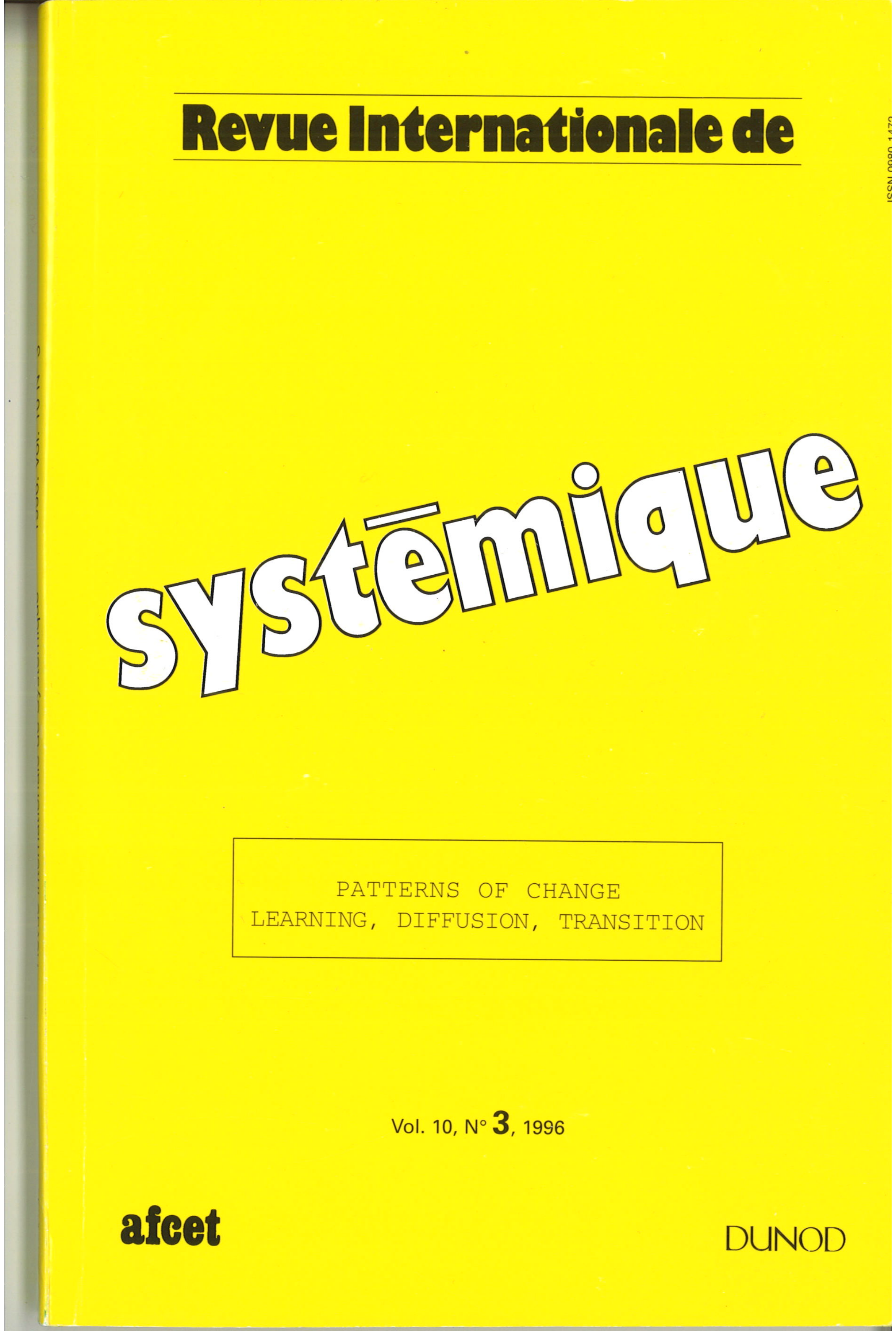

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PATTERNS OF CHANGE
LEARNING, DIFFUSION, TRANSITION

Marc WILLINGER [1] and Ehud ZUSCOVITCH [2]

The present issue of the *Revue Internationale de Systémique* contains a selection of papers presented at the *EUNETIC* conference that was held in October 1994 at Strasbourg. EUNETIC (European Network on the Economics of Technological and Institutional Change) is a research network based on five European Research Institutes, that was created with the support of the EC "Stimulation Program in Economic Science" (SPES). The five teams are BETA (Strasbourg, France), ISIDE (Rome, Italy), IKE (Aalborg, Danemark), SPRU (Brighton, UK) and MERIT (Maastricht, NL). Several other European research institutes and independent researchers are connected to this basic network. EUNETIC organizes joint workshops, scientific meetings and summer schools for doctoral students. The general goal is to promote evolutionary thinking in the research field of innovation and technological change.

