in human history. The purposes of this essay are to interpret both the characteristic features of Japanese economic organization in terms of the concept of complementarity, and some recent developments in Japanese economy, and to speculate on its future.

* An earlier version of this paper was presented by the second-named author at the XII Latin American Meeting of the Econometric Society in Tucuman, Argentina, in a lecture sponsored by *Estudios Económicos*. We are indebted to our colleague, Masahiko Aoh, for his careful and perceptive comments on an earlier draft. The

The performance of the Japanese economy in the last forty-five years, during which it has gone from post-war destitution and near collapse to one of the richest and most productive in the world, is unmatched in human history. Between 1950 and 1990, real GNP per capita increased from $1 230 to $23 970 (both calculated in 1990 prices), rising from one-eighth of the level in the United States to surpass it. Since the War, life expectancies have increased by half, from 50 years for males to 75, and from 54 to 81 years for females.[1] Naturally, Japan's experience has attracted much attention among those concerned with economic growth: How did Japan do it? Can other nations replicate the Japanese success? What are the key lessons from Japan for countries seeking economic growth?

A unique set of institutional arrangements, organizational structures and managerial practices are characteristic of Japanese economic organization, and many observers have seen various of these as important causal elements in Japan's economic success. They have consequently advocated imitating these features elsewhere, both in the practices of individual firms and at an economy-wide level. Very often, however, attempts to import elements of Japanese practice to other countries have been partial or complete failures.

Our first purpose in this essay is to interpret the characteristic features of Japanese economic organization in terms of the concept of complementarity. We will argue that these features together constitute a system of complementary elements, each of which fits with the others and makes the others more effective than they would otherwise be. Further, this system has been particularly well adapted to the demographic, social, macroeconomic, legal, political and regulatory environment in which Japanese business has operated since World War II.[2] The result is a coherent whole that is much greater than the sum of the individual parts.

Consequently, the individual features and their contribution to the success of the Japanese economy cannot be properly understood

financial support of El Colegio de México and the National Science Foundation of the United States is gratefully acknowledged.

[1] The data in the preceding two sentences are drawn from Clive Crook (1993).

[2] The roots of the system lie partly in the wartime planned economy of Japan, as explained in Okazaki (1993).

by examining them one at a time, in isolation from the other complementary elements of the system or the environmental context in which the system has been embedded. Moreover, this analysis suggests that copying individual elements of Japanese practice and transplanting them piecemeal into other countries' systems, where the complementary elements are absent, cannot be expected to yield the sort of results experienced in Japan, because the positive interaction effects that the elements of the Japanese system exert on one another will be missed. Instead of a coherent pattern of mutually supporting elements, the result of organizational "mix-and-match" is an ill-adapted misfit. This helps explain the limited success that attempts to adopt particular aspects of Japanese practice in isolation have often met. At the same time, it is consistent with the fact that there have been notable instances where adopting many of the features more-or-less simultaneously has met with real success.

The second purpose of this essay is to use this framework to interpret some recent developments in the Japanese economy and to speculate on its future. Many of the features of the environment in which Japanese business has operated are now changing in ways that worsen the fit between the environment and the organizational structure. At the same time, in the early 1990s Japan has experienced the longest and most severe recession in its recent history. The environmental changes threaten the viability of particular elements of the organizational system. But, given that these elements must change or be replaced, the coherence of the whole system is threatened: It may not be possible to change only a few elements of the system and maintain its performance without also changing the other aspects that were dependent on these. Thus, the Japanese arguably need to make much more far-reaching, systemic changes in their economy than an analysis that ignores the complementarities would suggest. The weak performance of the Japanese economy over the last several years may then be both a reflection of the worsening fit between the organizational structure and the environment and a spur to more rapid adaptation.

This essay is interpretive. In particular, we will not present a formal, mathematical model of Japanese economic organization. Nonetheless, precise mathematical concepts underlie our analysis.

We review some of the basic elements of the mathematical theory of systems of complements that are most relevant for the present purpose in the first section of this essay. In the second section we describe the characteristic features of the Japanese system and explore the sources of complementarity among them and their fit with the environment in which they have been embedded. The final section explores the changes that are occurring in the environment and considers the need for and implications of organizational adaptation.

1. Complementarity

The most common notion of complementarity is that from standard price theory, where, for example, two inputs are complements if raising the once of one of them lowers the use of the other. Here we adopt a broader conception (due to Edgeworth) that is not dependent on the special structure of prices and quantities and that permits analysis of such complex phenomena as organizational structures and government policies.

Specifically, we say that a group of activities are (Edgeworth) complements if doing more of any subset of them increases the returns to doing more of any subset of the remaining activities. In a differentiable framework, this idea corresponds to positive mixed-partial derivatives of some payoff function: The marginal returns to one variable are increasing in the levels of the other variables. However, for many of the problems one wants to address, it is unnatural or extremely restrictive to assume even divisibility of choice variables, let alone smoothness of objective functions. Fortunately, however, those conditions are also unnecessary for analyzing systems of complements. Looking at the informal definition above, we see that Edgeworth complementarity is a matter of order– "doing *more* of one thing *increases* the returns to doing *more* of another".

Formally, consideration of choices from sets of objects that are (partially) ordered leads into the branch of mathematics known as lattice theory. The analysis of complementarity then becomes the study of so-called supermodular functions on lattices. We will actually need very litlle of this formal structure to exposit the key results of this area that are useful for analyzing the questions of complemen-

tarity and systems that arise in the study of Japanese economic organization, but some minimal terminology is useful.

First, a *lattice* is just a set X whose elements are (partially) ordered and that has the property that, for any two points x and y in X, X also contains a smallest element under the order that is larger than both x and y and a largest element that is smaller than both. We write $x \vee y$ (read "x join y") to denote the smallest element larger than both x and y, and $x \wedge y$ (read "x meet y") to denote the largest element that is smaller than both x and y.

Any subset of the real numbers with their natural ordering forms a lattice. A different lattice is obtained by taking the real numbers but reversing the usual order. For a richer example, consider the N-dimensional Euclidean space $\mathbf{R}^N$ together with the familiar component-wise, product (partial) order, denoted $\geq_N$ and given by $x \geq_N y$ if and only if $x_n \geq y_n$, $n = 1, \ldots, N$, where $\geq$ is the usual order on the real numbers. This is a lattice, and the meet and join operations are given by the component-wise min and max:

$$x \wedge y = (\min\{x_1, y_1\}, \ldots, \min\{x_N, y_N\})$$

and

$$x \vee y = (\max\{x_1, y_1\}, \ldots, \max\{x_N, y_N\}),$$

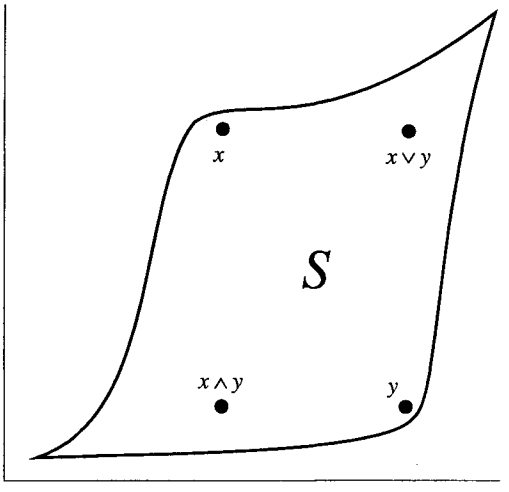
as in Figure 1. Clearly $x \wedge y$ is (weakly) smaller than either x or y, and it is the largest point having this property because any higher point is larger in at least one component than one or both of x and y. Similarly, the component-wise maximum, $x \vee y$, is the smallest point that is larger than both x and y. Generally, instead of doing this construction with the product lattice $\mathbf{R}^N$ obtained from N copies of the lattice $\mathbf{R}$, we could have begun with any N lattices and constructed a new lattice as the N-fold product, with the product, component-wise order.

