

Working Paper

The Institutional Embeddedness of
Economic Change. An Appraisal of
the 'Evolutionary' and
'Regulationist' Research
Programmes

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WP-95-117
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Support to this research by the Italian Ministry of University and Research (MURST, “Progetti 40Systems Analysis (IIASA), Laxenburg, Austria, is gratefully acknowledged. A preliminary version of this work has appeared in French in Boyer and Saillard (1995).

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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

1 Introduction

There are at least two complementary ways to present the ideas which follow. One is with reference to some “grand” questions that have faced social sciences since their inceptions, namely, how do institutions shape the behaviour of individual agents, within and outside the economic arena? And what are institutions in the first place? How do they come about and how do they change? What are the relationships between ‘agency’ and structure? And also, nearer economic concerns, what is the role of institutions in economic coordination and change?

Another, more modest, way of tackling some of these grand issues is to see how this is done in practice by different research programmes which nonetheless share a common preoccupation to understand economic change as a historical, institutionally embedded, process.

This is what we shall attempt to do in this work, by discussing the links, overlapping, tensions and possible interbreedings between an emerging *evolutionary* theory of economic dynamics and various strands of *institutionalist* theories, with particular attention to the *Regulation* approach.

Some definitions are in order of what we mean by those terms and of where we put the boundaries of different theories. This shall be done, albeit in a rather telegraphic fashion, in sections 2–4. In Section 5 we sketch, as an illustration, the interpretations of growth process in general, and in particular, the case – very familiar to institutionalist macroeconomists – of the so-called “Fordist” phase of development experienced by Western Countries after World War II, and assess the different “styles” of explanation of evolutionary and *Regulation* theories, respectively. In turn, these differences in “style” partly hide different levels of observation – hence, probably entailing fruitful complementarities – and partly also reveal genuine differences in the choice of explanatory variables and causal relationships. We shall discuss some of these issues with respect to the nature of institutions and behavioural microfoundations (Section 6). Finally, we propose a sort of taxonomy of potentially complementary levels of descriptions and analytical methodologies and, together, we suggest some items that in our view are high on both evolutionist and institutionalist research agendas (Section 7).

2 Evolutionary Theories: Some Definitions

For the purposes of this work let us restrict our discussion to evolutionary theories of *economic* change. In brief, a sort of ‘archetypical’ evolutionary model possesses, in our view, the following characteristics (much more detailed discussions of the state-of-the-art are in Hogson (1993), Dosi and Nelson (1994), Nelson (1995), Silverberg and Verspagen (1995)).

1. As Sidney Winter uses to summarize it, the methodological imperative is *dynamics first!!*. That is, the explanation to why something exists intimately rests on how it became what it is. Or putting it in terms of negative prescriptions: never take as a good ‘explanation’ either an existence theorem or a purely functionalist claim (entity x exists *because* it performs function y ...).
2. *Theories are explicitly microfounded*, in the sense that they must involve or at least be consistent with a story of what agents do and why they do it.¹
3. Agents have at best an *imperfect understanding* of the environment they live in, and, even more so, of what the future will deliver. Hence, “bounded rationality” in a very broad sense is generally assumed.
4. Imperfect understanding and imperfect, path-dependent, learning entails persistent *heterogeneity* among agents, even when facing identical information and identical notional opportunities.
5. Agents are always capable of discovering new technologies, new behavioural patterns, new organisational set-ups. Hence, also the *continuous appearance* of various forms of *novelty* in the system.
6. Relatedly, while (imperfect) adaptation and discovery generate variety (possibly in seemingly random fashions), collective interactions within and outside markets, perform as *selection mechanisms*, yielding also differential growth (and possibly also disappearance) of different entities which are so to speak ‘carriers’ of diverse technologies, routines, strategies, etc.
7. As a result of all this, aggregate phenomena (e.g. regularities in the growth process or in industrial structures, etc.) are “explained” as *emergent properties*. They are the collective outcome of *far-from-equilibrium interactions* and heterogeneous learning. Finally they often have a *metastable nature*, in the sense that while persistent on a time scale longer than the processes generating them, tend to disappear with probability one.²

¹Note, however, that there are a few ‘aggregate’ (i.e. non-microfounded) models which are nonetheless ‘evolutionary’ in spirit (for a survey, Silverberg and Verspagen (1995)).

²On the notions of “emergence” and “metastability” cf. the discussion in Lane (1993).

This is not the place to review the growing number of contributions which share some or all of these seven broad methodological building blocks³.

Suffice to mention, first, the flourishing number of formal models and historical interpretations of economic growth as an evolutionary process propelled by technical change which have followed the seminal work of Nelson and Winter (1982). (See among others Dosi, Freeman, Nelson, Silverberg and Soete (1988), Day and Eliasson (1986), Silverberg and Verspagen (1994), Conlisk (1989), Chiaromonte and Dosi (1993), Silverberg and Soete (1993) and the discussion in Nelson (1995) and Silverberg and Verspagen (1995)).

Second, the diffusion of innovations has been fruitfully analysed, from different angles, as an evolutionary path-dependent process (cf. among others David (1985) and (1992), Silverberg et al (1988), Arthur, Ermoliev and Kaniovski (1987), Nakicenovic and Grübler (1992), Metcalfe (1992)).

Third, the very development of an evolutionary perspective has been deeply intertwined with the historical analysis of the processes by which technical change is generated, ranging from the microeconomic level all the way to ‘national systems of innovation’ (within an enormous literature, see Freeman (1982), David (1975), Rosenberg (1976) and (1982), Basalla (1988), Mokyr (1990), Granstrand (1994), Vincenti (1990), Nelson (1992), and the reviews in Dosi (1988) and Freeman (1994)).