The EUNETIC conference was organized by BETA at the European Parliament in Strasbourg in October 1994 [3]. Although the Eunetic framework was indeed dedicated to the evolutionary perspective on technological change the conference itself was neither limited to evolutionary contributions nor was the participation restricted to members of the Eunetic network. The conference was organized around the following topics: alternative

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methodologies on economic dynamics; learning and organizational change; evolutionary dynamics of industries; patterns of development of open economies; evolutionary dynamics of industries; patterns of development of open economies; mapping and measurement of technological change; local and global innovation systems and innovation diffusion. Over 80 contributions on various topics on the economics of technological change have been presented and discussed. Several selections of papers have been composed adjusting the content and structure of each to the aim and scope of the scientific publication media. The present selection is devoted to "Patterns of Change-Learning, Diffusion, Transition".

Change and subsequent adjustment to differences stimulate development and growth. Thus understanding the process of economic change is an essential ingredient of economics as a whole. It is a difficult task because change in itself, as Nicholas Georgescu-Roegen used to say, eludes arithmomorphic representations. Yet we can analyze both the causes and the consequences of change. The emphasis on change, here mainly technological and institutional, is essential to the evolutionary framework. Change creates diversity and diversity feeds the selection processes that operate in economics through imperfect competition among learning agents. The understanding of this process is a considerably more complicated task than analyzing economic order. Although some progress has been recently achieved along the evolutionary theoretical trajectory, meaningful theoretical foundations to understand economic evolution and development is a research construct and ambition that still lie head of us.

Traditional economic analysis has mainly dealt with stable systems. In such systems the structure of the economy is set. Technologies, products, preferences, the institutional arrangements that define the relations among agents and the informational context are all treated as given. In such stable environments, the dynamics is mostly generated by random fluctuations and appears essentially as adjustment processes towards equilibrium positions. Learning in such systems is restricted to updating of beliefs. In a sense such dynamics is bound to the analysis of system's reproduction or to stationary conditions. Increasing or decreasing the size of the system does not change its underlying structural components. Such dynamic properties, which characterize systems that exhibit high resilience, can be found in many systems, such as the mass-production postwar industrial system. Contrasting which such a description, most contemporary systems are characterized by high vulnerability of their structural components, exposure to sudden and large shocks, and by unpredictable changes.

The reason for which many economic systems nowadays seem to be characterized by low resilience, is a fact that still remains to be explained. The failure of macroeconomic theories to correctly predict the evolution of very basic magnitudes like output, employment and inflation, let alone controlling for their stability, is due to an industrial transformation in which aggregates are loosing consistency. Not only do industries evolve heterogenously but there is a distinct decline in the stabilizing capacity of traditional institutional intermediates to deal in the name of the representative firm of the industry, or of labor unions to bargain for the representative worker. At least part of the explanation is due to the fact that the current industrial transformation allows for the design of highly flexible and adaptable structures that stimulates change and diversity. Indeed the strong increase of informational intensity driven mostly by modern technologies, generates an increasing variety of products, technologies, patterns of behavior and institutional settings that create powerful destabilizing and creative forces in the system. In many of the high-tech sectors of the economy, competition occurs primarily by successive modifications of product configurations and model vintages, and only in the absence of such change does the traditional "price quantity tandem" play a role. The traditional realms of short run and long run are by and large reversed. These trends strengthen the theoretical appeal of evolutionary theories in economics and indeed the last 15 years or so have witnessed an important development. Together with the enhanced capability that we gained from advances in the development of information structures by game theory, emphasis on bounded rationality, irreversibility, various information asymmetries and mutation-selection dynamics forcefully enters and diffuses in many areas of economic theory and in some cases it tends even to penetrate the economic main-stream concerns.

The consequences of such transformation are far from trivial. In turbulent environments the exercise of standard economic rationality is less feasible than it ever was, and in fact, search and learning activities replace optimization. Unlike evolutionary biology, conscious learning plays an important role in the inter-temporal transmission of properties and hence the relationship between learning, coordination and organization is an important component of the evolution of the industrial organization. Innovations are not any more an exogenous force that hides in some curious R&D laboratory but are an essential component of all economic activities. Diffusion processes appear then as a better analytical medium through which we analyze the overall process of generation, absorption and transformation of useful knowledge. Even markets that are the cornerstone of economic theory appear more and more as subject to development processes leading to outcomes of differentiation or standardization of emerging skills and products than a pure allocation instance. Transition increasingly appears to be the predominant metaphor rather than equilibrium.