A quite different example is provided by starting with some arbitrary set Z and considering the set 2^Z of subsets of Z, with set inclusion defining the partial order: $x \leq y$ means $x \subset y$. In this context, given any two subsets x and y of Z, $x \wedge y$ is simply the intersection $x \cap y$, because the intersection is contained in both sets (that is, it is smaller than both in this order) and it is the largest set with that property. Similarly, $x \vee y$ is the union $x \cup y$. Besides helping in remem-

bering the meaning of the symbols $\wedge$ and $\vee$, this example illustrates that the elements of a lattice can be complicated objects.

A *sublattice* of a lattice X is a subset S of X that is closed under the operations of meet and join that are defined in the original lattice, that is, if x and y are each in S, then so are their meet and join. Any lattice is a sublattice of itself. In Figure **1**, the set S, the four-point set $\{x, y, x \wedge y, x \vee y\}$ and the two-point set $\{x \wedge y, x \vee y\}$ are all sublattices of $\mathbf{R}^N$ and each of the sets in this list is a sublattice of the preceding ones. Each of the singleton sets is also (trivially) a sublattice.

Figure 1
The set S and the four point set $\{x, y, x \wedge y, x \vee y\}$
are both sublattices of $\mathbf{R}^2$



The two-point set $\{x, y\}$ in the figure is an example of a set that is not a sublattice of $\mathbf{R}^2$. Formally, one verifies this by observing that the set does not contain either the meet or the join of x and y. From a modeling perspective, what this means is that starting from the feasible point x, one cannot increase the first component from x_1 to y_1 without also decreasing the second component. If we think of $\{x, y\}$ as a constraint set, then the constraint forces the decision maker to choose between high values of the first and second component.

Sublattice constraints never restrict a decision maker in that way: Increasing the value of some decision variables never prevents one from increasing the others as well, and, similarly, decreasing some variables never prevents decreasing others. Intuitively, sublattice constraints represent a kind of technical complementarity. For example, a sublattice constraint could be used to model the idea that investing in more flexible equipment and a more broadly trained factory work force never prevents a firm from widening its product line or even that these are a necessary prerequisite for such a change.

There is a second element in the formalization of complementarity that is expressed not through the constraints but through the objective function. Given a real-valued function f on a lattice X, we say that f is *supermodular* and its arguments are *(Edgeworth) complements* if and only if for any x and y in X,

$$f(x) - f(x \wedge y) \leq f(x \vee y) - f(y).$$

This is simply a mathematical restatement of the verbal definition given earlier: The returns to increasing some of the variables are greater the larger are the values of the other variables. This is easy to see in the $\mathbf{R}^2$ example. There the defining inequality says that the change in f going from the coordinate-wise minimum, $x \wedge y$, to x (or y) is less than that associated with the parallel move from y (or x) to the maximum, $x \vee y$ (see Figure 1 again): increasing one argument of the function has a bigger impact when the other argument is at a higher level. If f is twice continuously differentiable, the condition is equivalent to nonnegative mixed-partial derivatives: The marginal returns to increasing any one argument are increasing in the level of any other argument. Note that complementarity is symmetric: If doing more of activity a raises the value of increases in activity b, then increasing b also raises the value of increasing a. Note too that in multi-dimensional problems, one can check supermodularity pairwise: The function $f(x_1, \ldots, x_N)$ is supermodular if and only if for all i and j, $i \neq j$, f is supermodular when viewed as a function of only x_i and x_j with all the other arguments held fixed. This fact facilitates discussing complementarities, because one does not have to deal with all the variables simultaneously.

Any function of a single real variable is trivially supermodular. The Cobb-Douglas function $f(x, y, z) = ax^{\alpha}y^{\beta}z^{\gamma}$ is supermodular if a is positive and all of the exponents are of the same sign. If g is concave, then $f(x, y) = g(x - y)$ is supermodular, and if g is convex, then $f(x, y) = g(x + y)$ is supermodular. In each case these results can be checked by calculating mixed partial derivatives if differentiability is assumed, but they continue to be true without any smoothness assumptions and even when the domains of the functions are restricted to sublattices of Euclidean space, such as the integer points.

The theories of optimization of supermodular functions and of non-cooperative games in which the payoff functions are supermodular originated in the 1960s in the unpublished work of Donald Tophs and Arthur Veinott. The first published results are those of Tophs (1978, 1979). Extensions of the theories and applications in economics and management have proliferated recently: See, for example, Bagwell and Ramey (1993), Gates, Milgrom and Roberts (1995), Holmstrom and Milgrom (1993), Meyer, Milgrom and Roberts (1992), Meyer and Mookherjee (1987), Milgrom (1994), Milgrom, Qian and Roberts (1991), Milgrom and Roberts (1988, 1990a, 1990b, 1991, 1994a, 1994b), Milgrom and Shannon (1994), Shannon (1990, 1992), Topkis (1987, 1994) and Vives (1990). A brief, very informal survey of some of the key properties and results will suggest some of the reasons for this interest (see the above references for the missing details and for applications).

First, supermodularity very nicely captures the important concept of complementarity. Further, it provides a way to formalize the intuitive ideas of synergies and systems effects —the idea that "the whole is more than the sum of its parts". To see this in a simple context, let x and y be any two points in R^n with x strictly larger than y. Supermodularity is mathematically equivalent to the statement that for every such x and y, the gain from increasing every component from y_i to x_i is more than the sum of the gains from the separate individual increases:

$$f(x) - f(y) \geq \sum_{i=1}^{n} [f(x_i, y_{-i}) - f(y)].$$

Moreover, the implications of supermodularity described below do not depend on the usual kinds of "standard" assumptions that

economists often make but that seem so implausible in many contexts, including the study of economic systems. For example, we do not need any divisibility or concavity assumptions, so increasing returns are easily encompassed. (Indeed, the existence of strong and widespread complementarities among sufficiently many choice variables will itself imply that the objective cannot be concave.)

Further, because the theory concerns functions on arbitrary lattices, choices might be over such —messy— things as business strategies and organizational policies, provided we can order each of them in some useful way. In this regard, it is often useful to consider product lattices in which particular dimensions of choice involve just two points. Frequently, when we do this, it is straightforward to order the two points in a way consistent with supermodularity of the objective function. In doing so, however, one needs to be concerned that important alternatives are not being ignored whose inclusion might invalidate the analysis.

Because the theory does not require concavity of the objective function or convexity of the constraint sets, it encompasses situations where some choice y is a local maximum but not a global maximum, that is, where no adjustments of the choice y in some neighborhood are worthwhile and yet there are more distance points that yield distinctly higher payoffs. Moreover, the theory can also encompass situations where each of the terms on the right-hand side of the last inequality is negative —meaning that changes in the individual components are not worthwhile— and yet the left-hand side is positive —so that changes in all the components together are profitable.

This last point is the basis for an interpretation of the failure of piece-meal adoption of organizational innovations in terms of complementarities: If the several elements of organizational structure are complementary determinants of performance, then there may be multiple patterns of organization which are coherent in that each (proper subset of) choice variable(s) is optimally chosen, given the specified values of the other variables, and yet which need not yield equivalent performance. Further, adopting only some of the features of the betterperforming pattern may actually worsen performance. Thus, in particular, adopting only some of the features of a successful economic system while adhering to other elements from another coherent system may be disastrous.

The mathematics also suggests why change may be difficult to achieve in such systems, even when all the dimensions on which change must occur are understood. Even if a coordinated adjustment on all the relevant dimensions might yield an improvement in performance, it may be that until all the features of the new pattern have been implemented, the performance of the system may be much worse than in the original position. Because simultaneous, coordinated change on many dimensions may be difficult, any attempt at reform must actually be piece-meal, and so may initially result in worsened performance. This in turn may lead to reconsideration of the planned change and its abandonment.