Fourth, a growing number of industrial case studies and models of industrial change fits quite well the evolutionary conjectures outlined above (again, just as examples, see Pavitt (1984), Utterback and Suarez (1992), Klepper (1993), Malerba and Orsenigo (1994), Winter (1984), Dosi et al. (1995)).

Fifth, one is starting to explore learning itself as an evolutionary process at the levels of both individuals and organisations (limiting ourselves to economic applications, see Marengo (1992), Marengo and Tordjman (1995), Lindgren (1992), Dosi et al. (1994), Levinthal (1990), Warglien (1995), Palmer et al. (1994)). This links also with a wide tradition of studies in the fields of organisational economics which is impossible to review here (but see the remarks in Winter (1986) and (1995)).

Finally, there is a good overlapping between the evolutionary perspective – as we have defined it – and various types of “self-organisation” models (see Lesourne (1991)), and

³Note that, given the above quite broad definition of the ‘evolutionary research programme’, it may well describe also the contributions of authors who would not call themselves ‘evolutionist’ in any strict sense.

also with the expanding field of *evolutionary games* (see for example Young (1993), Kandori, Mailath and Rob (1993), and Kaniovski and Young (1994)). Short of any detailed discussion of analogies and differences (which will be briefly recalled below), let us just mention that certainly they have in common the emphasis on dynamics (point 1 above) and bounded rationality assumptions (point 3), but much less so the role of novelty (point 5) and the focus on non-equilibrium, finite time, properties (point 7)⁴

So, yes: indeed, we do have a rich and growing body of economic literature which at last tackles change and evolution, whereby increasing returns are the norm rather than the exception (and, with that, also the possibility of ‘lock-ins’), history counts, and agents are presumed to be less than perfectly rational and knowledgeable. But where do institutions fit in this picture?

Let us now turn to this issue.

3 Institutions and Evolution

Again, for the sake of clarity, starting with some definitions helps.

Here we use the term “institution” with a broad meaning to include

a) formal organisations (ranging from firms to technical societies, trade unions, universities, all the way to State Agencies);

b) patterns of behaviours that are collectively shared (from routines to social conventions to ethical codes);

c) negative norms and constraints (from moral prescriptions to formal laws).

Distinctions between the three sub-categories will be made in the following when necessary.

The proposition that in sense “institutions count” in shaping economic coordination and change is certainly shared by all breeds of “evolutionists” mentioned earlier with various strands of ‘neo-institutionalists’ (see for example Williamson (1985) and (1995), and North (1990) and (1991)), and also, of course, with “old” institutionalism (drawing back to Veblen, Commons, etc.). But, clearly, the tricky issue is *in which sense* do they count.

Simplifying to the extreme, two archetypical, opposing views can be found in all these literature. At one end of the spectrum, the role of institutions can be seen as that of (i) parameterizing the environmental state variables (say the comparative costs of markets, hybrids and hierarchies

⁴To repeat, this is not meant to be any thorough review but just an approximate roadmap. Moreover, at least a partial overlapping with the ‘evolutionary archetype’ can be found in quite diverse fields of economic theory: see for example M. Aoki (1995) and Stiglitz (1992).

in Williamson or, nearer to evolutionary concerns, technological opportunities and appropriability conditions); and (ii) constraining the menus of actions available to the agents (which in some game-theoretic versions reduces to “the rules of the game”). Conversely, at the opposite end, let us put under the heading of *embeddedness view* all those theories which claim, in different fashions, that institutions do not only ‘parameterize’ and ‘constrain’, but given any one environment, also shape the ‘visions of the world’; the interaction networks; the behavioural patterns; and, ultimately, the very identity of the agents. (In the contemporary literature, under this heading come e.g. Granovetter (1985) and (1995), and also March and Olsen (1989), DiMaggio and Powell (1991), just to name a few, and has a close relative in ‘cultural theory’: cf. Schwartz and Thompson (1990) and Grendstad and Jelle (1995)). Note that where a theory is placed along this spectrum has significant implications in terms of the predictions that it makes with respect to the collective outcomes of interactions and to the directions of change. On the grounds of the former view, the knowledge (by the analyst) of the (institutionally shaped) system parameters is sufficient to determine the collective outcomes (*precisely*, under “perfect” rationality – with the caveat of multiple equilibria –; and *approximately* under “bounded” rationality). Conversely, the embeddedness view implies that in order to understand “what happens” and the directions of change over time much richer institutional details are needed. (First of all, one is likely to require to know much more about the multiple institutions of which the agents are part, and also much more of their histories . . .).

As discussed at greater length in Dosi (1995), three other dichotomies are relevant here.

One concerns the origin of the institutions. Briefly put, are institutions themselves a *primitive* of the theory or is *self-seeking rationality* the primitive and institutions are a derived concept? Under the latter view, whatever institution one observes, one has to justify it, asking the question how self-seeking agents have come to build it (with an answer that could be either via forward looking rationality or myopic adaptation . . .). Conversely, under the former view, the existence of an institution is “explained” relying much more heavily on the institutions that preceded it and the mechanisms which led to the transition. Relatedly, one is also entitled to ask why do people embedded in certain institutions behave the way they do (i.e. how institutions shape their specific “rationality” and equally specific perceptions of their interests.)

Another dichotomy regards the degrees of intentionality of institutional constructions, that is, are they purposefully built according to some sort of collective *constitutional* activity or, conversely, are they mainly the outcome of an unintentional *self-organisation* processes/(point 7) ?

Table 1. Weak and Strong Varieties of Institutionalism.

