

Working Paper

**Learning How to Govern and
Learning How to Solve Problems:
On the Co-Evolution of
Competences, Conflicts and
Organisational Routines**

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WP-95-06

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Preface

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

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

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

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

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

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

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

The research focuses upon the following three major areas:

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

I. INTRODUCTION

This work is meant as an exploration of the origins and roles of different organizational routines which sustain diverse corporate structures and reproduce over time different "strategies" and performances.

There is indeed quite robust evidence that firms -despite obvious regularities- persistently differ in their characteristics, behaviours and revealed performances. For example, they clearly differ in their sizes, their forms of internal organization, their degrees of vertical integration and intersectoral diversification, etc. But they also differ in their revealed performances - in terms, e.g. of innovative success, speed of adoption of new technologies, inputs productivities and profitabilities -. Relatedly, a major puzzle concerns the reasons of persistence of these asymmetries. Why apparently "superior" organizational forms diffuse very slowly, if at all, within industries and, even more so, across national borders?

A good part of the answer, in our view, certainly rests upon the specificities of organizational competences. In fact, the first building block in our argument, directly developing on evolutionary theories, is that firms are crucial (although not exclusive) repositories of knowledge, to a large extent embodied in their operational routines, and modified through time by their "higher level" rules of behaviour and strategies (such as their "meta-rules" for innovative search, diversification, etc). In this view, competences are the collective property of the routines of an organization, and - due to their partial tacitness - are often hard to transfer or copy. Competence specificity leads straightforwardly to an easy possibility of "lock-in" and thus also to persistent diversity at firm-level and, moreover, to specificities at the level of "national trajectories"¹.

In this work we shall focus primarily on the non-random distribution of competences across countries (and, relatedly, on the differences in the national patterns of organizational evolution).

In order to interpret these international (or, also, inter-regional) differences, one must account, first, for the properties of the networks in which firms are embedded: these linkages with other firms - within and outside their primary sectors of activity -, and with other organizations (such as public agencies) shape and constrain the opportunities facing each firm to improve its problem-solving capabilities. Second, "national systems" of production and innovation entail also a broader notion of *embeddedness* of microeconomic behaviours into a set of social relationships, rules and institutional constraints (Granovetter [1985]). In turn, these embeddedness properties contribute to determine the evolution of organizational structures and, together, competences and strategies.

¹ Cf. Boyer [1992], Coriat [1994 b], Lazonick [1990] and [1993], Zysman [1994].

There are, however, two complementary aspects of this embeddedness argument (as well as to the earlier "lock-in" one). These two aspects also correspond to two perspectives on the nature and function of business firms themselves.

A first one - which has been highly emphasized in the evolutionary literature - concerns the *coordination* and *problem-solving* nature of organizational routines. Hence, their specificities are shown to be related to the "cognitive" features of the operational or search tasks at hand.

Indeed, one of the author in earlier works has claimed that, in a first approximation, one could start with the assumption that a "weak incentive compatibility" among individual agents could be taken for granted, and directly analyze the collective problem-solving features of particular ensembles of routines composing the repertoire of each organization (Dosi and Marengo [1994])². It is proving to be a fruitful investigative strategy. However, it neglects the second major role of organization and organizational routines, namely their being a *locus of conflict, governance, and a way of codifying microeconomic incentives and constraints* -as often emphasized by the other author (Coriat [1979-1994] and [1990-1994]).

In this work we begin an exploration of this double - "cognitive" and "governance" - role of organizational routines.

Just to mention few archetypical examples, the "Chandlerian" (primarily American) modern large corporation embodies the development of novel competences of managerial problem-solving, as recently Teece [1993] and Chandler [1992] himself have convincingly argued. At the same time, however, that organizational form embodies equally specific forms of internal governance of conflicts and incentives, which, in a shorthand, can be identified with "Taylorism" and "Fordism".

Conversely, in an archetypical "Japanese" corporation (Aoki [1988] and [1990], Coriat [1991b]), the patterns of competence accumulation are nested in quite different forms of governance and conflict management. Many other historical examples could be cited, from Germany to Italy to Britain...

Of course, governance mechanisms are today a quite familiar domain of economic analysis, but, most often, elegant equilibrium rationalizations have assumed away the crucial problem-solving tasks associated with the development of routinized, inertial and conflictual behaviours. Here, we take a rather different route, and move some steps toward an appreciation of the co-evolution of (highly imperfect) *mechanisms of governance*, on the one hand, and "*what a firm is able to do and to discover*", on the other.

² That assumption is in the same spirit as Nelson and Winter [1992].

In this preliminary work, we aim to identify the properties, in both the "cognitive" and "governance" domains, of some distinctive set of routines - or protocols - of different organizational forms, and suggest a co-evolutionary story on their origins.

The embeddedness argument clearly comes out enhanced. Particular patterns of conflict, "truces" and mechanisms of incentive governance present an intrinsic collective nature, grounded in the institutions of each country. Together with the cumulative nature of learning processes, they contribute to explain the persistence of national specificities in organizational set-ups and corporate routines.

II. SOME BACKGROUND FINDINGS AND HYPOTHESES ON LEARNING, CORPORATE ORGANIZATIONS AND GROWTH.

Let us start by placing the discussion that follows concerning the relationships between processes of learning and mechanisms of organizational governance in the perspective of a broader set of questions and findings regarding the linkages between technological change, specificities in the institutional organization of economic activities and growth.

A useful point of departure are a few findings that evolutionary-inclined practitioners in economics, but also many economists of other intellectual origins, economic historians and organizational theorists would consider robust stylized facts (although of course this is a theory-ridden and by no means uncontroversial evaluation).

For our purposes, the preliminaries of our argument are **a)** even within commonly shared organizational patterns, the persistent heterogeneity across firms - an, even more so, across countries - in their abilities to develop, imitate, adopt technological innovations; **b)** roughly similar persistent differences across countries in their input productivities and incomes; **c)** the long-term correlation between the two sets of phenomena (which, indeed, a few economists would theoretically interpret in causal manners, in terms of co-evolutionary processes).

Many more details on the evidence and the causality linkages have been discussed elsewhere (cf. Dosi, Pavitt and Soete [1990]). For example, there is an emerging evolutionary view on the microeconomics of technological innovation, grounded in the specificities of the learning processes which characterize particular classes of problem-solving activities. In turn, this view naturally leads to predictions of inter-sectoral heterogeneity in innovative patterns, asymmetries in innovative performance across firms, possible path-dependency and "lock-ins"³.

³Within a rapidly growing literature, see Freeman [1982], Nelson and Winter [1982], Pavitt [1984], Rosenberg [1985], Dosi [1988], Dosi et al. [1988], David [1985], Arthur [1988], Saviotti and Metcalfe [1992].

At a more aggregate level, a few scholars have attempted to show - both at theoretical and empirical levels - that growth can be viewed as a process fuelled by heterogeneous efforts of innovation checked by some market selection⁴. One is also able to show that these same processes in multi-economy settings may yield convergence but also (and more often) divergence, forging ahead and falling behind in relative per capita income⁵. Complementary empirical findings highlight the crucial importance of technological change as apparent determinant of trade patterns and growth⁶.