The second key set of properties of systems of complements relate to comparative statics. If the domain of a supermodular function $f(x, \theta)$ is a sublattice consisting of vectors of choice variables x and vectors of parameters θ, then the comparative statics on the maximizers are unambiguous: (Some selection from) the maximizers $x^*(\theta)$ will be monotone nondecreasing in the parameters θ. In particular, the choice variables tend to move up or down *together* in a systematic, coherent fashion in response to environmental changes, and a change that favors increasing any one variable leads to increases in all the variables. Moreover, the magnitude of the change in any component, say x_j, as θ changes and the other components adjust optimallv is larger than the change that would be made if the other components remained fixed.

The logic here is simple. Any change in the parameter that leads to an increase in any one variable will raise the returns to increasing each of the other variables. But the resulting increase in each of the variables then increases again the gain from increasing each of the others. Thus, the effects are all mutually re-enforcing, and the initial change is subject to a multiplier effect –a conclusion that we shall later argue is highly relevant for forecasting the likely future of the Japanese economy.

Third, if the payoff can be written as $f(x_1, \ldots, x_n) + \sum g^i(x_i, y^i)$ for some n disjoint sets of variables y^i and if f is supermodular, then so too is the function $\hat{f}(x_1, \ldots, x_n \equiv \mathrm{Sup}_y f(x_1, \ldots, x_n) + \sum g^i(x_i, y^i)$ obtained by maximizing out the y^i variables. Note that while each y^i is allowed to interact with only one of the components of the vector x, there are no restrictions in this formulation on the nature of the

variables y^i –they need not be vectors or numbers or ordered variables– nor are they required to be complementary with one another or with the core choice variables in x. This result allows the theory to be extended to situations where the overall objective function is not supermodular, perhaps because some of the choice variables are substitutes for one another. So long as the objective can be divided up among a set of complementary effects that extend across subunits through the strategic choice variables x and other effects that enter only through the local variables y, the conclusions about complementary choices and their comparative statics are unaffected.

Combining these last two observations suggests that a firm adapting to environmental change will be most likely to find profitable new activities in areas that are complementary to the newly increased activities. For example, suppose the y^i variables are non-negative real numbers and that $y^i = 0$ initially before a parameter change that increases the optimal value of x^i. Then, at the new optimum after the parameter change, y^i is still zero if $\partial g^i / \partial x_i \partial y^i \leq 0$,[3] but y^i can be positive if the reverse inequality holds. Even if the initial position was not an optimum, if the chosen level of x^i increases and the cross-partial with y^i is positive, then increasing y^i is now more attractive. Thus, the search for complementary new activities can help direct the activities of boundedly rational firms in a changing environment, and we might expect that as systems evolve, they do so by adding features that are complementary with existing elements. Thus, complementarity can be the basis of models of *path dependence.*

Fourth, the expected value of a supermodular function in which the choice variables are perturbed by random errors is higher when the perturbations are the same than when they are independent random variables. That is, if $\varepsilon_1, \ldots, \varepsilon_n$ are independent and identically distributed, then

$$E[f(x_1 + \varepsilon_1, \ldots, x_n + \varepsilon_n)] \leq E[f(x_1 + \varepsilon_1, \ldots, x_n + \varepsilon_1)].$$

[3] This holds because the objective function with x and y_j as arguments is supermodular, so the optimal value of y_j is a nonincreasing function of x.

In this mathematical sense, when complementarities are present, "fit" is important, that is, even mistaken variations from a plan are on average less costly when they are coordinated than when they are made independently.

Fifth, in a dynamic setting, an upward or downward movement of a whole system of complementary variables, once begun, tends to continue. This applies equally to the emergence and growth and to the decline and collapse of systems of complements. As one formalization of this idea, suppose that for each date t, x_t maximizes $f(x_t, x_{t-1})$ subject to $x_t \in S$, where x_{t-1} is fixed by history. If f is supermodular, S is a sublattice, and $x_t \geq x_{t-1}$ for some date t, then the conclusion is that $x_t \leq x_{t+1} \leq \ldots$ Similarly, if the values of x ever-decrease, they will continue to do so ever after (until disturbed by some shock.) The same implications remain true when the choices after some date t are made non-myopically to maximize $\sum_{s \geq t} \delta^{s-t} f(x_s, x_{s-1})$ starting from any x_{t-1}.

Many of the popular growth models based on returns to scale can be fit into the foregoing framework, because returns to scale in those models is equivalent to complementarity of choices at different points in time. For example, suppose the payoff earned by a decision maker in period t is a convex function of the stock of capital at that time, which in turn depends on periodic investments. For example, the net benefit might be $B(\sum_{s \leq t} \rho^{t-s} I_s) - C(I_t)$, where B is convex. Then this objective is supermodular in the investment levels $\{I_t\}$: Returns to scale in this sense imply that complementarity among investments at different points in time. Similarly, suppose the net capital stock at any date is $K_t = \rho^t K_0 + \sum_{s \leq t} \rho^{t-s} I_s$ and the net benefit at any date is $p_t K_t - I_t C_t(I_t / K_{t-1})$ where each C_t is increasing and convex and $K_0 > 0$. The function C_t describes the average cost of investment; its argument is the rate of expansion of the capital stock. Then, investments at different points in bme are mutually complementary, so higher early investments increase the pace of later investments. The benefits of non-myopic investment planning in such models are much the same as the benefits from coordination in any other situation with extensive complementarities.

The next set of results concern supermodular games. These are finite –or infinite– strategy non-cooperative games in which (1) the

strategy sets are compact sublattices (2), each player's payoff function is supermodular in the player's own strategy choice variables and (3) each player's marginal returns are nondecreasing functions of the competitors' strategy choices. These games exhibit "strategic complementarities" in the terminology of Bulow, Geanakoplos and Klemperer (1985): If some players increase their strategic choices, then the optimal choices of the other players increase too –reaction curves are upward-sloping.

In such games, there exist largest and smallest pure strategy Nash equilibria, so that all the Nash equilibria lie in the multi-dimensional interval between these two. Moreover, these extremal Nash equilibria coincide with the largest and smallest serially undominated strategy profiles.[4] Thus, the interval of strategy profiles between them contains all the strategies played in any common noncooperative solution concept, and every process of adaptive learning leads eventually to the exclusive play of strategies in that interval. Thus, even if one questions the relevance of Nash equilibria as a prediction about behavior in complicated games, there are good reasons to expect that behavior will yield something in the interval defined by the largest and smallest equilibria of a supermodular game.

Supermodular games also have attractive comparative statics. If the player's marginal returns are nondecreasing functions of a parameter, then the largest and smallest equilibrium profiles are nondecreasing vector functions of that parameter. Consequently, the set containing the predicted behavior moves up with the parameter. Moving to a framework of bounded rationality or learning, there is an analog to the momentum result: If the evolution of play in a (repeated) supermodular game is described by each player's choice for any period t being the maximizing choice[5] against the others' choices at $t-1$, and if the resulting vector of strategies increases from one period to the next, then in every succeeding period the strategy vector will again move up (at least weakly).

[4] Serially undominated strategies are strategies that survive a process of iterated elimination of pure strategies that are strictly dominated by some other pure strategy.

[5] If there are multiple optima, an appropriate selection must be made. For example, it suffices always to select the smallest (or largest) maximizer.

Increasing returns to scale is a source of strategic complementarity in games. Diamond's (1982) macroeconomic search model and the network externality models of Farrell and Saloner (1986) and Katz and Shapiro (1986) provide good illustrations. In these models, the payoff of an individual player j has the form $f(\sum_i x_i) - C(x_j)$ where f is convex or $f(\sum_{i \neq j} x_i)x_j - C(x_j)$ where f is increasing. These conditions are usually interpreted as reflecting returns to scale in matching processes, telephone systems, shared technologies, and the like. The key implication is that the mixed partial derivative of the player j's payoff function with respect to x_j and any other x_i is positive. Moreover, complementarity —rather than general returns to scale— provides a better descriptive account in such applications. For example, the gains to personal computer users from focusing on just one or two standards is that doing so eases the development of complementary products including both software (operating systems, applications software) and hardware (fax boards, monitors, storage devices).