	“Weak” Institutionalism	“Strong” Institutionalism
1) Role of institutions	Parameterize system variables; constrain menu of strategies	Also “embed” cognitive and behavioural patterns; shape identities of actors
2) “Primitives” of the theory	(Perfectly or boundedly) rational self-seeking agents; institutions as derived entities	Institutions as “primitives”; forms of “rationality” and perceptions of self-interest as derived entities
3) Mechanisms of institution-formulation	Mainly intentional, “constitutional”, processes	Mainly unintentional self-organization processes
4) Efficiency properties	Institutions perform useful functions; may be considered equilibria in some selection space	Institutions as “carriers of history”; reproduces path-dependently, often irrespectively of this functional efficiency

A final dichotomy concerns the efficiency properties (and the equilibrium nature) of institutions themselves. Do they exist *because* they “perform a function” and, thus, are the equilibrium outcome of some process that selected in favour of that function? Or conversely paraphrasing Paul David (1994) are they mainly “carriers of history”, in the sense that they tend to path-dependently reproduce themselves well-beyond the time of their usefulness (if they ever had one)?

The four dichotomies together define the distance between any one institutionalist view and the standard “neoclassical” paradigm (institution-free, with perfectly rational agents, well-formed and invariant preferences, etc.). As shown in Table 1, one may identify different *gradations* of institutionalism, ranging from *weak* forms – retaining a lot of the canonic microfoundations – to *strong* forms – wherein institutions have much more life of their own and also much more influence on what microentities think and do.

How does the evolutionary research programme (as we have defined it) relate to the various strands of institutionalism, if it does at all? It is our view that the links are indeed profound (the famous plea for an evolutionary approach to economic analysis by one of the founding figures of institutionalism, T. Veblen (1898), is a historical symbol of this intuitive relationship). However, it seems to us also true that the linkages so far still are to a large extent implicit.

Certainly, there are a lot of institutional assumptions in evolutionary reasoning. So, for example, it is quite natural to assume that the particular behavioural rules, interaction mechanisms and learning patterns that one finds in evolutionary models are embedded into particular

institutions. In fact, markets themselves are viewed as specific, history-contingent, institutions.

Moreover, it is straightforward that *routines* – which play a prominent role in evolutionary theorizing of economic behaviours – are shaped by the history of the organisations in which they have developed and also by a broader institutional history. (For example, one is quite at ease with the idea that the routines and strategies of e.g. a firm from Victorian Manchester are likely to be quite different from those of American multidivisional corporations analyzed by Alfred Chandler; that differences in the institutional contexts contribute to explain the behavioural differences between contemporary Japanese, American, and European firms, etc.).

Finally, a lot of effort has gone into the understanding of the specificities of the institutions supporting technological change (cf. for example, Nelson (1993), Lundvall (1992) and the chapters by Nelson and Freeman in Dosi et al. (1988)).

However, it is fair to say that the institutional embeddedness of technological opportunities, routines, forms of market interactions and selection mechanisms, etc. while abundantly acknowledged, has received little attention on its own (with the mentioned exception of those institutions more directly linked with innovative activities and notwithstanding the suggestions in Lundvall (1992) aiming to provide a broader institutional meaning to the notion of ‘national systems of innovation’). So, for example, one is still lacking any systematic mapping between classes of institutional arrangements of the economy and classes of interaction mechanisms/adjustment rules that one finds in evolutionary theories. As a consequence, one is equally still unable to map institutional arrangements into particular dynamic properties of aggregate variables – say income and productivity growth, employment, etc.. (See, however, Chiaromonte et al (1992) for an initial, still quite preliminary attempt.) Conversely, these types of mapping are precisely the *starting point* of “strong” institutionalist approaches as defined above. As a term of comparison, let us consider in particular the “Regulation” school.

4 An Institutional View of the Economic System:

The “Regulation” Approach

For those who are not familiar with this tradition of studies, which originally developed in France (see Aglietta (1982), Boyer and Mistral (1978), Boyer (1987), (1988a-b), and (1990), Coriat (1994), Jessop (1989), Boyer and Saillard (1995)). First note that by *regulation* – in French – one does not mean the legal regulatory apparatus as understood by the same term in English. Rather, its meaning is nearer the notion from system theory of different parts

or processes that under certain conditions reciprocally adjust yielding some orderly dynamics. Hence, *regulation* stands for the relatively coherent *socio-economic tuning* of any one economic system, and different *regimes of regulation* capture the specificities in the “mechanisms and principles of adjustment associated with a configuration of wage relations, competition, State interventions and hierarchisation of the international economy” (Boyer 1987, p. 127).

In this perspective, and unlike evolutionary models, the description of the system is *immediately institutional and taxonomic*, attempting to identify some sort of archetypical *structural forms* which distinguish alternative socio-economic regimes.⁵

For our purposes here, let us define different *regimes of accumulation* in terms of the institutional arrangements concerning six domains, namely:

1. *The wage-labour nexus*. Under this heading come the nature of the social division of labour; the type of employment and the mechanism of governance of industrial conflict; the existence and nature of union representation; the systems of wage formation; etc.
2. The *forms of competition* in the product markets (whether nearly-competitive or oligopolist; the related mechanism of price formation; etc.)
3. The institutions governing *financial markets* and monetary management (including the relationships between banks and industry, the role of stock exchanges in industrial financing; the mechanisms of liquidity creation in the system; etc.).
4. The norms of *consumption* (i.e. the composition and changes in the baskets of consumption and their differences across social groups).
5. The forms of *State intervention* in the economy (e.g. monetary and fiscal policies; “State as arbiter” vs. State as an active player with respect to social conflict, income distribution, welfare; etc.).
6. The organisation of the *international system* of exchanges (e.g. the rules of international trade; the presence/absence of a single hegemonic power; the patterns of specialization; etc.).