As annoying as it might be for economists of other entrenched beliefs, here we shall take these phenomena for granted while investigating their microeconomic foundations and some implications for "national trajectories" and possible lock-in phenomena.

Indeed, a few implications are *prima facie* observationally undistinguishable from those derived from other modeling assumptions. For example, "new growth" and "evolutionary" theories at least in a first approximation overlap in their prediction of, first, innovation-driven self-sustained growth, and, second, long-term differentiation in growth patterns across countries⁷. Most likely, one encounters here a generic property of learning : technological learning, no matter how roughly represented, tends to imply the possibility of international differentiation, even when embedded into equilibrium dynamics and scarcity constraints on underlying endowments (eg. in the labour force, skills, capital, etc...). It is, indeed, an important theoretical result, already implicit in the pioneering work of Arrow ([1974] on the peculiar nature of "information" - even when neglecting those differences between "information" and agent-specific "knowledge" emphasized by evolutionary theorists (Pavitt [1984], Winter [1981] and [1987], Dosi and Egidi [1991])).

As argued at greater length elsewhere⁸, a distinctive feature of evolutionary models is the attempt to represent the possible emergence of relatively ordered and differentiated economic systems as self-organising processes floating in a world where "endowments" and "available technological blueprints" are seldom functionally binding constraints. Rather, technological learning within a notionally unlimited space of opportunities, at the levels of both individual firms and whole industries and countries, determines economic performances. "Endowments" are seldom binding because one can continuously improve their quality and

⁴See the pioneering work of Nelson and Winter [1982], and, among others, Silverberg et al. [1988], Eliasson [1986], Chiaromonte, Dosi and Orsenigo [1993], Metcalfe and Gibbons [1986], Silverberg and Verspagen [1994].

⁵Dosi et al. [1994a].

⁶Cf. Dosi, Pavitt and Soete [1990], Fagerberg [1987] and [1988], Soete and Verspagen [1993], and the broad discussion in Abramovitz [1989].

⁷Cf. Romer [1986], [1990a], [1990b], Helpman and Krugman [1989], Grossman and Helpman [1991], Aghion and Howitt [1992].

⁸Dosi and Orsenigo [1988], Dosi [1992].

efficiency, while one can hardly separate the contribution of individual factors to growth, because of a rich structure of positive feedbacks. In this respect the evidence on the microeconomics of innovation (cf. Dosi [1988]), shows a highly variegated patterns of search and development of new products and production processes, which nonetheless manifest a general inseparability between what firms do to allocate their resources to production and the processes through which they learn how to do better what they already do, or how to do new things.

First, learning is to a good extent a sort of joint production with manufacturing activities themselves. Obviously, this includes phenomena of learning by doing, but it is also likely that search activities, such as R & D, will occur within firms and industries in fields related to what they are currently good at doing. *Second*, part of the technological knowledge is often tacit, specific to particular problem-solving activities, somewhat idiosyncratic, embodied in people and organizations, cumulative in its developments. *Third*, there are sorts of *general knowledge* inputs (often related to "dominant" and pervasive technologies, such as mechanical engineering, electricity and more recently microelectronics) which enter most manufacturing activities, irrespectively of one country's specialisations, so that the rates at which these general competences grow influence the overall efficiency of each country.

As a consequence, current allocative processes influence future *opportunities of learning* in ways that, to a good extent, are not and *cannot* be signalled and traded through the market.

The coupled dynamics between learning and resource allocations may entail "virtuous circles" of sustained learning and efficient allocation of resources, or conversely, in "vicious circles", whereby, irrespectively of the efficiency by which available resources are used, the system generates relatively low rates of innovation and, thus, also relatively low rates of increase in input efficiencies. This conjecture, already expressed in a quite confused fashion by some continental European writers on trade of the nineteenth century (eg. Ferrier, List, etc...), is quite akin to the Kaldor-Myrdal idea of "circular causation". A contemporary, more rigorous formalisation is in terms of path-dependent processes wherein "localised" learning and dynamic increasing returns amplify microfluctuations and may "lock" the system-dynamics into trajectories that may well be "inferior" from a normative point of view, but still be stable over time (cf. Arthur [1988], Arthur, Ermoliev and Kaniovski [1987], David [1975] and [1985]). One can also intuitively see how international trade may reinforce polarisation among countries and lock-in into particular patterns of growth : competition on the world market and specialisation influence the rates and direction of innovative learning by firms and countries, which in turn affect international competitiveness and specialisation... Both the evolutionary story and the "equilibrium story" on endogenous technical change, trade and growth, it has already been mentioned, easily generate

international differentiation in income levels and rates of growth. In addition, in our view, the former is capable of generating a richer variety of dynamic patterns (albeit trading it off against lower formal elegance), and also mapping them into the underlying characteristics of technological learning (eg. its features of cumulativeness, partial tacitness, appropriability, etc...). However, this is not the issue we want to discuss here. Rather, let us consider the nature and importance of alternative microeconomic assumptions.

As obvious, in the standard aggregate-production-function story on growth, organisational specificities of firms and countries are entirely absent. The most natural way of interpreting its microfoundations is in terms of an underlying General Equilibrium. In several of the "new trade" and "new growth" models there is indeed an explicit microfoundation, based on imperfectly competitive equilibria. However, precisely because of the equilibrium assumption, it is hard to account for any influence of particular forms of corporate and industrial organisation upon competitiveness and growth. Putting it another way, one senses a striking conflict between any equilibrium account of trade and growth and, say, Porter's analysis of the specific organisational and technological features underlying, for example, the Italian competitiveness in ceramic tiles or the British failures in mechanical engineering (cf. Porter [1990]), or, even more so, the stories that business economists usually tell about painstakingly discovered "superior" competitive strategies.

Empirically, corporate organisations embody specific innovative search heuristics, modes of internal management, production rules, strategies for dealing with suppliers and customers (eg. vertical integration, arm-length relationships, collaborative agreements, reliance on the markets, etc...), patterns of labour-relations, strategies toward multinational investment, etc... but do these differences affect *aggregate* competitiveness and growth ?

One hypothesis could be, of course, that the microeconomic links between organisational forms and competitiveness identified by business economists are local disequilibrium phenomena which cancel out in the aggregate.

An alternative hypothesis to the same effect is to assume that, in general, organisational specificities are only epiphenomena without any long-lasting consequences on performance⁹.

⁹ Indeed, the irrelevance of organisational forms can be argued from quite different theoretical points of view. Take, for example, an extreme version of a transaction-cost model of corporate organisation. The model would suggest that observed institutional set-ups (eg. within and between firms) are the organisational response to a requirement of efficient governance of exchanges. Hence, any observed international difference in the typical modes of organising transactions would be primarily attributed to lags and leads in diffusion of more efficient forms of organisation (if transaction costs do not dramatically differ across countries, which is likely to apply to developed economies, although it might not to comparisons among countries at different stages of development). In the long term, an extreme version of

Conversely, we build here on the ideas that specific problem-solving *competences* deeply affect the ability of both individual firms and whole countries to generate and adopt new technologies and that these competences are not orthogonal to the forms of corporate organisation. Indeed, an emerging view on firm-specific “dynamic capabilities” supports this view (cf. Teece et al. [1992] and 1994)), naturally overlapping with a much longer tradition of business studies pointing at the two-way causality between corporate strategies and structures, and their effects on performances. A *locus classicus* here is Chandler’s interpretation of the emergence of the modern multidivisional corporation in the United States and the specificities of its development in other countries (Chandler [1962] [1990] and [1992]). And, as forcefully emphasized by Teece [1993], a major distinguishing feature of the Chandlerian corporation rested in its ability to accumulate specific managerial competences in the domains of innovative search, production coordination and marketing.