Finally, the equilibria of some supermodular games have clear and strong welfare properties. If each player's payoff is increasing (decreasing) in the choice variables of the other players, then the largest (smallest) equilibrium is Pareto preferred to any lower (higher) combination of strategies, including any other equilibria. However, if the payoff functions are differentiable, an increase (decrease) in all players' strategies from this equilibrium would generally be Pareto-improving. It is also true that in such games, there is no possibility of a subgroup of players' successfully deviating as a group from the Pareto preferred equilibrium. This can be formalized as follows. Consider any set of players M and any Nash equilibrium of the induced game where these players select their strategies given that the players not in M adhere to the strategies given by the Pareto best (that is, the largest or smallest) Nash equilibrium. Then the original Nash equilibrium is Pareto-preferred for the members of M to any other equilibrium in the induced game. The same conclusion holds even if the individual payoffs are not monotone in the other players' strategies so long as the game has a unique equilibrium.

2. Japanese Economic Organization[6]

Table 1 lists many of the distinctive features of the Japanese pattern of economic organization, as well as some key characteristics of the post-War economic environment in which this system has developed and flourished. Examining these from the perspective of complementarity reveals important interactions and systems effects.

Table 1

Characteristic Features of Japanese Management

Human Resource Policies
Permanent employment guarantees
Recruiting only at the bottom
Extensive training–general and specific
Pay for skills
Firm-wide group bonuses
Seniority-based promotions
Flexible work rules
Limited pay differentials
Absence of stock-based executive incentives
Frequent transfers
High status of the Personnel Department
Early mandatory retirement
Governance and Ownership
Consensus decision making
Firms run for the employees
Insider Boards of Directors
High debt-equity ratios
Mochiai (Cross-holdings of stock)
Main-bank relations

[6] Parts of this analysis first appeared in Milgrom and Roberts (1992). For richer descriptions of the characteristic features of Japanese organization, see Aoki (1988) and Ito (1991).

Table 1

continued

Manufacturing Operations
"Modern" manufacturing strategy flexible equipment and workers frequent product improvements broad product lines increasing quality decreasing cost and price low inventories
Use of workers' local knowledge
Team organization
Kaizen
Corporate Strategy
Growth and market share orientation
Reinvestment of earnings
Low dividends
Long-term relations with suppliers and customers
Keiretsu
External/Social/Governmental
High savings rate
Low cost of capital
Pro-business attitudes and policies
Social commitment to growth
Rapid national economic growth
Openness of world markets
Closed domestic markets
Flexible, competitive smaller firms

As stated earlier, we are not offering a formal model in which these features represent particular values for choice variables and parameters that together constitute the arguments of a supermodular objetive function or of the payoff functions in a supermodular game. Still, when we argue that two features are complementary, we will mean precisely that doing (more of) one increases the returns to doing (more of) the other.

One way to evaluate complementarities in the Japanese economy involves conceiving of it a supermodular game, where the players are individual consumers, workers and firms. In this case, some of the complementarities are strategic: One player's undertaking some ac-

tivity increases the returns to some activity (perhaps the same one) for other players. Nevertheless, we will for the most part attempt to interpret the good past performance of the Japanese economy as emerging from coherent practices in an environment rife with complementarities. That simplifies our exposition by allowing us to avoid issues of how the diverse decision makers are led to pursue coherent policies and focuses instead on why the policies are coherent. Thus, we will usually describe complementarities as if the economy shared a single objective of producing value, with occasional remarks where the concept of strategic complementarity would apply under the game interpretation.

Much of our discussion focuses on practices of the largest firms in Japan. These companies are not generally representative of all of Japanese business. Indeed, the practices of small and medium-sized firms that are responsible for the bulk of Japanese GNP are quite different in many regards. Nevertheless, the large firms play a special, central role in Japanese economy and in Japanese life.

Two policies have been most frequently noted in discussions of the human resource practices in major Japanese firms: Long-term employment guarantees for so-called permanent employees,[7] and recruiting of permanent employees only at the very early stages of their careers.

These two features are not uniquely Japanese, nor are they followed universally by all major Japanese firms. Nor are they particularly common in small and medium-sized businesses in Japan. They do, however, appear to be carried further in major Japanese firms than elsewhere. At least since the early 1950s, it has been extremely rare for a major Japanese firm to dismiss a permanent employee except for specific cause, let alone to institute a mass layoff.

[7] Some large Japanese firms have made use of workers to whom no long-term employment promise was made. In many cases, however, these "contract workers" have been kept on by the firms in question for long periods. Married women whose children were in school and who had returned to the workplace have often been employed on this basis. (Until quite recendy, younger women who joined large firms after high school or university were expected to leave at an early age to marry and raise children, and litde provision was made for their continuing employment.)

This has been true both for white-collar and blue-collar workers, and both groups have long expected to enjoy employment security unless their employer was faced by imminent failure. Even when major firms have closed, they have often found their employees other jobs with related firms (see Sheard, 1992). As we vill discuss below, the employment guarantee has not been open ended –it does not extend through to normal retirement age, and so the frequently used terminology of "life-time employment" is inappropriate in this regard– but it has been real.

It has been similarly rare for a major firm to hire someone at other than one of the lowest entry levels. These firms recruit directly from high school and the top universities, and all the new employees of a given year's cohort start work together on April first of that year. There is some mobility of employees in the first year or so, when obvious mismatches are corrected, but after that there is little or no hiring from outside.

One effect of these policies has been to reduce turnover among permanent employees of large firms. A widespread policy of hiring only at the bottom means that there are unlikely to be many attractive job opportunities in other major firms for experienced, mid-career workers. Meanwhile, smaller firms do not usually offer as attractive compensation as large ones. They also give fewer advancement opportunities, have less job security, and are less prestigious places to work.[8] This limiting of the opportunities for moving from major firms both makes retention easier and simultaneously reduces the costs that employees would otherwise incur in monitoring the market for better opportunities. However, such a system would load excessive risk on employees if they did not have job security: Being let go would not just mean losing this particular job, but also being very unlikely ever to find a comparable new one. To the extent that this would represent an inefficient pattern of risk-bearing or would result in inefficient consumption-savings decisions, it should be avoided. The permanent-employment policy mitigates this risk, and so it supports

[8] Aoki (1994) has accentuated the importance of the hierarchical ranking of firms, relating it to the ranking hierarchy within firms (see below) and arguing that they are complementary.

the hiring policy, making it more valuable than it would otherwise be: The two are complementary.[9]

Of course, there may be other mechanisms through which having limited ports of entry to employment in the major firms and their offering permanent employment guarantees support one another. For example, if major firms frequently hired mid career people away from other firms, then any single firm offering permanent employment would face an adverse selection problem: The best employees would face active outside markets and would have to be treated as well by the firm as they would be in their next-best opportunity (or else they would leave), while those with little appeal to the outside market would stay on in the safety of the firm. At a minimum this would be inconsistent with the narrow pay differentials that mark Japanese compensation, and it might even render the permanent employment policy infeasible. Another possibility is that the lack of comparably attractive outside opportunities creates incentives for employees to care deeply about future of their firm and to work to help it survive and prosper. These incentives would be reduced if employees could easily move to another job if the firm got in trouble, and this would make it more difficult to maintain a credible promise of permanent employment.

As well, a major firm that released employees while other firms were offering permanent employment would not be able find comparably experienced workers to replace those it released except, perhaps, at much higher rates of pay. Thus, large numbers of firms' adopting these employment practices makes their adoption more attractive to the remaining firms —there is a strategic complementarity here.