To illustrate some trends of the above features we have selected some of the contributions that were presented at the Eunetic conference on the topic of « Learning, diffusion and transition ». The first cluster of ideas is built around the learning, organization and coordination complex. Starting from concerns about limited computational capabilities different forms of bounded rationality appear in the literature and they are framed in organizational concerns. Indeed, in the same manner that "pure" rationality is relaxed so is the assumption that the outcome of the competitive process can only be of the « market-type ». The institutional setting becomes part of the selected economic configurations. After the Coase-Williamson line that looked upon organizations as an outcome of market failures, in the late eighties the Teece-Aoki research stream introduced a notion of hybrid structures in economic coordination and learning. This neo-institutional drive is now further advanced to include wider institutional phenomena such as works on routines, rules, conventions and their evolution.

The present collection of papers has two contributions in this cluster. The first, by Nathalie Lazaric, deals with « Organizational learning and combinatory capacity during technological agreements with evidence from the robotics sector ». This works sheds an interesting light on the fact that learning is becoming increasingly social and hence the organizational dimension is a vital ingredient of the innovative capacity as a whole. It analyzes the components of the knowledge accumulation processes in terms of absorption and interaction and views the interpretation process which lies at the heart of the technological interaction. Information exchange must rely on confidence-building mechanisms in addition to a common language. This issue of the progressive convergence of such processes is tackled in this paper through the irreversibility/lock-in approach. This dimension is usefully complemented by a self-organization approach in the contribution of Stéphane Ngo Mai and Alain Raybaut, which places the understanding of technological change within the study of complex interactive systems such as markets. They study a simple self-organization model applied to growth theory, which they simulate and compare to empirical data.

The learning issue finds another important and somewhat independent contribution in the present reformulating of the diffusion models. Lock-in considerations have emphasized issues of technological competition. At the

heart of all diffusion processes there is an interaction of private and social knowledge and the purpose of the adopters is to combine both types of information as to endorse smaller costs than those required by a purely personal experimentation. Some precision may be useful here. By adopting one of the available technologies, the firm that adopts first gives the signal to the others that it values more the chosen option. This signal may be right or wrong, but it is inevitably interpreted by others as evidence that the adopter believes that he has chosen the right technology. This means that the adopter has some private information that makes him believe that the option chosen is the better one. When adoption is sequential, the second firm to adopt will combine the public information provided by the first adopter with its own private information. If its own private information matches the public information, it will choose the same option than the first adopter. In this case, all the other firms will almost surely follow the first two by choosing the same option, creating a "cascade" in the diffusion process. If the information of the second firm to adopt does not match the public information, it may be the case that the private information of one of the next adopters does match one of the previous choice, in which case a cascade may begin. This process happens almost surely after some time, and leads to a collective adoption that may be right or wrong. It is important to point out that this process is completely independent from any rationality assumptions from the part of the firms: it may arise as well with firms that are rational bayesian decision-markers than with bounded rationality decision markers. It is not the internal or individual process of learning that is important but the collective outcome of the individual learning process. In this sense the collective and sequential aspects of diffusion are much more important than firm by firm adoption. Another two contributions in this collection illustrate some of the current trends in modeling diffusion.

Willi Semmler and Alfred Greiner present a model of competing technologies with passive and active firms, and study the influence of various parameters on the market share of these technologies. Their framework allows for a richer class of interactions among the two types of firms than in standard models, generating a larger diversity of effects than the traditional diffusion models. Simulations show that contrary of these models, when two populations of firms interact, the diffusion process will not necessarily converge to a « high equilibrium » in which all the firms adopt the new technology. The opposite may happen, where the « low equilibrium » is reached. More generally the two technologies, new and old, may coexist. The trajectories, are very sensitive to change in parameters, such as diffusion speed.

Christian Lebas and Patrick Sylvestre-Baron study another type of diffusion models, based on the frequency distribution approach. According to the frequency distribution approach, the probability that a given firm adopts technique A over technique B depends, among other variables, on the frequency with which technique A has already been chosen within the population of potential adopters before. The authors replace the traditional binary diffusion process by a selection process in a large set of alternative technologies, and study the influence of learning effects on the selection process. One of the results of this model shows coexistence of technologies, a feature shared by many other recent models, and in accordance with many empirical studies about technological evolution.

It should be noted that the selection process can work in a very perverse direction, leading to the question of the possibility of control over the diffusion path. It appears that control can be effective only in the very early stages of the diffusion process. Once a cascade has begun, it is very difficult to reverse the dynamics, and the costs may be larger than the positive effects generated by the learning process on a inefficient path. But of course an inferior technology will always represent a loss of well-being for future generations, and an irreversible loss of better opportunities.

The more industrial and macroeconomic ingredient of our « patterns of change » view in this collection, is linked to transition between alternative systems. Economic development in the capitalistic system, Joseph Schumpeter taught us, is driven by a creative destruction process where individuals, firms, industries and cultural behavior take the place of others who sink and disappear for the benefit of all social and economic strata. The industrial transformation is never a peaceful equilibrium compromise.