At a microeconomic level, all this implies also that given any set of technological competences and techniques of production which a firm can master, particular organizational structures and strategies affect both the actual efficiency that a firm displays and the rates and direction of accumulation of innovative knowledge (and, relatedly, the patterns of competitiveness over time).

A growing empirical evidence corroborates this view. For example, Patel and Pavitt [1994] find that “a firm’s existing product mix and associated competences strongly constrain the directions in which it seeks to exploit technological opportunities and acquire competences”; and that “... the firm’s home country will influence its rate of technological accumulation” (p. 20) (See also Cantwell [1989], Nelson [1994], Porter [1990]).

At an aggregate level, the argument implies that the international distribution of organisational structures and strategies is not random but reflects some country-specific characteristic which display persistence over time. In open economies, this means also that, given the patterns of technological and cost-related advantages/disadvantages of any one country, the degree to which these advantages are exploited in terms of international competitiveness¹⁰ depends

a transaction-cost theory of organisation would suggest that one should observe *convergence in institutional set-ups*, driven by the differential efficiency of various organisational modes.

At the symmetric opposite, consider an extreme version of the Marglin–Piore-Sabel interpretation of industrial organisation (more faithful and sophisticated arguments along these lines are in Marglin [1974], Piore and Sabel [1984] (needless to say, we are purposefully overemphasizing in order to clarify the point). Here, in a first approximation, the cross-sectional and intertemporal differences in the modes of organisation of firms and industries would be simply responses to power criteria, and reproduce with the inertia that institutions generally entail. The set of *equally efficient* organisational regimes, this interpretation would suggest, is wide, and the observed variety results from a selection within such a set, driven primarily by considerations of social control and income distribution. Hence, again, national specificities in corporate and industrial organisation would not be among the fundamental variables explaining “why levels and growth rates of income differ across countries”.

¹⁰On this notion of “competitiveness” cf. Dosi, Pavitt and Soete [1990].

also on the organisation forms and strategies of the domestic firms. Size, degrees of diversification and vertical integration, propensity to invest abroad, etc... are obviously indicators, but at least equally important are the attitudes toward growth, profitability, market shares, uncertainty, innovation, the nature of internal hierarchies, the relationship between industry and finance, the ways conflict is managed, etc...

Finally, this implies that country-specific organisational characteristics may reproduce over time despite the selective pressures of international competition.

The general interpretative perspective, as discussed in Dosi [1992], might be summarized in four general propositions.

Proposition 1: In contemporary economies, a good deal of knowledge about technology and exchange governance is embodied in organisations (primarily business firms), which reproduce and augment it via institutionalized procedures and "routines" that are only limitedly subject to strategic decision at each point in time.

Another way of saying the same is that a lot of what is commonly considered as part of the "control variables" of corporate decision-makers is in fact part of the "state variables" of individual business units - possibly modifiable only in the long-term (more on this in Winter [1987]).

Proposition 2: Since the prevalent forms of market interaction are generally quite different from pure competition, agents plausibly engage in strategic behaviours. However, the environments are complex and non-stationary, so that the high-dimensionality of the state - and control - spaces renders strategic behaviour quite "opaque". The mapping between information, actions and outcomes is, at best, imprecise - often undertaken on the grounds of roughly calibrated heuristics and sheer untested beliefs. Hence, behavioural discretionality is very high. In general, neither "backward inductive" rationality nor environmental selective pressures and adaptive learning are able to render behaviours uniform. Putting it another way, neither learning nor selection are likely to induce anything resembling symmetric Nash equilibria, or, for that matter, equilibrium behaviour of any sort.

Proposition 3: Technological and organisational learning within each firm is to a good extent local and path-dependent. Agents learn, building upon previous knowledge and are often also "blind" vis-a-vis other learning trajectories. They are rather good at solving particular classes of problems but not others, irrespectively of the economic incentives that an ideal external analyst would be able to identify¹¹.

¹¹Promising explorations of the idea are in Levinthal [1992], and Levinthal and March [1994]. See also Dosi and Lovallo [1994].

The model of the firm telegraphically hinted here suggest that a firm is a *behavioural entity* (we borrow the definition from Kreps [1990]) embodying highly *idiosyncratic, specific and inertial compromises* between different functions, namely (i) resource allocation ; (ii) information processing; (iii) incentives to individual performance ; (iv) control and power exercise ; (v) learning. Remarkably, most breeds of economic theories focus primarily upon one single function, often trying to “explain” it on the grounds of the usual maximisation cum equilibrium assumptions (for an impressionistic map, see Table 1). In the picture of the firm proposed here on the contrary, we broaden the analysis of its evolutionary features accounting also for fundamental trade-offs between the functions mentioned above.

To illustrate them in a somewhat caricatural way, think of the possible trade-offs between performance control and learning. While the former is likely to imply rigid task specifications, the latter generally involves a lot of experimentation, trial-and-error, “deviant” behaviours. (More on this below). In fact, it is easy to imagine a lot of different organisational arrangements on an ideal continuum between the Prussian army and a university department full of crazy scientists... Indeed, some of these functional trade-offs are discusses at length in, for example, the microanalytic part of Nelson and Winter [1982], or, from a diverse angle, in the works of Simon, Cyert and March. Moreover, the organisational and management literature is rich with taxonomies describing the specificities of the sociological and “cultural” architecture of firms and the way they affect internal relations, behaviours toward the external environment and performances.

TABLE 1: Representations of the firm in economic theories

Functions	Theories	
· Allocations of resources.	Marshallian firms.	
· Information processing. · Incentives to individual performance	Team theories, principal/agent, cooperative-games, transaction costs.	French Theories of "Regulation" and "Conventions"
· Control and power exercise.	“Radical” (anglosaxon) theories.	
· Learning and problem-solving.	Evolutionary theories.	

One of the points of this paper is precisely to expand on the notion of “competence” and suggest that it also involves specific patterns of governance of the functions hinted earlier. That is, competences do not only involve problem-solving skills concerning the relationship between the firm and the outside environment, but also skills and rules governing internal relationships. The two are not disjoint : the rates and direction of learning are shaped by the internal structure and the internal norms of behaviour of individual organisations. In this respect Aoki’s suggestive comparison between two “ideal types” - the “Japanese firm” and the “American firm” - is a good case in point: different internal

governance structures affect learning and performance, even in the presence of identical economic opportunities (Aoki [1988]).

More generally, this leads us to our last proposition.

Proposition 4 : Firms are behavioural entities embodying specific and relatively inertial competences, decision rules and internal governance structures which, in the longer term, co-evolve with the environment in which they are embedded.