The limited opportunities for Japanese permanent employees to move to comparable jobs with other major employers mean that much of their incomes are appropriable quasirents: Large amounts could be taken away at any time without pushing their pay below the levels available in their next-best alternatives and thereby inducing wholesale resignations. This possibility for *ex post* opportunism could

[9] Viewing the economic system in game-theoretic terms, this is an instance of strategic complementarity: Other firms' not hiring mid-career people increases the value to a given firm's employees of its employment guarantees.

present a constant temptation in a firm that was run primarily in the interests of investors. Presumably, concerns with the long run response that such behavior might elicit would be a check on the temptation to seize employees' rents. Nevertheless, the temptation might become overwhelming in periods of low profits, when investors are less concerned with the long term and the reputation of the firm and more concerned with current returns. The employees' fear of this potential opportunism would then make them leery about committing to a major firm in the first place. It might also make them unwilling to invest in firm-specific human capital that was uniquely valuable to the large firm employing them, because they would have no way to protect their returns from these investments, which are not valued by other potential employers. The governance and ownership structure of Japanese firms, which gives considerable power to the employees as a group, enables them to protect their valuable employment rights and thus supports their developing and committing their human capital.

In fact, in many ways it appears that the employees are "owners" of the Japanese firm at least on a par with the financial investors in the firm. Ownership of a firm has often been seen as having two aspects: Holding power over key decisions (such as the decision to liquidate the firm's assets or to appoint its top managers) that are not allocated elsewhere by contract, and being the residual claimant on the returns from the asset. Both of these adhere to the employees of major Japanese firms.

Surveys of senior executives in major Japanese firms indicate that they regard the interests of employees as being as worthy of consideration in the formulation and execution of strategy and tactics as those of shareholders. They also believe that employees' interests actually do guide policy to a very important degree (Milgrom and Roberts, 1992). Middle management shares these views. Thus, both senior and middle managers believe the interests of the employees ought to weigh heavily in decisions about how the firm is run, and they assert that they do in fact run their firms in this fashion.

The formal governance structure supports this orientation. The majority of the directors of a typical major U.S. firm are not employees. They are "independent" outsiders, elected by the stockholders. Outside directors also make up a large fraction of the board

in firms based in the United Kingdom, and in Germany half the supervisory board that oversees management are direct representatives of investors. In the typical major Japanese corporation, in contrast, outside directors have almost no role, because the board of directors is made up almost exclusively of the thirty to forty most senior managers of the firm. Their nominal duty as directors is to the shareholders who legally elect them as their representatives and entrust them with overseeing top management (the representative directors). How effective such a large group of employees could ever be in disciplining top management is certainly open to some question. More to the point, a board consisting of employees who have spent their whole careers in the organization and whose social relations are with the other employees in the firm is certainly unlikely to give primacy to the shareholders' interests when these are in conflict with those of the employees.

Moreover, the method in which Japanese firms have been financed supports this. Relatively little of the typical large firm's financing comes from voting equity, and only a small fraction –between a quarter and third– of this equity is held directly by investors. Instead, most of the common stock in the typical large Japanese firm is held by other major domestic firms: Insurance companies, banks, and other industrial enterprises.[10] These in turn have similar governance structures and similar managerial attitudes concerning the appropriate way to run firms. They also often have long-term business relations with the original firm, which may in turn hold significant fractions of their stock. This ownership pattern (called *mochiai)* supports managing the firm in the employees' interests, or at least giving consideration to their interests over those of stockholders, because most of the voting shares are effectively in the hands of managers who themselves accept the desirability of this practice. Consequently, any pressure that investors might try to exert to affect firm behavior will be muted.

Traditionally, the rest of the firm's financing has been from bank loans, often with one "main bank" playing a central, long-term role both as a lead source of financing, as a monitor, and as an ultimate

[10] While these cross-holdings of stock are perhaps most familiar in the case of member firms in *keiretsu* groups, they extend beyond *keiretsu* boundaries and exist among firms that are unaffiliated with *keiretsu*.

risk-bearer in circumstances of financial distress. These banks have similar ownership and management structures to the industrial firms. They have also operated under governmental regulations that limited price competition for funds and that encouraged them to focus on the size of their asset bases rather than on earnings. Consequently, they have not been as much of a threat to running the firm in the interests of employees such as other outside providers of finance might represent.

Within the firm, decision-making power is pushed down the managerial hierarchy, often right to the shop floor, where worker teams are responsible for determining how they will do the tasks they face, where employee suggestions are eagerly sought and acted upon, and where an individual has the right and duty to stop the assembly line if a problem arises. Despite the existence of a managerial hierarchy, communication within the firm is often horizontal, with adaptations to changing circumstances being determined by the affected line personnel directly rather than by hierarchic superiors. Corporate policy and strategy is formulated at the lowest possible levels and then moves up through the hierarchy. It becomes adopted only after affected employees have had their say and a "consensus" has been achieved. These measures again help assure that employees' interests are considered.[11]

Clearly, executive incentive plans based on stock-price performance, such as have become common in large U.S. firms, are inappropriate in such a context. Indeed, instituting them would undermine the tendency to run the firm in the employees' interests.

Employees receive a large percentage of their incomes (25 to 30% in normal times) in the form of bonuses that are perceived to be tied to the overall performance of the firm. This makes them effectively residual claimants as well as residual decision makers, at least in the long run. It also facilitates maintaining permanent employment, because pay can be cut in bad times to reduce labor costs without layoffs. It also increases the value of running the firm in the interests of the employees, so that they need not fear that the managers, acting

[11] Paul Sheard (1994) offers a similar argument regarding complementarity among crosssshareholding, the employment system and the participatory governance structure.

in the interests of outside claimants, will fail to pay the bonuses to which the employees are entitled.

Meanwhile, only a small part of the firm's cash flow has traditionally been paid out to investors as dividends, with the bulk being reinvested in the firm. This arguably helps ensure that the firm will survive and grow, thereby making the permanent employment promise more credible. (A firm run primarily in the interests of investors would distribute its earnings back to investors unless its internal opportunities for investing these funds carried higher returns than were available outside.) More generally, a strategy that emphasizes growth and market share rather than profit maximization serves very directly to support the permanent employment policy by helping ensure that there will be jobs in the future and, beyond that, on-going opportunities for promotion. As seen in the recent example of IBM in the United States, life-time employment could easily come in conflict with strategies aimed at maximizing stockholder returns.

Corporate strategies accentuating of growth and market share have fit well with the external environment in which Japanese business has operated. This is more than just a matter of noting that growth for an individual firm is easier if the overall economy is growing. Japan's high national savings rates combined with government restrictions and regulations on financial institutions and financial markets combined to give large, established Japanese firms a lower cost of capital through much of the post-War period than prevailed in other countries. This made the gap between growth-oriented and profit-oriented policies smaller, encouraging high levels of investment and the patience to wait for deferred returns to these investments. The opportunity to import technologies and to export to world markets that were increasingly open to international trade in the post-War era also facilitated Japanese growth, both in the aggregate and at the level of the individual large firm. This growth was further supported by a widely-shared social goal of rebuilding Japan from the wartime destruction and bringing it up to world levels of productivity and weaith. This encouraged accentuating economic growth over current consumption, as did a set of social and cultural values that honored and rewarded devotion to one's employer. Also important were a range of government policies (such as limiting market access for imports, restricting foreign firms' activities in Japanese

markets, minimal antitrust enforcement, and maintaining low costs of capital) that favored the interests of vested interests generally and particularly those of large businesses over current consumer interests. These in turn were the outcomes of the complex of supportive relationships within the "iron triangle" of the Liberal Democratic Party, which controlled the government of Japan throughout the period, the bureaucrats in the ministries, and big business.