The identification of discrete regimes implies then a sort of combinatorial exercise among these six domains; the historically-informed identification of dominant ones in particular periods;

⁵A related perspective, which is not possible to discuss here, pursued especially by “radical” American economists is known as the theory of “Social Structures of Accumulation”. See for example Bowles and Gintis (1993) and the references therein.

the assessment of the conditions of their viability and eventual crises; the specific realizations of a dominant regime in different countries. So a lot of work has been done in order to identify the nature of the “classical” (or “competitive”) regime which ran through most of last century, as opposed to a “Fordist” (or “monopolistic”) regime coming to maturity in the developed West after World War II (cf. Aglietta (1982), Boyer and Mistral (1978) and the works reviewed in Boyer and Saillard (1995)). The focus of the analysis is to a good extent the *long-term*, influenced by Marxism and the French historical tradition of the *Annales*, and the emphasis is *macroinstitutional*: it is centered, for example, on the institutions governing “social compromises” among major social groups (Delorme and André (1983), Coriat (1982) and (1990)), educational institutions (Caroli (1995)), financial institutions, etc.

One could say that the *Regulation* approach is an ambitious attempt – paraphrasing John Hicks – to develop a “theory of contemporary history”. It has proved indeed to be a very rich source of heuristics and categories for historical analyses and comparative studies (a thorough survey of the state-of-the-art is in Boyer and Saillard (1995)). But there are also a few exercises of formalization of sorts of *reduced forms* of the theory whereby the (institutionally-shaped) regularities in the above six domains are summarized by some functional relations linking aggregate variables (e.g. wages with prices, productivity and employment; productivity growth with the growth of output, investments and R&D; output growth with investment and exports. See in particular Boyer (1988b) and the contributions by Billandot, Juillard and Amable in Boyer and Saillard (1995)). The models have a strong Keynesian/Kaldorian ascendancy, but certainly expand upon the ancestors, and, more important, attempt to capture the differences across regimes in terms of different parametrizations and functional specifications of those aggregate relationships (e.g. do wages depend mainly on unemployment, as in the “competitive” regime, or are they basically linked to consumer prices and productivity, as in the “Fordist” regime? Does some sort of ‘Verdoorn–Kaldor law’ apply to productivity growth? How sensitive are investments to profits as opposed to ‘accelerator’ effects? etc.). In these reduced forms, the stability of ‘regimes’ is investigated in terms of the existence of stable steady states engendered by particular ranges of parameters. Moreover, by specifying dynamic couplings across these same aggregate variables one is able to identify quite rich long-term patterns including bifurcations (Lordon (1994)) and phase transitions.

At this point, readers not too familiar with both the evolutionary and the *regulation* approaches might reasonably wonder what they have in common. *Prima facie*, they do indeed share some methodological commitment to the understanding of dynamic patterns which do

not simply involve “more of the same”. They both also depart from the canonic view of the economy of a “naturally” self-regulating system. Moreover, their microfoundations (explicit in most ‘evolutionary’ contributions, implicit in most of the ‘regulationist’ ones) imply much less than perfect rationality and foresight. And, finally they share a deep commitment to the idea that ‘institutions matter’. But what else beyond that? Are they talking about the same objects of analysis? And, when they do, how do their interpretations overlap or diverge? In order to clarify these issues for the discussion, let us briefly check the two perspectives against an object of inquiry that both have abundantly addressed, namely growth and in particular the observed post-World War II patterns.

5 Some Different Theoretical Stories on Growth, in general, and the Post-War Period, in particular . . .

It is revealing to compare the barebones of the interpretative stories that ‘evolutionists’ and ‘regulationists’ would be inclined to put forward about the basics of the growth process, were they forced to summarize them in few sentences.

Most likely, the story provided within an evolutionary perspective would start with a multitude of firms searching for more efficient techniques of production and better performing products, and competing in the markets for products and finance. Differential success in search, together with different behavioural rules and strategies (concerning e.g. pricing, investment, etc.) would then determine their differential revealed performances (in terms of e.g. their profitability, market shares, or survival probabilities) and hence their ability to growth in the next “period”. Aggregate growth, in this view, is essentially driven by technological advances. Relatedly, the eye of the analyst is naturally led to look for the origins, nature and accessibility of technological *opportunities*; the easiness by which firms can imitate each other (i.e. *appropriability* conditions); the ways firms are able to store and augment their knowledge (i.e. the relationships between *organisational routines and competences*); and finally the mechanisms and speed of market selection.

As already emphasized, such an evolutionary story is comfortable with complementary institutional factors. Most straightforwardly, for example, it is consistent with (*and indeed demands*) an institutionally-grounded explanation of the mechanisms of generation of ‘opportunities’ to be tapped by private agents; of the legal framework contributing to shape appropriability conditions; of the origins of particular sets of corporate routines; of the nature of market interactions;

of the ways wages react to the changes in the demand for labour induced by technical change and growth; etc.

However, compare this story with the much more directly institution-based story within a *Regulation* perspective. In the latter, plausibly, the starting point would be an analysis of the factors which render a particular *regime of accumulation* viable (note incidentally that while it was possible to tell a caricature of an evolutionary story of capitalist growth *in general*, here one needs from the start history-contingent specifications). One part of the story would concern the institutions governing wage formation, the labour process and income distribution – determining labour productivity and the surplus available for investment. Another part of the story would focus on the mechanisms of generation of aggregate demand (including the ways income distribution and social institutions affect the composition and dynamics of consumption baskets). Yes another part would address the ways the State intervenes into the economy (Is it a “Keynesian”/Welfare State or is it a Laisser-Faire one?, etc.) Moreover, one would look at the ways products and financial markets are organized. In a nutshell, the answer to the question of “what drives growth” is found in the *consistency conditions* among those major pieces of institutional organisation of the socio-economic fabric. Hence, consistent *matching* foster sustained growth, while mismatching engenders instability, crises and macroeconomic depression.

Having focused, *in primis*, on the institutional features of the system, the approach – in manners somewhat symmetrically opposite to the ‘evolutionary’ interpretation – is complementary to detailed specifications of the patterns of technological change. For example, it easily acknowledged that technological innovation is a major determinant of the division of labour and work organisation; of the importance of economics of scale (and thus of the aggregate relationships between productivity growth and income growth); of demand patterns; of international competitiveness; etc. However, it is fair to say that what appears as the major driver of growth in the evolutionary account, here (in the *Regulation* approach) tends to feature more in the background among the necessary or constraining conditions for growth, while the opposite applies to the thread of country-specific and period-specific institutions.