The strength of norms, routines, “corporate cultures” resides precisely in their persistence and reproduction over time. As sociologists and organisational theorists tell us, such an inertiality provides some degree of consistency among individual behaviours and motivations to action even if incentive compatibilities are much weaker than those prescribed by economic theory, and even if information about a changing and complex world border pure ignorance. But precisely that same inertiality makes organisational arrangements quite differentiated, and, often highly suboptimal in their ability to seize technological and market opportunities. (A more detailed discussion is in Dosi and Marengo [1994]).

All four propositions, taken together, imply that, certainly, learning and environmental selection tend to reduce the variety of both technological and organisational innovations that continuously emerge. However, the “locality” of learning, the “opaqueness” of the environment and the positive feedbacks linking particular directions of technological learning with particular organisational set-ups all imply persistence of different forms of corporate and industrial organisation, even when ex-post they yield different competitive performances. In a jargon nearer to economists: as one can easily generate multiple equilibria stemming from non-convexities and increasing-returns in the technology space, so one can easily conjecture multiple “organisational trajectories” stemming, in a loose analogy, from organisational learning about norms, competences, corporate structures.

Moreover, if these propositions are correct, one can identify a possible bridge between (evolutionary) modelling of growth and the rich and variegated account of the patterns of industrialisation and growth provided by historians and industrial sociologists alike. Just to give some hints. Ronald Dore’s fascinating anatomy of the Japanese industrial system (Dore [1973]), Albert Hirschman’s analyses of the emergence and role of markets (Hirschman [1977] and [1982]) a Lazonick’s account of the relationship between industrial relations and patterns of industrial development (Lazonick [1992]), all appear indeed compatible in principle with an evolutionary “explanation” of growth embedded in the dynamics of changing behavioural entities (firms, but also other social actors, for

example banks, workers, public agencies, etc...) and in a technological dynamics with path-dependent learning and widespread increasing returns¹².

In this respect, we share Zysman's view that collective social entities - such as nations -, grounded in specific institutions and commonly shared norms of behaviour, shape the patterns of opportunities and constraints facing micro agents and, as a consequence, also the aggregate paths of economic change (Zysman [1994]).

However, while a lot of promising investigations have focused on technologies and firms as units of analysis, much less attention has been devoted so far in this perspective to the detailed anatomy of corporate organisations, the ways this links up with economy-wide institutions, and, ultimately their effect on economic performances.

III. COMPETENCES AND FORMS OF ORGANISATIONAL GOVERNANCE : A PRELIMINARY LOOK INTO THE ORGANIZATIONAL BLACKBOX.

As already mentioned, evolutionary economists and business analysts alike most often share the inclination to look at the repertoire of behavioural norms and practises - or **routines** - within each organization in order to identify "what a firm is good at", how it differs from other firms and also its proximate domains of future change.

Indeed, there are good reasons for the widespread presence of routinized behaviours which we do not need to repeat here¹³ : suffice to say that they appear to be robust forms of adaptive learning in complex and changing environments¹⁴. Moreover, as Nelson and Winter [1982] thoroughly argue, the ensemble of organisational routines, to a large extent, stores and reproduce the problem-solving knowledge of the organisation itself. Together with the hypothesis on the widespread emergence of routinized behaviours, a common feature of most evolutionary analyses is the emphasis on their problem-solving properties. This is indeed a major distinguishing building-block of this perspective - and of the earlier pioneering contributions of Herbert Simon - as compared to more ortodox

¹²And, at a more aggregate level of description, this interpretation is highly complementary with a "Regulationist" view - in the French institutionalist sense of the patterns of "socio-economic tuning" characterising particular countries and phases of development (Boyer [1988a] and [1988b], Boyer and Coriat [1987]).

¹³(cf. Nelson and Winter [1982], March [1994], Dosi and Egidi [1991], Dosi and Marengo [1994], Dosi et al. [1994], Cohen [1987]).

¹⁴Alike Nelson and Winter [1982], Dosi et al. [1994] and Teece et al. [1994], we include under the broad heading of "routines", relatively invariant norms of behaviour which are context-dependent and approximately event-independent (in the sense that they are rather insensitive to the information on changes in the states of the world, given a particular context). Moreover, routines might be straightforwardly stationary rules (such as "...close the door of the factory every day at 7 p.m....") or higher level "dynamic rules" (such as "...search for new techniques in such and such directions..."; "...when something goes wrong do x and send a message to y..."; etc.).

interpretations of organisational arrangements, primarily focused upon the relationships between distribution of information, incentives and resulting equilibrium outcomes. Putting it in a somewhat extremist way, "evolutionists" tend to assume that some, rather rough, incentive compatibility is sufficient to motivate individual efforts and then get down to the analysis of how the set of particular individual actions painstakingly combine in order to solve some equally specific problems, say, building cars and, moreover, doing it at competitive costs, search for better varieties of them, etc. Conversely, e.g. a "principal/agent" theorist would more easily assume that everyone is naturally able to build the "optimal" car - whatever that means - conditional on the available information, and then point at the details of sophisticated self-seeking interactions which could be undertaken by the members of the organisation on the grounds of asymmetric access to information. Elsewhere (Dosi and Marengo [1994]), one argues at greater length that the former approach is indeed a much more promising *first approximation* to organisational behaviours.

Relatedly, a growing effort has gone also into formal representations of processes of search, recombination, reinforcement of sequences of elementary operations yielding particular problem-solving procedures (see Marengo [1992]). However, routines emerge and are implemented in organisations composed of a plurality of individuals who might have diverging interests. Certainly, a *"firm can be understood in terms of hierarchy of practised organisational routines, which define lower order organisational skills and how these skills are coordinated, and higher order decision procedures for choosing what is to be done at lower level"* (Nelson [1994], pp. 234-5). This hierarchy, however, also entails a mechanism of exercise of authority and governance of the admissible behaviours by which individual members can pursue their interests. This is indeed acknowledged by Nelson and Winter [1982] who suggest that routines can be seen also as "truces" amongst potentially conflicting interests, but this complementary nature of routines has been so far relatively neglected in that literature which explicitly builds upon evolutionary ideas¹⁵. The double nature of routines as problem-solving skills and as mechanisms of governance appears with particularly clarity when analysing the emergence and establishment new principles of management and work practises.

Here, we shall consider two archetypical examples, namely "Taylorism" and "Fordism" on the one hand and "Ohnism" and "Toyotism", on the other.

IV. TAYLORISM, "SCIENTIFIC MANAGEMENT" AND ROUTINES.

Much has been written about Taylor's "Scientific Management" principles based on the systematic subdivision of organisational tasks and grounded in so called

¹⁵Important exceptions are Postrel and Rumelt [1992] and Kogut [1992].

“Time and Motion Studies” (Taylor [1907 - 1967] and [1971]) : however, except for the work of a few historians, largely unknown to economists, the implications of that approach to management has been largely underestimated in organisation theory, let alone economics.