Peter Swann studies the industrial impact of the evolution of competition due to product innovation. If the characteristics of a product change, and if new characteristics appear, the product not only competes in new areas, but it's production will be organized differently, leading to industrial restructuring. New industrial clusters may therefore emerge, and more generally, industrial clusters evolve. The author uses econometric analysis to explore the relative success of clusters in the US computer industry. Simulations results show that technological diversity of the cluster is an important factor in the case of technological convergence, but when there is little convergence of technologies, single-technology clusters will be more efficient.

Gérard Duménil and Dominique Levy deal more directly with macroeconomic facet of this transition and analyze the emergence of a new paradigm since the Civil War, characterized by a new type of management characterized

by search for efficiency. In their view the change in paradigm is merely a change in the way productive activities are organized, rather than a revolution in the technology as such. They study the transition towards the new paradigm on the basis of an evolutionary model in which innovations are random, and apply this model to the US. By combining the effects of two representative sectors of the industrial and post industrial activity they offer an interesting characterization of the transition and shed a new light on the evolution of capital, productivity and profits in the different periods in their study.

An important consideration that relates to unstable economic systems, is sustainability. To what extent for instance is such a system able to produce a non-declining level of consumption per capita over time? The question of sustainability has been much discussed in the context of natural resources but it is also relevant for our discussion. If some natural assets, do not have close substitutes, how should they be allocated over time, if one wants to guarantee a level of consumption for future generation, at least as large than the current level. More generall, how can the current generation guarantee at least as much "freedom of choice" to future generations than today. The answer is obvious. Too much exploitation of natural assets today can deprive future generations from an essential input for producing indispensable products, which reduce their freedom of choice. On the other hand, the current economy, can increase the production capacity of the next generations by exploiting the available natural assets, which would increase their freedom of choice. There is obviously a dilemma for the current generation in making a choice that is both efficient, ethically acceptable, and sustainable.

The problem of sustainability becomes even more complex if the choices of the current generation affect the system's resilience. If the system has lower resilience it offers less guarantee to remain on a given path, and it can become very difficult to predict the variation of per capita consumption. But from an ethical point of view, it seems that the current generations, has to provide insurance to the next generations, that some minimum standard is guaranteed. Sustainability must be defined with respect to a lower bound that should be guaranteed from one generation to the next. This is simply applying the Rawl's principle, which seems the most natural criterion for such questions. But adopting such a rule has implications for the system's regulation. Although we noted that for unstable systems, control will be necessarily weak, policy should be designed to allow for such a stable lower bound. However, as we have seen the system's instability is partly due to a lack of control on informational intensity, which introduces much noise and randomness in the system.

The issue of sustainability is therefore of particular importance under information intensity. The paper by Ehud Zuscovitch tries to tackle the issue as a problem of "Sustainable differentiation". He shows that the joint specialization in flexible organizations such as networks present one of the potential answers to the constraint of capital accumulation should the capital-specialization evolve as it does. He also shows that an institutional adjustment in the form of new rules for sharing ownership may be needed in such a perspective.

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ORGANIZATIONAL LEARNING AND COMBINATIVE CAPACITY DURING TECHNOLOGICAL AGREEMENTS : some Empirical Evidence in the Robotic Sector

Nathalie LAZARIC [1]

Abstract
The aim of this contribution is to discuss about learning and organization of knowledge during cooperation. We define organizational learning in a cognitive perspective as a process of knowledge mobilization without ignoring its political dimension. During alliance combinative capacity may be very fruitful for innovating but requires some specific conditions (absorptive capacity, organization of knowledge, prior knowledge...). We will illustrate this proposition by an empirical study which over a period of 10 years, shows eight cases of agreements in Germany, France and Italy in the robotic sector and observes the dynamic of learning (through rules, routines and trust). These immaterial investments create strong path-dependency leading to exploit the externalities of learning and the benefits from the relational rent. Our investigation shows the difficulty to learn from learning once shared frameworks are present because it is easier to exploit current knowledges than to explore new way of working and solving problems. Organizational inertia stabilizes cooperation and avoids uncertainty facing an agreement with a new partner but precludes another articulation of knowledge which may decrease innovative capacity.

Résumé
L'objectif de cet article est d'observer la dynamique d'apprentissage des accords interfirmes à travers l'organisation des différentes bases de savoirs. On définira ce que l'on entend par apprentissage organisationnel dans le cadre des accords en soulignant plus particulièrement la dimension cognitive de ce processus, tout en n'occultant pas sa dimension politique. Nous insisterons sur la capacité à combiner des connaissances différentes, capacité qui nécessite quelques conditions

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