A similar difference (which might be just a matter of emphasis or might be much more; see below) emerges when handling the interpretation of specific historical circumstances. Compare, as an illustration Nelson and Wright (1992) and Aglietta (1982) on American performances in this century (notwithstanding the only partial overlapping between the two, with the former focused on *technological* performances and the latter, more broadly, on growth patterns). In

brief, the Nelson-Wright story reconstruct the origins of American leadership, after World War II tracing it back to

“...two conceptually distinct components. There was, first of all, the longstanding strength in mass production industries that grew out of unique conditions of resource abundance and large market size. There was, second, a lead in “high technology” industries that was new and stemmed from investment in higher education and in research and development, far surpassing the levels of other countries at the time” (Nelson and Wright (1992), p. 1960).

The erosion of that leadership is then analyzed in terms of the factors which allowed a more or less complete technological catching-up by other OECD countries over the last four decades (subject to the qualifications put forward by Patel and Pavitt (1994) on the long-term specificities in the patterns of technological accumulation by individual countries).

Nelson and Wright do not explicitly talk about the impact of technology on growth, but a strong evolutionary conjecture is that innovation and imitation have a major importance in explaining both trade patterns and growth patterns (for some empirical tests see Dosi, Pavitt and Soete (1990), Verspagen (1993), Amendola et al. (1993), Fagerberg (1994)). Conversely, the Aglietta story, directly concerning American (and international) *growth* patterns, is an archetypical application of the *Regulation* framework sketched above. The conditions for a sustained regime of growth are identified into the “virtuous” complementarity (i) mechanization/automation/standardization of production (entailing also ample opportunities for the exploitation of economies of scale); (ii) the development of “Fordist” patterns of management of industrial relations; (iii) mechanisms of governance of the labour market on the grounds of implicit or explicit conventions indexing wages on productivity and consumer prices (with the effect, among others, of smoothing business cycles and sustaining effective demand); (iv) symmetrically, relatively stable forms of oligopolistic organisation of product markets (which, twined with the above wage dynamics, sustained rather stable patterns of income distribution and easy, “accelerator driven”, investment planning); (v) the diffusion in consumption of mass produced durables; (vi) “Welfare” and “Keynesian” fiscal policies; (vii) the development of an international monetary regime conducive to international exchanges (the Bretton Woods setup) under the hegemony of one economic and technological leader (the USA).

Correspondingly, the end of the “Golden Age” following World War II is seen as the outcome of “mismatched dynamics”, for institutional and technological reasons, at all the foregoing seven levels: e.g. the exhaustion of the potential for economies of scale; inflationary pressures amplified by the wage formation mechanism; the entry of new competitors destabilizing cosy oligopolis-

tic arrangements; increasing social conflict favoured by near-full-employment conditions; the collapse of the Bretton Woods regime; etc.

Are these two basic stories essentially two complementary ways of looking at a broadly similar object? But in this case where does the complementarity precisely rest? Or do they entail competing explanation of the same phenomena? As we shall see, it is our conjecture there is a bit of both (and sorting out what is what would be already a significant step ahead ...).

6 Different Levels of Analysis or Competing Interpretations?

Certainly, part of the difference in the ‘building blocks’ of the basic stories outlined above relates to different levels of observation and different primary phenomena to be explained (and this of course militates for a would-be complementarity). In many respects, a much greater parsimoniousness on institutional assumptions that one finds in evolutionary models is due to the higher level of “historical abstraction” in which they are set. Metaphorically speaking, this is the level at which one investigates the properties of an (imperfect) *Invisible (or oligopolistically visible) Hand* operating in presence of the *Unbound Prometheus* – as David Landes puts it – of technological change. In other words, evolutionary models – at least the first generation of them – start by addressing, *in a first approximation*, some stylized properties of capitalist dynamics *in general*, such as the possibility of self-sustained growth driven by the mistake-ridden search by self-seeking agents. Relatedly, the primary objects of interpretation are broad statistical regularities (or “stylized facts”) at aggregate level, such as exponential growth, the *rough* constancy of distributive shares, the secular increase in capital/labour ratios, the degrees of persistency in macro fluctuations and more generally the spectral density of time series; the broad patterns of divergence/convergence of per capita income in the world economy; etc. (see Nelson and Winter (1982), Dosi, Fabiani, Aversi and Meacci (1994), Silverberg and Verspagen (1994) and the – far too modest! – overview in Silverberg and Verspagen (1995)). Similarly, at ‘meso’ level - i.e. that of single industries – evolutionary models have proved to be quite capable of interpreting statistical phenomena such as skewed size distributions of firms by size, ‘life cycle’ patterns of evolution, inter-sectoral differences in industrial structures grounded in different ‘technological regimes’, etc. (cf. Dosi et al. (1995)).

With respect to this level of observation, in many ways, the degree of abstraction of *Regulation* theories is much lower and the interpretative ambition is higher, in the sense that the aim goes well beyond the account of broad statistical invariances but points at the understanding

of *discrete forms* of development and the transitions across them. Relatedly, the degrees of institutional specification is bound to be much higher and, as it happens, the ‘microfoundations’ much more implicit (when they are there at all).

So, yes, we have here a potentially fruitful complementarity concerning two different levels of description (see also below). As we see it, the aggregate functional and institutional regularities which are the *starting point* of most *Regulation* models,⁶ could possibly be shown to be *emergent properties* of an underlying, explicitly microfounded, evolutionary models, appropriately enriched in their institutional specifications.