That underestimation appears also in the pioneering work of March and Simon [1993]. While they acknowledge Taylor’s as one of the classic contributions to organisational theory (and practice)¹⁶ they primarily emphasize, the “...*the use of men as adjuncts of machines in the performance of routine productive tasks...*”, ...aimed to “...the goal (of using) the rather inefficient human organism in the productive process in the best way possible” (March and Simon [1993])¹⁷. On the contrary, we shall argue that, *first*, Taylor had the pioneering understanding that questions of organisation of production are essentially questions of know-how and competence; and *second*, that the distribution of knowledge is intimately connected with the distribution of power. *Third*, the establishment of Tayloristic *practices* is a paradigmatic example of co-evolution between forms of incentive governance, routines, competences, under circumstances of acute interest conflict.

In all this, it is certainly true that one of Taylor’s major contributions to management practices have been Time and Motion Studies (TMS), but the latter have been the pre-condition of an epochal wave of codification of previously tacit knowledge of working operatives into a set of elementary procedures and acts. In turn, such a codification was a prerequisite for a changing control upon such knowledge itself, previously embodied in its “aggregate” form into the specific experience of skilled workers, whose abilities to bargain on the condition of its use had been a major obstacle to productivity growth in the 19th century.

Some historical examples and some references to Taylor’s own analysis might help in illustrating these points.

At the beginning of the 20th century a prevalent form of production organisation was still the system of “inside contractors/helpers”¹⁸. Under that practise, the owner of a firm would entrust production to a set skilled workers, operating on its premises, who acted as “inside contractors”, hiring in turn their own “helpers”. The contractors directly supervised and rewarded the helpers, either with a fixed salary or in proportion to their own gains.

Under the system, the possibility of control of the owner upon the contractors were quite limited: only the latter knew the methods of production and times and rates of remuneration had to be painstakingly negotiated. Hiring directly the

¹⁶The other being that by Guklick and Urwick, concerned with “the grand organisational problems of departmental division of work and coordination”.

¹⁷Hence they characterize the approach as “physiological organisation theory”, because it encompasses primarily physiological variables (p. 32) and add “Traditional Time and Motion Study Methods have avoided problem-solving tasks, and thus have not dealt with the aspects of human behaviour that will concern us throughout most of this volume” (p. 33)

¹⁸Cf. Montgomery [1979], Hounshell [1984], S. Meyer III [1982].

skilled workers as waged employees did not improve very much the outcome, since worker-specific, and tacit, knowledge allowed workers to master the pace of work. "Soldering" (nowdays one would say "shirking") was a normal pattern of behaviour:

"Underworking, that is deliberately working slowly so as to avoid doing a full day's work, "soldering" as it is called in this country, "hanging it out" as it is called in England, "ca canae" as it is called in Scotland is almost universal in industrial establishments and prevails to a large extent in the building trades; and ... this constitutes the greatest evil by which the working people of both England and America are now affected (Taylor [1901 - 1967], p. 13-14). And moreover,

"So universal is soldering .. that hardly a competent workman can be found in a large establishment, whether he works by the day or on piecework, contract work, or under any of the ordinary system, who does not devote a considerable part of his time to studying just how slow he can work and still convince his employer that he is going at a good pace" (ibid., p. 20).

Taylor's description of the phenomenon in terms of "initiative and incentives" is surprisingly near the current parlance of principal/agent theorists, although he does not at all share with the latter the faith into the existence of some incentive-compatible equilibrium contract, irrespectively of the chosen reward system. The diagnosis is that

"... as the cause for soldering - the relations which exist between employers and employees under almost all systems of management which are in common use - it is impossible to make clear to one not familiar with this problem why it is the ignorance of employers as to the proper time in which work of various kind should be done - makes it the interest of the workman to 'soldier'"(Taylor [1911 - 1967], p. 18).

In turn, this ignorance concerns the tacit knowledge associated with each trade¹⁹.

Incidentally note that -unlike most current representations of incentive compatibility issues-, one finds here an explicit emphasis on problem-solving knowledge as distinguished from sheer information²⁰, and also an implicit assumption that particular social groups (e.g. skilled workers), independently of the fine tuning of incentive mechanisms, share particular forms of collective behaviours (in this case, rendering *de facto* collusion easier).

Rather than attempting to adjust the incentive structure, the general tayloristic programme involves a major redefinition of the nature of productive knowledge and a novel distribution of it within the organization. Times and Motions Studies aim precisely at the control of the knowledge of working operatives themselves,

¹⁹ "...The managers recognize frankly the fact that the 500 to 1000 workmen included in the twenty or thirty trades who are under them, possess this mass of traditional knowledge, a large part of which is not in the possession of the management". "...This mass of rules of thumb or traditional knowledge may be said to be the principle asset or possession of every tradesman" (*Ibid.* p. 32).

²⁰ That distinction is of course a major building block of the analyses of production and innovation of Nelson and Winter [1982], Winter [1981], Dosi [1988], Pavitt [1984].

yielding the development of detailed operational protocols, that were to become the elementary production routines of modern corporations.

This transformation required also a major organizational transformation, namely the establishment of a specific corporate function, the *Department of Planning* - as repository of the general "production intelligence" of the factory. The Department analyzes the elementary tasks, allocates them to the individual workers and establishes the coordinating procedures. A major transfer of knowledge occurs, from individual workers to the management; a good deal of tacit knowledge is decomposed, codified and made easily transmissible via operational protocols.

The end result has been that the tasks of the Tayloristic organization, "first are repetitive ; second, these tasks do not require complex problem-solving activity by the workers who handle them"... (Simon and March [1993], p. 32). But this is so precisely because the overall problem-solving and coordinating activity had been taken in charge by a specific managerial institution, the Dept. of Planning. Indeed, the story of "Scientific Management" - and, at its core, TMS procedures - is precisely the story of the *transformation of individual skills into organizational competences codified into hierarchies of routines*.

This transformation, we suggest, had the same importance for the emergence of the modern (archetypically "American") corporation as the Chandlerian emergence of the managerial divisionalized organization. In fact, the two can be seen, to a large extent, as different levels of descriptions of the same major organizational innovation. The "Tayloristic revolution" describes at the level of production-routines a process which co-evolves with the reshaping of the organizational structure of the firm, entrusting the general knowledge on coordination and strategies upon professional managers - as described by Chandler²¹.

Further down, we shall also argue that the rates and modes of international adaptation of such "American" (Chandlerian **and** Tayloristic) corporation have deeply affected for a long period the growth patterns of each country.

First, however, let us focus on the nature of the emerging Taylorist routines and their birthmarks stemming from the conflict that they triggered.

At a social level, the introduction of Scientific Management has been accompanied by the *open shop campaign*, in the effort by the managers to hire non-unionized workers. Here is another element of the co-evolutionary dynamics between transformation of the knowledge bases and transformation of the collective institutions - *in primis*, the labour market -, in which firms are embedded. The organizational transfer of tasks from skilled workers to "specialized" ones has been painfully accompanied by the formation of new rules of hiring, firing and labour mobility which sustained the implementation of the new working procedures inside the organizations.

²¹On the importance of routines and competences underlying the Chandlerian corporation, see Chandler himself [1992] and Teece [1993].

Not surprisingly, the process was ridden with conflict. The case of the Watertown Arsenal (documented by the Aitken [1985]) is only one of the many examples of the resistance of the labour movement to the diffusion of Scientific Management²².