The Japanese employment and corporate governance system, in which employees did not fear for their jobs, expected to share in the fortunes of the firm, did not anticipate leaving for another employer, and had a say in the directions the firm would take, encouraged both employees and the firm to invest heavily in firm-specific human capital. This was further encouraged by the low cost of capital. To the extent that the employees had to bear the costs of these investments, their doing so was further encouraged by the policy at several firms of paying blue-collar workers not for the particular jobs to which they were currently assigned, but instead for the skills they had acquired from a list established by the firm. An analogous pattern developed for white-collar workers, who could be promoted to a higher level in the "ranking hierarchy" as a reward even though there was no position open at the corresponding higher level in the reporting hierarchy, so that the job assignment would be unchanged.[12]

At the same time, the extensive acquisition of firm-specific human capital, the resultant job-related rents, and the associated low turnover allow the firm to finance the acquisition of *general-purpose* human capital –human capital that would be valuable to a variety of employers. Typically, firms operating in active labor markets are reluctant to finance their employees' acquisition of general-purpose human capital because the necessity of meeting competitive employment offers means they cannot expect to recoup the costs of the investment. Japanese firms, in contrast can underwrite their employees' gaining such capital without fear that the employees will use it to obtain offers of higher-paying jobs from other employers. This may explain why Japanese firms invest very heavily in formal training for blue-collar workers and pay significant numbers of their

[12] Aoki (1988) has accentuated the role of this dual hierarchy system.

managerial employees to get graduate degrees in business and law at the firm's expense (a practice European and North American firms rarely follow). Frequently transferring employees across functions is another element of this investment activity.

With high levels of firm-specific human capital, the decisions taken by the firm place risks on employees' human assets that are comparable to those borne by investors' physical capital. The need to protect the value of this human capital then supports having employees' interests figure into the firm's decision-making.

An environment of economic and technological change means that a firm's employment needs will be changing too. In this context, a guaranty of long-term employment would be tremendously expensive if the firm could not reassign workers to new tasks as the needs arose. Thus a system of permanent employment differentially favors the sort of flexible work rules for which Japanese firms are known, as well as frequent inter-functional and geographic reassignments of white-collar workers. Extensive worker training in both general and specific skills clearly facilitates these sorts of reassignments. As well, a system of company unions (rather than industry-wide ones) supports flexibility, because the company union can more easily be responsive to the individual conditions of the specific firm.

Within the major Japanese corporations, promotions are constrained by seniority. A new white-collar recruit can expect to spend at least a decade with the firm before being considered, along with the others in the same cohort, for a promotion. Then members of any experience cohort are evaluated for further promotions only after more senior people have had their chances. Pay, too, is tied to seniority, with individual merit or performance pay being less significant than in North American firms and with the amounts involved being quite small. Also, the differences in pay levels between ranks are typically smaller than in European firms, and much smaller than in North America. These systems would be infeasible if there were an active outside labor market that could bid up the pay of star performers. Thus the promotion and pay policies rely on the practice of hiring only at the bottom.[13]

[13] This is another instance of a mutually supporting relationship among the policies of different organizations –a strategic complementarity.

The system of decision-making by consensus requires that large numbers of individuals have a role in decisions, and that all affected parties be allowed to make their views, interests, and concerns known. This would leave the organization susceptible to costly influence activities[14] if pay and promotions were less a matter of seniority, more sensitive to apparent qualifications and merit, and more a matter of managerial discretion. As well, the policies of promoting growth and pursuing market share, even at the possible cost of reduced investor returns, help ensure that there will be good opportunities for promotion when the time comes. Such opportunities may possibly reduce the competition among workers, limiting influence activities and promoting effective consensus decision-making. It is also possible that the policy of reinvesting most of the cash flow also limits the competition among groups and business units within the firm for the resources needed to develop their projects. If the resources were more limited and internal projects had to compete with paying the money out to investors, those inside the firm would campaign much more intensely for their interests. The standard policy of moving white-collar workers around within the corporation, rather than having them build their careers in a single function or unit, also contributes to their taking a broad view of their personal interests that is more in line with overall organizational success, and this too helps control influence activities. Paying bonuses that depend on aggregate profitability rather than individual or unit performance has this same effect.

The permanence of employment ensures that employees need not fear that attempts to increase efficiency will cost them their jobs, while the fact that the firm is run (at least in part) in their interests and that their incomes vary with firm performance cause them to value efficiency gains positively. Together, these facilitate enlisting employees actively in searching for and implementing cost and quality improvements and making use of their special local knowledge of

[14] Influence activities in firms are the analogue of rent-seeking activities in regulated markets. Both are activities aimed at affecting the distributional impact of decisions. Such activities are costly both because they dissipate energy and resources and because they may result in inefficient decisions. See Milgrom and Roberts, 1990c and 1992.

their jobs. The resultant constant improvement (*kaizen*) in quality tends to increase demand directly, and the improvements in costs are complementary with increasing output and sales through price reductions. Both of these support the growth and market-share strategy. They are also, as we have argued in Milgrom and Roberts (1990a), complementary with the other aspects of the system that mark modern manufacturing: Flexible equipment, reduced time-to-market, low inventories, increased communication with suppliers and customers, greater reliance on external suppliers rather than complete vertical integration, and so on. Of course, several of these features are directly complementary with other aspects of the system. For example, a permanent employment policy is supported by a policy of supplementing internal procurement with outside suppliers from which work can be withdrawn in periods of weak demand.[15]

The use of work teams supports both flexibility and the acquisition of on-the-job training because it allows workers to practice and use the multiple skills they develop and it affords experienced workers considerable opportunities to participate in training new workers. Organizing work in teams, however, makes individual performance measurement difficult and so discourages developing significant pay differentials among team members. At the same time, if pay were allowed to vary more across individuals then the resulting influence activities would likely be intense and costly.

As noted earlier, the promise of permanent employment does not extend through to normal retirement age. Large Japanese firms impose mandatory retirement at a relatively early age –typically in the early to mid-fifties– with only the most senior executives normally being exempted. It is, however, standard that those who retire from major firms find new jobs to carry them through until they are eligible for social security payments at sixty-five. These positions are frequently at smaller companies that are connected with the original employer (through ownership or long-term commercial relations)

[15] For this to be effective, either the shocks affecting the firm and its suppliers must be imperfecdy correlated, or else there must ultimately be firms in the supply chain outside the system offering employment guarantees. Thus, it is actually important that small and mediumsized firms do not offer promises of permanent employment.

and that rely on the employer for recommendations. As well, until relatively recently vested pensions were a rarity Instead, the firm would make a cash payment to the worker at retirement. The practice of systematically forcing almost all employees out at a relatively early age makes room at the top and, by shortening the period over which the commitment is made, makes a permanent employment policy less expensive. Beyond this, however, these practices together provide potentially important individual performance incentives.

Lazear (1979) has argued that withholding a portion of earnings and then paying them out on successful retirement can be a means of implementing a system of bonding by workers and thus can deter misbehavior. Moreover, as the managerial hierarchy narrows toward the top, the opportunities for promotion worsen. To the extent that promotion opportunities are an important motivator, some substitute is needed. As well, the reluctance of firms to terminate employees even when they are not performing quite adequately (because doing so makes it harder to monitor whether the firm is keeping the promise of permanent employment) also increases the value of some mechanism to provide incentives. The prospects that one's performance might influence the assistance one receives from the firm in finding a postretirement job (and even, in the case of higher level people, the amount of the retirement payment) provide incentives to those who are not going to move higher in the original firm.

In this system, the demands on the corporation's personnel department are quite extensive. With permanent employment, the initial selection of suitable recruits for the company is of utmost importance, and Japanese firms commonly devote much more time to the initial interview and testing stages than the typical North American firm. After hiring, the personnel department must be able to track employees effectively, to provide appropriate training and job rotations, and to identify and encourage the candidates who are most likely to move up into higher management positions.[16] This is a crucial and complicated task that involves managing an important and valuable resource and that hears directly on the welfare of an important group of residual claimants. Thus, the personnel function

[16] Aoki (1988) emphasizes these roles and the complementarities among them.

is accorded great respect in a major Japanese corporation, and it is able to attract among the best employees in the organization. It also is typically much more centralized than in North American firms, as is consistent with the need to assemble information on any single individual from former supervisors in a variety of disparate parts of the firm.