Take for example the Verdoorn-Kaldor functional form relating productivity growth and income growth which is *postulated* in *Regulation* models. Evolutionary models are in principle suited to establish the microeconomic conditions under which it emerges in the aggregate as a stable relation: e.g. what are the micro-learning processes that sustain it? What happens to its form and parametrizations if one varies the underlying mechanisms of search and sources of technological opportunities? Under what circumstances can one identify phenomena of ‘symmetry breaking’ engendered by microfluctuations and yielding the transition to different structural forms?

Similarly, with respect to wage formation mechanisms. Again, the ‘structural forms’ in the *Regulation* account tend to postulate aggregate invariances, say in the elasticities of wages to unemployment, prices and productivity. Conversely, evolutionary-inspired models of the labour market and labour processes (still to be built!) might well account for the conditions of their emergence, stability and crises. And the same could be said for most other ‘primary building blocks’ of *Regulation* models.

Of course we do not want to push the ‘emergence philosophy’ too far. It would be naive to think that straightforward links between levels of description can be made without resorting to a lot of further ‘phenomenological’, history-based, specifications. Jokingly, we illustrate all this with the *parable of the cow* (!). If anyone is asked to describe what a cow is, it would be silly to start from a quantum mechanics account of the atoms composing it, and then move on to the levels of atoms, molecules, cells . . . all the way to the morphological description of the cow. However, the example is handy because it illustrate, *first*, the consistency *in principle* between the different levels of description; *second*, the fact that a good deal of higher level properties (e.g. concerning cells’ self-maintenance) can be understood as emerging properties from lower level

⁶Note that we do not mean only formal, mathematically expressed, ‘models’, but also rigorous, albeit verbally expressed, theory-based propositions about whatever phenomena.

dynamics; and, *third*, that without a lot of additional ‘phenomenological’ information, generic emergent properties are not enough to determine why that animal is a cow and not an elephant or a bird . . .

Admittedly, in economics we are very far from such a consistency across levels of descriptions (and certainly the compression to one single a-historical level that the neoclassical tradition has taught us did not help . . .). However, we want to suggest that a theory-informed dialogue between *bottom-up* (microfounded, etc.) evolutionary approaches and more *top-down* (aggregate, albeit institutionally richer) *regulation* ones is likely to be a formidable but analytically promising challenge.⁷ Not only it would help to rigorously define the bridges between micro behaviours and entities at different levels of aggregation, but it would also highlight potential conflicts of interpretations which are currently often confused by level-of-description issues. Having said that, few unresolved questions and areas of possible conflict come already to mind.

The Descriptive Counterparts of Socio-Economic Regimes.

We have already mentioned earlier that, in a sense, the *Regulation* approach sets to itself the ambitious task of dissecting the anatomy of discrete regimes of growth. But then, it seems to us, a unavoidable task is the empirical, *and also statistical*, identification of these regimes. Some work has been done in this direction, especially concerning long-term wage dynamics, but also labour productivity and demand formation (for surveys, see chapter 10 by C. Leroy, chapter 22 by M. Juillard, chapter 23 by B. Amable in Boyer and Saillard (1995) and also Boyer (1988b)). However, a lot remains to be done – as difficult as it is. For example, if phases of development and crises are traced back to the properties of underlying regimes, how is it revealed by the dynamics of statistical aggregates? And, which ones? And at which level of aggregation? (e.g. are GDP series too noisy and unprecise so that one should look at sectoral data?) Or is one forced to the conclusion that current econometric methods are ill-suited to detect changes which appear very important when inspecting qualitatively ‘how the economy works’, but are blurred by statistical noise in the reported series?

Notably, an answer to these questions will help a lot in pinning down the common objects of interpretation (and also in revealing the comparative merits of an institutionalist approach to macroeconomics as compared to more traditional ones). Moreover, a crucial part of the *regulationist* exercise involves the mapping of socio-economic regimes into dynamic properties of the system. But then a lot more work is required to find statistical proxies for those regimes

⁷Broad historical interpretations building upon a *lato sensu* evolutionary microeconomics, such as Freeman and Perez (1988), might be considered as another point of departure of this dialogue.

themselves (this mirrors the effort that scholars in the evolutionary tradition have started putting into the statistical identification of ‘technological regimes’; cf. Malerba and Orsenigo (1994)).

The Institutional Specifications of Evolutionary Model

In a sort of complementary way, in order to start talking about (roughly) the same things, it is urgent that a new generation of evolutionary models begins experimenting systematically with *variations in the institutional contexts* in which evolutionary processes are embedded. One can think of different ways of doing it (corresponding also to different degrees of difficulty). *First*, holding constant the system parameters, concerning e.g. notional technological opportunities, one may ask what happens to aggregate dynamics if one changes behavioural routines (an early example is in Chiaromonte, Dosi and Orsenigo (1992), and the constraints on those routines themselves (well expanding upon the exercise of Nelson and Winter (1982) regarding different financial constraints on borrowed funds). *Second*, even holding routines constant, one should experiment with different interaction environments (e.g. centralized vs. pairwise forms of interaction; price-based competition vs. selection based on multidimensional product attributes; bank-based vs. market-based access to finance; etc.). In fact a major claim of *both* evolutionary and *regulation* theories is that markets are themselves institutional constructions whose organisational details deeply affect collective outcomes. However one knows very little of how markets actually work⁸ and even less so one has taxonomies of sort of ‘archetypes’ of markets which can thereafter be stylized and formally explored. *Third*, one might allow for routines themselves to be learned in different institutional environments⁹ That would imply, in turn, the identification of distinct learning procedures in different environments. *Fourth*, (and harder), it might be time to explore in an evolutionary perspective other domains of economic activity (e.g. the labour market, financial markets, the endogenous dynamics of consumer preferences, etc.)

Some Possible Misunderstandings: Microfoundations, Representative Agents and Method-

⁸A noticeable exception is Kirman (xx) on the fish market in Marseille (!!)