Tayloristic routines as they finally emerged fully displayed their double nature as sets of problem-solving protocols and as devices of social control. TS M methods defined a new "economy of time" together with a new "economy of control". This implied also a new production paradigm whose implicit but fundamental assumption was that the productivity of any industrial unit is a positive direct function of the productivity of the individual worker considered at his workstation; and "productivity" itself is measured by the number of elementary units of work performed by the individual worker during a given unit of time (e.g. the hour or the working day). This production paradigm performed also for a long-time as a "focusing device" - in Nathan Rosenberg's terminology - shaping the direction of routine-improvement and competence accumulation.

As argued at greater length elsewhere (Coriat [19198 - 1994] [1992] [1993a]), this led to a very specific trajectory of production learning, whereby an increasing fragmentation of tasks proved to be conducive to efficient manufacturing of high volume, standardized, low-cost products but is likely to be less suitable to differentiated high-quality products.

It is important to notice that this particular paradigm of organization of collective competence and of social control embodies also a specific mechanism of incentive governance. The approach Taylor suggested was two fold: on the one hand, he designed a new pay system (the so called "differential piece rate system"); on the other hand, incentives had to be matched by direct visual control upon workpractices by foremen.

Patterns of problem-solving and patters of governance and control turned out to be intimately linked within a structure of organizational routines which constrained also the patterns of learning (the "trajectory" of technological and organizational change).

In order to highlight the specificities of these routines and their internal consistency requirements between problem-solving and governance, let us compare "Taylorism" with another organizational archetype, namely "Ohnism" and "Toyotism" - as the new Japanese production practices are often called.

²²Taylor himself had also to justify his practices before a Special Committee of the House of Representatives, cf. Taylor [1971].

V. "OHNISM" AND JAPANESE PRODUCTION ROUTINES.

As it is handy to identify an archetype of labour management practices with Taylor's original vision and normative programme - notwithstanding the obvious nuances in the fulfillment of such a model -, so it is easy to point at T. Ohno as the general statement of an alternative set of "Japanese" production practices (cf. Ohno [1988]).

The two major specificities of "Ohnism" might be identified with a) "Just-in-time" organization of production flows and b) production routines based on the principle of "auto-activation" (More on this in Coriat [1991a]). Briefly, just-in-time coordination methods consist of producing only in the neighbourhood of what is actually sold, catering for orders in so far as they appear, rather than producing and stocking on the grounds of expectations of future sales²³. "Auto-activation" or "autonomation" (*Jodoka*) is a complementary organizing criterion for production tasks based on the idea that each worker has the time needed to complete his assignments and pass on a flawless product to his partner at the next stage of production. Moreover, "autonomation" entails the possibility - and, indeed the duty - to apply "local intelligence", identify anomalies, and, in case, stop the entire production flow. In turn, "autonomation" implies (i) a multiplicity of skills of each worker; (ii) some discretionality and autonomy in decision-making; and (iii) patterns of coordination between production tasks smoothly flowing in temporal sequences from inputs to outputs²⁴.

A casual observer, and especially an economist, might consider all this as belonging to the domain of diverse and ephemeral managerial practices. On the contrary, one of us has argued elsewhere (Coriat [1991a]) that these two basic principles of production entail organizational forms significantly different from the "Tayloristic" (or "American") archetype sketched above, and with that, also different patterns of organization of knowledge.

The "seeding" of the evolutionary process which yielded these organizational outcomes, can be identified - as in the earlier Tayloristic example - into complementary problem-solving and incentive-compatibility dilemmas, most likely embedded in broader, more inertial institutions and cultures. Japan, in its industrializing and reconstruction efforts, especially after WWII, was forced to find ways of achieving productivity gains other than classic "Fordist" methods based on the exploitation of economies of scale. To a good extent, it shared also the requirement, felt earlier so acutely by the Tayloristic philosophy, to place operatives' knowledge under management control (a lag most likely due also to the previous authoritarian regime which tended to surrogate for incentive-incompatibility with loyalty and force). In any case, the crux of the matter was, as in other modernizing countries, to reshape the distribution of knowledge away

²³The so-called *Kanban* approach, originally named after a procedure of dropping paper orders of components "upstream" the production chain, has been a well known implementation.

²⁴Note that this does not apply to "Taylorist"/"Fordist" patterns of organization of production whereby each elementary "shop" (e.g. "the drilling shop", "the boring shop", etc.) produces for a buffer stock of intermediate goods.

from variegated groups of highly skilled workers. And on the conflict-of-interest side, social polarization, in the decade following WWII, was certainly at a rather critical level. The course that labour relations and working organization actually took - by no means the only notional one²⁵ - was a *specific and original way of work rationalization* which did not stop to the Tayloristic breakdown of complex workers skills, but recomposed the tasks for *multi-functional workers, with flexible working standards*²⁶. A major consequence of this organizational innovation was that it implied a production engineering approach (concerning design and layout of production lines, programming principles, etc.) radically different from that which has prevailed in America amid the numerous Ford-inspired recommendations²⁷.

For our purposes, we want to emphasize that the combination of just-in-time with "auto-activation" has given rise to a novel series of routines, both at the level of intra -and inter- organizations practices.

A first crucial difference with the "American" theory and practice can be sketched as follows. Whereas the Tayloristic approach has been aimed to separate the functions of production, maintenance, quality control, planning, etc and to fragment the tasks required by each function, the Japanese way on the contrary has been to create workstations where the different tasks are to different degrees reaggregated²⁸. Thus, one can observe that the fundamental

²⁵To make a more general theoretical point: alike path-dependent models with multiple attainable limit states, conditional on the initial set-ups, we are far from claiming that the Japanese initial conditions telegraphically sketched here "determined" in any strong sense the observed outcome. Rather we just suggest that they contributed to select the feasible evolutionary path, together with broader social circumstances, analyzed from different perspectives by Aoki [1988], Dore [1973], Gerlach [1993], among others.

²⁶Cf. Monden [1983]. The linearization of the production processes hinted above is associated with these more flexible production standards and also permits to switch from some predetermined production time to a "shared" time: cf. Monden [1983] and Coriat [1991].

²⁷Broadening the field of observation from the shop floor level to the enterprise as a whole, the same principle of relative de-specialisation can be observed, particularly with the establishment of horizontal lines of communications between marketing, R & D and manufacturing . These flexible inter-departmental communications make it possible to get closer to the market as regards quality trends and at the same time to reduce lead times (Cf. Clark & Fujimoto [1989], for example).

²⁸In more detail, this process of de-specialisation and re-aggregation of tasks affects four domains.

- The first of these re-aggregations concerns the reassociation of tasks within direct *manufacturing* itself : "versatility" and multi-specialisation are the norm and stand in opposition to the principles of compartmentalisation and repetitivity featured by American Tayloristic patterns.
- The second consists of the *re-acquisition by direct operatives of the tasks of diagnostics, repair and light maintenance* ; self-management and self-inspection make sense and prove effective only if the front-line operatives are also in charge of the routine maintenance of the plant and machinery.
- The third is the *reintroduction of quality control at the working stations*. Here again, the be-all and end-all of the principle of self-management and self-inspection is to tackle product quality at the workstations themselves.
- Lastly, there is also a *re-aggregation of programming and manufacturing tasks*, which constitutes the **necessary condition** of the Kan-ban method (Coriat [199a] and [1992]).

significance of the Japanese approach consists of a reconstitution at shop floor level of something like a *general and re-aggregated function of manufacturing*, the main characteristic of which is that it puts together again tasks which Taylor's approach recommended be carefully and systematically kept apart²⁹. On this basis, one observes the introduction of specific protocols entailing permanent manipulation of "Kan-Ban" and used either to command or to deliver "just-in-time" the internal flows of semifinished products.