The ownership, financing and governance structure described earlier mean that stockholder discipline through proxy contests or tender offers is weak in Japan: The market for corporate control is not active. Moreover, employee directors are not likely to be the most effective monitors or disciplinarians for senior management, at least in comparison to outside directors in such U.S. firms as General Motors, American Express, IBM and Westinghouse, were the outside directors, spurred by investors, all recently removed the CEOs. Further, shareholder law suits were not a significant threat under the commercial code in effect until 1992, which required a party suing a corporation to pay 0.5% of the claimed amount in taxes to file the suit. All this increased the value of other sorts of external monitoring. This role has been largely filled by the institution of the main bank. The bank might play little role in a firm that was doing well, but its untensity of scrutiny and involvement could be very great when the firm was in serious difficulties (see Aoki, 1992; Aoki and Sheard, 1992). For example, main banks have replaced senior managers in troubled companies. Sumitomo Bank's replacement of the head of Mazda in the context of the bank's rescue of the troubled automaker in the mid 1970s is an important instance. Strikingly, the ousted executive was a member of the founding family and a major shareholder. Thus, the system of monitoring and, when necessary, control by the main bank has been complementary with other aspects of Japanese corporate governance and financing.[17]

[17] Note that the patterns of financing and corporate control practiced in the United States and United Kingdom and those in Japan are *substitutes:* Having one means you do not need the other. The former system, however, is incompatible with other aspects of Japanese organization, as we have argued. The formal argument that Japanese financing methods are complementary to the rest of the system in this context is based on the assumption that the Japanese and U.S.-U.K. pattern are the only alternatives.

The long-term relations that exist among Japanese companies have frequently been noted, especially in their institutionalized form of the *keiretsu.* These relations are sometimes supported by cross-ownership of stock, but they also exist even when there is no ownership relation, and they occur both between firms that have frequent direct commercial dealings (as in the "vertical" or "production" *keiretsu* involving a manufacturing firm and its suppliers) and among firms that transact with each other only on a small scale (as with typical members of the "horizontal" *keiretsu* that are organized around a bank or general trading company). The permanent employment policy facilitates these relations, because the inter-firm dealings are also dealings between specific individuals who stay with their respective firms for long periods. Significant resources are expended on building these inter-personal relations: Major Japanese firms spend as much on entertaining managers from other firms as they distribute in dividends. Meanwhile, Japanese business people complain that building and maintaining a relationship with US firms of the sort they enjoy with Japanese ones is hindered by the frequent turnover of personnel in the US, which disrupts communication and slows mutual learning.

These long-term relations, which allow the promise of future rewards and punishments (both by directly affected parties and by others) to control current behavior, permit Japanese industry to adopt a relatively low level of vertical integration compared to what prevails in the US and Europe while still protecting specific assets and allowing close coordination (Asanuma, 1989, 1992). Thus, permanent employment and low turnover support the vertical industrial structure. At the same time, the *keiretsu* have helped with maintaining permanent employment by member firms' supporting other members that were in financial difficulties and absorbing employees from members that needed to reduce employment (as occurred, for example, in the aluminum industry in the wake of the first oil shock (Sheard, 1992).

Transfers of employees seem to be particularly common from major firms to subsidiaries and affiliates.[18] Sometimes these transfers

[18] A firm is a subsidiary if the parent has over 50% ownership, and an affiliated company if the parent's ownership is between 20% and 50 percent.

are temporary and are seen as a means to increase employee human capital: Employees learn about another business or acquire managerial experience in the related firm. In other cases, they are a means to utilize the skills of managers who are not destined to rise to higher levels in the core firm, and sometimes they are a means to reduce core firm employment without violating the permanent employment promise.

Major Japanese firms in fact typically have relatively large numbers of subsidiaries and affiliates, some of which were originally created as such and some of which were originally units of the parent that have been spun off as separate firms (Itoh, 1993). The creation of separate affiliates is also complementary with several other aspects of Japanese practice.[19] First, controlling influence activities in a system of consensus decision-making favors having the firm be relatively homogeneous, and separating off businesses that require different employee skill sets or management practices increases homogeneity of the core firm. As well, the avoidance of significant pay differentials means that divisions of Japanese firms cannot be given the independence that they often have in American firms, because the senior managers of the divisions cannot be given the appropriate performance incentives. Consequently, while Japanese firms often have a divisionalized structure on paper, the division heads frequently do not have profit and loss responsibility and do not have the authority of the corresponding managers in "M-form" organizations (as described by Oliver Williamson, 1975). Separating the division from the core firm by making it a subsidiary or affiliate then facilitates performance evaluation and the provision of incentives. As well, the relative lack of autonomy of the divisions means that central management is frequently making decisions that have potential distributional effects across divisions. These are an invitation to influence activities. Separation of a unit as a subsidiary or affiliate is then a means for the senior managers of the core firm to commit to limited interventions and thus reduces influence activities.

Thus, many features of the Japanese management system appear to be linked by a complex web of complementarities. It is, of course,

[19] These arguments are due to Itoh (1993).

an empirical question whether these links in fact are as we have claimed them to be and, if so, how strong the complementarities actually are. It is possible, too, that the web of linkages is even richer than we have described, with even more strict complementarities between pairs, and that it involves even more variables. Skill, assuming that many of the linkages are at least as rich as we have argued, the mathematics of complementarity presented in the previous section then can give significant insights on a number of issues.

First, and most obviously, the linkages through complementarity of the various features of Japanese economic organization suggest that we should often see all these features together: Japanese practices on all these various dimensions are not some random selection, but one that has a strong internal logic. This is so whether we interpret observed practices and patterns as the outcome of a game marked by complementarities among the various elements of each player's strategy choices and by strategic complementarities among the strategies of the different agents, or instead as the result of optimizing in an organizational design problem. The pieces of the Japanese pattern fit together, supporting one another, with each increasing the effectiveness of the others.

Of course, the Japanese system we have described has evolved and developed over time; it did not simply emerge full-blown in final form. The results cited in the preceding section on dynamics and bounded rationality are important in this regard for the plausibility of interpreting Japanese economic organization as we have, either as the result of a supermodular design problem or as the outcome of play of a supermodular game. For they imply that many forms of boundedly rational search or play will exhibit momentum: Once the system starts moving towards the pattern we have described, it will continue to do so, perhaps adding features over time that are complementary with the existing ones.

We have actually argued that the elements of the Japanese system are indecomposably linked: For each of the features listed in Table 1 there is at least one other that is made strictly more effective by the presence of the first, and that feature in turn is linked in turn to others. This means that piece-meal adoption of a few of the features of Japanese organization in a firm or economy that otherwise is designed according to a different model is unlikely to be effective and

might actually be quite damaging to system performance. If one is thinking of adopting some of the elements of Japanese practice, then it is important to bring along at least the other major supporting elements.

The indecomposability also means that a change in certain key features of the system –especially features that are strongly connected to many others– has the potential to lead to massive systemic change. This is so whether the original change is motivated by new constraints or by other changes in the environment that directly affect the relative payoffs of alternative choices. We will explore the implications of this point further in the next section.

3. Challenges to the Japanese Pattern

The tightly linked, highly successful system we have just described and analyzed may soon be a thing of the past. A variety of developments in Japanese society and politics and in the position of the Japanese economy in the world have worsened the fit between the current system and its environment and are threatening the continued viability of some of the key elements of the current system. If our arguments are correct, so that the Japanese system is one in which the individual elements are linked by complementarity and form a coherent pattern, then these developments that necessitate changes in a few of the features of the current organizational arrangements may ultimately lead to widespread, systemic changes. In a system of complements, altering the values of a few of the variables leads to predictable changes in the other variables. In the Japanese context, these effects will amount to a fundamental realignment of the patterns of economic organization.

An appreciation of the need for economic change, and even for the possibility that the changes may end up being be fundamental and systemic, seems to be developing in Japan. Even before it became clear how severe and extended the current recession would prove to be discussion had begun about the continued appropriateness or viability of some of the characteristic features of Japanese economic organization in light of secular trends and developments.