⁹A simple adaptive learning mechanism nested in a macro model is presented in Silverberg and Verspagen (1995a). Much more ‘constructive’ models of behavioural learning are in Marengo (1992), Marengo and Tordjman (1995) and Dosi et al. (1994), but they are far from any macro model. Moreover, they, too, lack experiments on different institutional specification.

Note that here, by routines we specifically mean those rules-of-thumb concerning e.g. pricing, R&D, investments, etc. It is a fundamental point of evolutionary theories that different techniques are intimately associated also with different *production* routines. And, indeed, the models provide a representation of the dynamics of the latter via a low-dimensional representation of search outcomes in the technology space. However, a major step forward would be an explicit account of the dynamics of the underlying problem-solving routines (see also below).

ological Individualism

In the argument so far, an implicit assumption has been that the degrees of “bottomupness” or “topdownness” (including the presence and details of interactions among lower-level entities *cum* emergence of higher-level properties) is essentially conditional on the *levels* and *modes* of description themselves.

So, for example, we do not have any problem in acknowledging the descriptive power of, say, the now-discredited Keynesian “income multipliers”, as a concise way of accounting – under historical conditions to be specified – for a specific relationship between modal behaviours of “firms” and “consumers”. In turn, such an aggregate description implies, of course, that *functional roles* in society *count*. (Here there should be little disagreement between the evolutionary and *regulation* approaches). The underlying idea is that an economic agent, Mr. Jones – even when he is at the same time worker at factory x, shareholder of company y which owns that factory, and consumer of the products of that factory and of many other ones – will behave according to modal patterns deriving from an institution-shaped *logic of appropriateness*, as James March puts it (how should Jones, *as a consumer or as a worker* behave? . . .). Most likely what Mr. Jones does as a worker ought to be interpreted on the grounds of the collective history of many Mr. Jones’s, their experiences at the workplace, their successes and failures in industrial bargaining, etc. Analogously, the same should apply to his behaviour as a consumer or a shareholder . . . The basic point here is that a reduction of Mr. Jones’ behaviour to a coherent exercise of utility maximization in a largely institution-free environment misses the point and is interpretatively misleading or, at best, void of any descriptive content. Mr. Jones might for example feel safe to buy shares of very conservative companies in order to ensure a rosy retirement age, fight in the meantime on the workplace against the very practices that these same companies try to implement, and buy Japanese products even when that endanger the wealth possibly stemming from the companies whose shares he bought. . .

Having said that, however, it seems to us that the hypothesis of institutional embeddedness of social behaviours – largely shared by the evolutionary and *regulationist* approaches – cannot be pushed to the dangerous borders of some renewed functionalism. There is some echo of all that when one finds a too cavalier use of sorts of “functional representative agents” in regulationist interpretations (“ . . . the behaviour of the Fordist firm”, “the unionized worker”; etc.). If anything, those stylized behavioural archetypes ought to be considered as rough *first approximations*, demanding further investigations into their microfoundations and the conditions of their sustainability over time. For example, under what context conditions will the behaviours

of many Mr. Jones's (or, for that matter, of many firms. 'Jones Inc.' ...) remain relatively invariant over time? What are the conditions on interactions and statistical aggregation which sustain relatively invariant *mean* behaviours? And, conversely, under what circumstances do *non-average* behaviours induce symmetry-breaking and, possibly, phase transitions? (Note that this last issue is particularly relevant when accounting for the dynamics *across* different regimes). Certainly, we share Boyer and Saillard's general conjecture that

“...a mode of *regulation* elicits a set of procedures and individual and collective behaviours which ought at the same time reproduce [particular] social relations ...and sustain the prevailing regime of accumulation. Moreover, a mode of regulation must assure the compatibility among a collection of decentralized decisions, without necessarily requiring the acknowledgement by the agents of the principles which govern the dynamics of the system as a whole” (Boyer and Saillard (1995), p. 64, our translation).

Work to support this claim (at both levels of empirical investigations and formal modeling) is urgently needed, and, in our view is also another area of fruitful complementarity between 'evolutionists' and 'regulationists'.

In this respect, a possible misunderstanding has to be dispelled. The requirement of *micro-foundations* of aggregate statements (i.e. foundations in what actually a multitude of agents do and, possibly, think), which we have emphasized throughout this work, *must not at all* be considered equivalent to any advocacy for foundations into any “methodological individualism”. The latter, in its canonic form, requires that any collective state of the system *first*, ought to be explained on the grounds of what people contributing with their actions to determine that state think and do; and *second*, that these micro “thoughts”, strategies and actions are the *primitives* of the theory. Our claim is much weaker. We share, in principle, the first requirement,¹⁰ but we strongly deny the second. So for example, we are perfectly happy with 'microfoundations' which are themselves *macrofounded*, i.e. whereby what 'people think and do' is *deeply but imperfectly* shaped by the organisation and states of the system itself.

As an illustration consider the following toy model. Take a competitive world (as similar as

¹⁰We also want to emphasize the fact that we share the requirement *in principle*, even if it might turn out that in many circumstances that link micro-macro turns out to be practically impossible. It is a circumstance familiar also to natural sciences where it is often the case that one can write the aggregate statistical properties (say, in a thermodynamic problem) without being able to derive them from an underlying micro description (say, detailed balance equations).

possible to a Temporary General Equilibrium, of pure exchange – in order to make things simple). Suppose the state of the system, $s(0)$ at time $t(0)$ is defined by a price vector $p(0)$ and allocations $\omega_i(0)$ to each agent i . As usual, given prices and allocations, preference relations will determine the demand functions. If we specify a mechanism of exchange (which indeed the theory seldom does) well-defined transition laws to $p(1), p(2) \dots$ and $\Omega(1), \Omega(2) \dots$ (the subsequent allocations). This is obviously a microfounded story. However, add to the story that the *preference relations themselves* depend, imperfectly, on the lagged $p(\cdot)$ and $\Omega(\cdot)$, for example, because of phenomena of reduction of cognitive dissonance (“...don’t desire what you were not able to get ...”), social imitation, learning-how-to-like-what-you-have, etc. In this case, we still have a microfounded story, but of course a) individual preferences stop being a ‘primitive’ of the explanation, and, b) we have here a sort of “macrofoundation of the micro”, in the sense that what micro entities do is to a good extent determined by the collective history of the system itself¹¹. This metaphor, we suggest, is of wide applicability, well-beyond the foregoing caricatural example.