One can wonder how it is possible to re-aggregate general functions in manufacturing without losing control on productivity : i.e. can the taylorian legacy be so deeply abandoned ?

The answer to this question (crucial for the understanding of the "control" dimension of the Japanese routines) is two fold.

First, TMS is not at all abandoned. As it has been pointed out by a very attentive and pertinent commentator, TMS has been "regained" (see Adler [1993]) : i.e. the idea of fragmenting tasks is maintained but, the jobs are now broken into basic "transferable work components". Such a component is defined as the "**smallest practical combination of acts that can be transferred from one worker to another**". Thus flexible work standards and re-aggregation of elementary tasks are made compatible with the objective of maintaining workers knowledge and work standards under control³⁰. Second, the Japanese methods embed specific practices of controlling workers tasks and activities, one of the most important being what is termed "management by eyes", elaborated and designed by T. Ohno himself. This principle is indeed very simple and consists in organizing the workshops, and the work on the lines, in such a way that everything can be very easily (physically) visible. For example, any worker have the right (and in fact more than the right : the duty) to stop the line any time he thinks it necessary to guarantee the quality of his performance ; at the same time, each stop is signaled by a red light appearing on an electronic panel hanging above the line (It is the so called "**andon**" system).

More generally, Ohno explains the principle of "managing by eyes" as follows :

*... "In order to allow "autoactivation" to detect anomalies, one needs that anything "abnormal" appear immediately at the naked eye. The principle ought to apply to quality (every faulted product should immediately surface) as well as to the quantity (progress of work vis-à-vis previous plans should be effortlessly measured on the very workplace). This should not only apply to the machines but also to the methods of production, the circulation of **Kanbans**, the levels of stocks, etc" (Ohno [1988]).*

²⁹In its spirit and in its practical details, the method appears as the implementation of principles of de-specialisation, not only in terms of the employee's work, but in a more global perspective as a de-specialisation of the "general work of the enterprise", re-aggregating on the shop floor the tasks (production, programming or quality control, etc.) systematically kept apart by Taylorism.

³⁰For a number of very convincing illustrations of this kind of practices in Japanese transplants in the US see Parker and Slaughter [1988].

Note again also the learning side of this set of routines -as well as those associated with just-in-time : far from being sheer devices to minimize yields of faulty pieces of output or minimize inventories, they fulfill primarily the task of immediately highlighting the presence of a problem and allowing or forcing operatives to handle it.

VI. MICROROUTINES, INCENTIVES AND INSTITUTIONAL EMBEDDEDNESS.

More generally, a crucial implication of each distinct pattern of organization of production is that it involves a specific set of problem-solving routines *and equally specific, and broadly consistent, forms of incentive governance and control*. In a telegraphic summary, Taylorism introduces also a new reward mechanism based on a piece wage system, made of a fixed part -corresponding to a minimum number of pieces per day -and a variable part- triggered by above minimum output and pushing upward the whole per-piece wage rates (also on the part below the minimum threshold)³¹.

"Fordism" further modifies the reward mechanism, introducing the famous "five dollar day" wage (well above the current wage at the time), but, *together*, eliminates workers' discretionality in the choice of working pace by incorporating it into the pre-determined speed of conveyors along the assembly line. Finally, it introduces systematic screening and testing of workers themselves, in terms of their social attitudes, their loyalty and obedience. This task is delegated to a special institution : the so called "Sociological Department"³².

Conversaly, "Ohnisme" implies a complex reward structure involving, a) a base salary ; b) individual bonuses ; and c) collective performance bonuses.

As M. Aoki has forcefully shown in several occasions, the two stylized and archetypical organizational forms, called the "American" and the "Japanese" enterprises, differing in the internal architecture with respect to both information-processing and incentive-governance, are likely to yield also systematically different performances³³. Our argument strengthens indeed the point. The set of "Japanese" (or "Ohnist") production routines does not only embody different channels of information processing but also distribute knowledge within the organization in ways remarkably different from the "Tayloristic"/"Chandlerian"enterprise. And at the same time, on the governance side, individual incentives to efficiently perform and learn are sustained by

³¹ So for example, suppose that the minimum output is 200 pieces per day corresponding to 2 \$ wages (i.e. 1 cent per piece) : output up to 10 % higher would entail, says, a 10 % upward adjustment of the whole wage ; a 20 % higher output a wage 40 % higher, etc. Incidentally, note that the principle appears in violation of "marginal productivity" criteria but seems more akin a modified version of an "efficiency wage" principle.

³² The "Sociological Department" goes as far as checking on the workers'families, their social habits, etc... On the story on the Five Dollar Day and the role attributed to the "sociological department" see : S.Meyer III [1992]

³³ Aoki [1988] and [1990].

company-specific rank - hierarchies, delinked from functional assignments (Aoki [1990]).

The collective "embeddedness" dimension is equally important. We mentioned earlier that the establishment of "Tayloristic" organizational routines co-evolved with the development of what one could shorthandedly call the "American labour market". Symmetrically, radically different institutional norms (such as life-time employment, etc.) became established with respect to large Japanese corporations. Yet at another level, different corporate strategies (with respect to investment growth, diversification, R & D, etc.) appear to taxonomically match specific institutional relationships between financial and industrial actors³⁴.

At a much finer level of detail, these modal patterns of relationship between diverse economic agents, again, are entangled into identifiable sets of behavioural routines. For example in Coriat [1994], one tries to identify typical protocols of inter-firm transactions, conditional on the internal modes of governance and problem-solving.

A revealing illustration is the relationship between "core" companies and their suppliers. Under the Japanese system of organizational routines, Asanuma ([1987] and [1989]) sharply illustrates the protocols for information-flows, competition/cooperation, "relational rent-sharing" - as Aoki [1988] would phrase it. Among these specific set of routines, those concerning quality selection are clearly of crucial importance. Producing almost without inventories (of either inputs or outputs) implies that product quality of the semi-finished products either ordered or received by core companies must be very high. As a consequence, the process of selection of subcontractors implies very detailed protocols (in the case of the French auto industry they are discussed in Coriat [1994])³⁵.