For example, in 1993 Akio Morita, Chairman of the Sony Corporation, called for Japanese business to adopt shorter working

hours, higher pay, higher dividends, and a greater orientation towards profit rather than market share. These changes were seen as moves towards doing business as it is done elsewhere in the world. They were justified not as necessarily being desirable on their own, but instead as being needed if Japan is to be a "good world citizen" whose policies and practices were compatible with those of its major trading partners. Morita's suggestions apparently did not meet with any wide acceptance, but others have echoed similar concerns with the fit between Japan and other economies.

Other business leaders, notably Ken-Ichi Ohmae of McKinsey & Company, have pushed for re-orienting Japanese politics and policy on purely domestic grounds. The organization founded and led by Ohmae, Reform of *Heisei*, has attracted immense popular attention with its call for reforms that would favor consumer interests and those of "outsider"-firms (new businesses and foreign firms) that are more likely to cater to consumer needs, over those of established big business. The stunning defeat of the Liberal Democratic Party, which had completely dominated post-War Japanese politics, in the 1993 election and the formation of the Hosakawa government with its promise of electoral and administrative reform and of economic deregulation signaled both the Japanese electorate's disgust with the prevailing system and their desires for political and economic change.

The recession that began in 1991 in Japan and that has extended into 1994 is intensifying concern with the need for economic change. The forces that have created these needs are, however, of longer standing.

We have argued that capital market conditions and practices have been key elements in the Japanese model. These are all changing in ways that threaten existing organizational patterns. Regulatory changes have already given rise to vested pension plans and to increased competition to invest and manage these. If U.S. experience is any guide, this may force the pension fund managers to insist on greater profits and payouts from the firms whose stocks they hold, endangering the policies of retaining the large bulk of corporate earnings and of accentuating growth and market share. More generally, on-going deregulation of the Japanese financial institutions is opening world capital markets to Japanese savers and so raising their required returns to world levels. This too will lead to pressure for corporations

to generate higher returns for investors. Meanwhile, Japanese firms (and especially the largest ones and those belonging to horizontal *keiretsu*) have earned returns that matched their low perceived costs of capital and that resulted from their growth-oriented policies, but that were well below those generated by corporations elsewhere.

These changes have been going on for some time, but initially the pressures for better performance were muted by the huge capital gains that resulted from the spectacular run-up of stock and land prices in the "Bubble Economy" of the late 1980s. This boom was occasioned by the Bank of Japan's keeping interest rates extremely low in the face of the huge rise in the value of the yen that followed the Plaza Accord. Investor beliefs that these gains would continue to mount also kept the perceived cost of capital low, because firms were able to issue corporate debt at negligible interest rates by offering warrants. For example, Sony financed some of its 1989 acquisition of Columbia Pictures, the Hollywood movie studio, with bonds carrying warrants. The interest rate on the bonds was less than a third of one percent!

The collapse of stock and real estate prices at the end of the "Bubble Economy", however, not only removes the safety valve of capital gains, but is likely to intensify the pressure for improved financial performance. The decreased asset values have also made it more difficult for the banks to finance expansive policies, especially because their portfolios contain large amounts of effectively non-performing loans. Stock market prices being at half their peak values further contributes to an increased cost of capital and further erodes the attractiveness of deferring profits to buy growth in market share.

The rise in the cost of capital is unlikely to reverse itself. In particular, the Japanese population is aging rapidly, and in 1996 14% of the population will be over age 65. This represents a doubling in only 26 years, and the aging will continue. (In contrast, it took 75 years in the U.S. for the percentage of the population over 65 to double from 7% to 14%, 45 years in the United Kingdom and 115 years in France!) Meanwhile, the size of the labor force is projected to peak in the year 2000, and then to begin to fall. These demographic developments will reduce future domestic savings rates and are likely to put further pressure on the cost of capital, making growth and market share

policies more difficult to maintain. This in turn threatens all the other features to which they are linked.

The gradual opening of Japanese product and service markets is also threatening established practices. While blue-collar, manufacturing productivity in many Japanese industries is among the highest in the world, white-collar productivity is low by international standards, especially in services (McKinsey Global Institute, 1992, 1993). The extreme manifestation of this are the "window sitters", employees who have no work but are simply assigned to sit at their desks by the window until they retire. The productivity problems are in part a result of the permanent employment policies and the use of promotions as rewards. The former has made shedding unproductive workers difficult, and the latter has resulted in excessive numbers of employees at high levels. Consensus decision making may have contributed as well: Honda recently shifted away from this approach, even though it was one of the cherished values of the firm, because its executives believed it rendered decision making too slow and unresponsive. The intense hiring by large firms during the "Bubble Economy", when capital seemed free and when anticipated future labor shortages seemed a pressing concern, and the current recession have intensified the effects of these long-term trends. As long as Japanese markets were relatively closed, these inefficiencies could be financed by high domestic prices. Markets are gradually opening, however, under the effects of deregulation, the reduction of non-tariff trade barriers, and a breakdown in norms against price competition. Competition, both from foreign products and firms and from new Japanese entrants, is intensifying and, increasingly, shifting towards price competition. For example, the U.S. personal computer maker Compaq recently entered the Japanese market at prices that were half what the major Japanese firms had been charging for similar equipment, while a new direct-importer of Scotch whisky has so undercut the previously established prices that duty-free imports of Scotch by Japanese travellers have fallen 80 percent. These developments are putting pressure to lower overhead costs. These in turn endanger the permanent employment policy.

Finally, the growth of the Japanese economy is sure to be much less in the future than it has been in the past. The Japanese population is forecast to stop growing and actually to start shrinking by 2010, with

an increasingly large percentage of the population having retired from the work force. Thus, growth in the labor supply will not contribute to overall economic growth. Capital deepening is a possible means of growth, but the rising costs of capital will limit this, and, at least for the present, Japanese industry faces massive overcapacity already. Moreover, Japanese firms are now operating on the technological frontier and cannot expect to continue to be significant net importers of superior technology, as they once were. All this makes it very difficult for the Japanese economy to grow at rates that much exceed those of the other advanced economies.

All these factors make the strategy of running the firm in the interests of long-term growth and continuing employment more difficult to maintain. At the same time, Japanese employees are increasingly willing to change jobs in mid-career. This trend seems to have started among managerial employees who had studied abroad and who were frustrated by the slow pace of advancement in their firms. They were then recruited by foreign firms seeking Japanese managers. It has, however, begun to spread beyond the foreign-trained and foreign firms. The long-term labor shortages that are predicted to follow from the established demographic trends of low birth rates and minimal immigration should intensify this trend, as should many of the changes in attitudes among younger generations towards work and employers that surveys have revealed. Increasingly, younger Japanese appear to be unwilling to devote themselves to work and to identify their interests with those of their employers to the extent that their parents did. Again, if the linkages among aspects of Japanese practice are as we have suggested, a breakdown in the permanence of employment will require many other fundamental changes.

While these secular developments are going on, the continuing recession has put special pressures on Japanese businesses. Under the pressure of the recession, with falling sales and profits, firms are actively considering ways to increase white-collar productivity, for example, by increasing the sensitivity of managerial pay to individual performance. Doing so, however, risks undercutting the other aspects to which pay policies are linked. Many have even begun to question openly the continued viability of permanent employment, and others simply state that it is a thing of the past. Already a number of firms

have not renewed contract workers' employment, and some have actually terminated regular employees (usually via pressured early retirements, but increasingly through direct layoffs). Even if the permanent employment policy is not officially abandoned, these forced quits will undermine its credibility.

With so many of the characteristic features of Japanese economic organization being challenged, it is clear that major changes will be needed in the economy. Combined with the multiplier effect that theory tells us is always associated with systems of complements, we are led to expect that the changes will have to be even larger and more pervasive than might otherwise appear.

Perhaps the most interesting question is what new pattern will ultimately emerge. In particular, many Japanese are concerned with whether their economy must necessarily end up in the American mold. Our analysis might suggest this, because parts of the analysis were written as if the Japanese and U.S. approaches were the fundamental alternatives. But that was merely a convenient assumption. Identifying the actual range of alternatives is beyond the scope of our analysis or the range of our forecasting powers.

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