Similar exercises could fruitfully be done (and, indeed, ought to) with respect to other types of interactive procedures (e.g. with respect to the labour market, financial investors, etc.) Just to mention an example, it seems to us that Lorenz' argument on the importance of trust (or rather the lack of it) in British production practices belong precisely to this domain of analysis: the "truces" that emerged codified in particular set of routines tended to foster conservatism, and hinder the diffusion of technological and organizational innovation (Lorenz [1994]). In any case, for the little we know about the behaviours of enterprises with respect to their external environment, the evidence seems to corroborate our conjectures, (i) that somewhat typical and rather inertial behavioural patterns tend to emerge, (ii) that these patterns can be roughly mapped into distinctive internal hierarchies of routines within the organization ; (iii) that broader collective institutions - e.g. on

³⁴For example, "market-based" and "bank-based" forms of finance of investment and inter-firm selection: cf. Zysman [1994], Aoki [1988], Dosi [1990]. A tentative combinatorial exercise among the viable forms of governance among internal routines, labour market interactions, modes of finance and innovative strategies is presented in Aoki and Dosi (1992).

³⁵Briefly, they typically show a five-stages procedure of selection and relationship construction, going from the "assessment of quality aptitude"; to tentative efforts of knowledge transfer to the contractors; evaluation of the preliminary outcomes; acceptance into the core company "product quality assurance circle"; and, finally, permanent "real time" assessment of deliveries.

the labour or financial markets - constrain and shape the sustainable routines ; and (iv) that also in the relationships amongst legally independent actors, interactive routines fold together problem-solving complementarities and asymmetric mechanisms of control³⁶.

"Taylorism", the Chandlerian M-form organization, "Fordism" or for that matter, "Ohnism" and "Toyotism" represent major organizational innovations, with -in principle- a universal character. And, indeed, at least the former three diffused internationally, well beyond the countries where they were originally introduced, spurring deep modifications in industrial structures and shaping long-term productivity growth (on "Taylorism" and the M-form, see Kogut [1992] and Chandler [1990]). It is possibly too early to evaluate the international diffusion of Japanese practices, but a rich case-study evidence already suggests their widespread impact (see S. Wood [1993])

However, the *rates* and *patterns* of diffusion of all these major organizational paradigms have been shaped by the institutional context of each country, which implied also some inevitable "hybridization". This, in some cases, yielded also major modifications further down the road. In this respect, Japanese practices may indeed be considered as a profound organizational innovation originally grounded in the local adaptation of Taylorism and Fordism, which eventually led to a distinct archetype of organizational routines for problem-solving and governance of industrial relations.

One can see here a good example of the notions of embeddedness, (limited) lock-in, and potential invadability. Embeddedness implies that earlier patterns of industrial organization, labour practices, etc. carry their influence over the ways new forms are introduced : it applies to the original adaptations of Taylorism and Fordism to Japan or Sweden, as well as to that of the M-form corporation in e.g. the UK, Germany or Japan. Lock-in entails the prediction of progressive dominance of some specific patterns of governance and problem-solving and their rather inertial reproduction over time. However, each "national system" remains potentially "invadable" -to use the jargon of current evolutionary games- : it might be unable to generate internally radically new organizational experiments, but is not immune to the progressive adoption of organizational innovations developed elsewhere.

³⁶For example, with respect to this latter point, in Coriat [1994] we argue that networking routines, while being certainly a mechanism of collective learning generally imply also persistent asymmetries and inter-firm hierarchies. The embeddedness argument is formulated, in quite general terms in Granovetter [1985], and more specifically with regards to corporate strategies of production and innovation, in Lazonick [1990] and [1993], Soskice [1993] and Zysman [1994]. See also Boyer [1988a] and Dosi, Pavitt and Soete [1990].

VII. FROM CORPORATE ROUTINES TO PATTERNS OF DEVELOPMENT : PRELIMINARY CONCLUSIONS AND MANY RESEARCH ITEMS ON LEARNING, INCENTIVES AND PATTERNS OF CHANGE.

We began this work by presenting what we consider to be a few “stylized facts” on the relationship between technical change and growth, together with some microeconomic evidence on innovative activities. In turn, many of these “facts” entail challenging puzzles for the theory. Old ones like “why levels and growth rates of income differ “ demand - it is increasingly acknowledged - to dissect the blackbox of technological change, as Nathan Rosenberg urged us quite a while ago. Investigations in this perspective have recently increased momentum and, in our view, are significantly adding novel insights into the processes by which knowledge is augmented, to a good extent also as a result of exploratory endeavours of profit-motivated agents, together with those of other institutions. While one progresses in opening up the “technological blackbox”, however, there is yet another blackbox - the organizational one - whose anatomy is plausibly quite important also for every macro economist who does not consider the specificities of corporate organizations simply as veil covering deeper and invariant economic mechanisms.

The proposition that organizational structures matter in terms of performances, in fact, can be quite easily supported even in term of otherwise quite ortodox theories, whenever one abandons the most restrictive assumptions on perfect information, complete markets, etc. (see, within an enormous literature, Aoki [1990], Sah and Stiglitz [1985], Radner [1992]). Even more so, if one accounts for the endemic occurrence of transaction costs as Oliver Williamson ([1985] and [1985]) emphasizes.

Of course, the learning dimension that evolutionary and organizational economists add to the picture further reinforces the point. The path-dependent, often organization - embodied, nature of knowledge make corporate structures the prime carriers of diverse problem-solving skills, to a good extent stored and reproduced via organizational routines

However, routines do not only represent problem-solving procedures but are at the same time control and governance devices. In this work we have analyzed precisely this double nature of theirs. Moreover, we have argued, specific set of routines often bear the mark of the conflicts which accompanied their emergence and establishment.

The two archetypical sets of routines which we have outlined in this work namely “Tayloristic” and “Ohnistic” (i.e. loosely speaking “Japanese”) production methods vividly illustrate these points. More precisely, we have tried to show that the explanation of particular sets of routines can be traced back to the coevolution between corporate patterns of knowledge distribution and mechanisms of coordination and governance.

All this, most likely, reinforces phenomena of path-dependence and international differentiation, generally sustained by mutually shared conventions, norms and implicit or legally enforced institutions.

There are several rather general implications of the perspective outlined in this work, which can only be sketched out in this paper.

As we have emphasized above, the multiple facets of organizational arrangements and the forms of their institutional embeddedness are, in our view, an integral part of the explanation of the diversity of development patterns that one observes : in fact, we suggest they are among the core elements of those diverse "social capabilities" identified by Abramovitz [1989] as "deeper causes" of contemporary growth.

Other -more theoretical implications- have only been briefly limited. For example, the foregoing interpretation of the nature of organizational routines encompasses the tasks of incentive governance analyzed by e.g. principal agent models. But it radically depart from the latter taht it consider "what the agents believe to be their interests", the ways they pursue them and the knowledge that they possess to be the evolutionary outcome of search, conflict and mutual adjustment sanctioned thereafter by rather inertial rules and organizational structures. Corrolaries of this view are also the predictions that a) might be generally unisleading to reduce whatever pattern of intra -or inter- organizational relations to a set of "contracts" (whether optimal or not) ; b) given the organizational routines, individual performances are likely to be rather insensitive to any fine turning of incentives ; and c) path-dependency phenomena will tend frequently to carry over the reproduction of particular organizational arrangements well beyond the time of their possible usefulness.

Other implications -nearer the concerns of the economics of innovation- regard the effect of established set of routines upon the "trajectories" of technical progress (and here is also where the economics of innovation can meet analyses from other disciplinary camps which have emphasized the aspects of "social construction" of tchnical change...).

Indeed, we see ahead a promising research agenda.

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