A Crossroad for Dialogue (or Conflict): The Nature of Economic Routines

We have mentioned earlier that both evolutionary and *regulation* approaches share the idea that a good deal of individual and collective behaviours are “boundedly rational”, context-dependent and relatively inertial over time – shaped as they are by equally inertial institutions in which they are embedded. In a word, both approaches share the view that a good deal of the reproduction of the socio-economic fabric rests on the development and implementation of *organisational routines*. However, as we discuss at much greater in Coriat and Dosi (1995) most organisational routines entail a double nature: on the one hand, they store and reproduce *problem-solving competences*, while, at the same time, they are also *mechanism of governance of potentially conflictual relations*.

As it happens, the evolutionary approach has focussed almost exclusively on the ‘cognitive’ aspects of routines (and by doing that has begun to open interesting avenues of dialogue with disciplines like cognitive psychology and artificial sciences), but it has largely neglected the dimensions of power and control intertwined into the routines themselves¹².

Almost the symmetric opposite applies to the *regulation* approach which has tended to

¹¹We have repeatedly underlined the *imperfect* adaptation of agents to the macro configurations of the system. A perfect adaptation would indeed imply a strong functionalist conjecture (“... people do and think what they are supposed to do, given the functional requirements of the system itself ...”). In our view, on the contrary, it is precisely imperfect adaptation which is an important source of dynamics.

¹²This notwithstanding the acknowledgement of their importance: cf. for example, Nelson and Winter’s definition of “routines as truces” among conflicting interests (Nelson and Winter (1982))

emphasize the requirements of social coherence implied by routines, but has not paid much attention to their knowledge content.

All this might be all right again as a first approximation but it is clearly unsatisfactory as an end result in either approach. Pushing it to the extreme, in the former perspective, an answer to the question of “how do Renault (or GM or United Biscuits ...) behaves” is inclined to account for operating procedures, mechanisms of knowledge accumulation, learning strategies, etc. leaving in the background phenomena like the conflict between different social groups, the links that particular organisational rules bear with income distribution and the exercise of power (well beyond their knowledge content), etc. Conversely, the *regulationist* answer, by putting most of the emphasis on the latter phenomena, tends to convey the idea that governance is the paramount role of routines, quite irrespectively of the fact that Renault or GM have to know how to produce cars and United Biscuit cakes, and they have got to do it well, and better over time ... The risks of one-sided accounts are particularly big when accounting for the *origins* of routines themselves, with an evolutionary inclination to trace them back to cognitive dynamics only, and the regulationists feeling a bit too comfortable with a reduction of the problem to a selection dynamics among well-specified menus of actions/strategies/conventions.¹³

We argue in Coriat and Dosi (1995) that the double nature of routines, and relatedly the double marks on their origins, are challenging points of encounter between the evolutionist and institutionalist research programmes. Or, conversely, it could be the crossroad where the former take some sort of ‘hypercognitive’ route, whereby microeconomics and cognitive psychology tend to simply merge, and *regulationists* could well discover that ‘methodological individualism’ and weaker forms of ‘neo-institutionalism’ (cf. Table 1) are not so bad after all ...

¹³In turn, as known, once the problem is posed in these terms it can be formally handled by means of e.g. “evolutionary games” (cf. Boyer and Orlean (1992) for such an attempt). Far from denying the usefulness of such exercises as sorts of *gedankenexperiment* on collective adaptation under potential conflict of interests (or conflicts between individual incentives and collective good), they still deliver a quite partial picture of the object of inquiry. ... For example, in the current state-of-the-art we do not know of any model allowing for adaptation on preferences themselves (i.e. in game terms, endogenously evolving payoff matrices). Neither there is the discovery of new “strategies” (with the exception of Lindgren (xx)). And finally, ‘learning’ tends to neglect any cognitive/problem-solving aspect and be reduced to a stimulus-response mechanism of reinforcement (possibly mitigated by stochastic search or mistakes).

7 Some Conclusions: Toward A Demanding and Exciting Interbreeding?

Notwithstanding a series of important analytical issues – which might indeed be a source of serious interpretative conflict, and of which we have provided some illustrations – we do see an ideal sequence of modes of interpretation and levels of description in which both the evolutionist and *regulationist* programmes could ambitiously fit. As sketched in Table 2, they run from a sort of ‘nano-economics’, wherein the abandonment of any magic of a perfect and invariant rationality forces a dialogue with cognitive and social psychology, organization theory, sociology, all the way to grand historical conjectures on the long term destinies of contemporary forms of socio-economic organisation. Even a quick look at the table highlights the enormous gaps between what we now and what such an ideal evolutionary-institutionalist research programme would demand. These gaps are high at all levels but in our view four issues are particularly urgent on the agenda.

A *first* one concerns *co-evolutionary* processes. The essence of the co-evolutionary point is that what happens in each partly autonomous domain of the system (e.g. technology or institutional structures) shapes and constrains what is going to happen in the other ones. Hence, the overall dynamics is determined by the ways each domain evolves but also by the ways the various domains are coupled with each other.¹⁴ We have listed “co-evolution” under a separate level of description in order to demarcate that broad area covering e.g. the interactions between the forms of economic organisation, social and political institutions and technical change. However, co-evolutionary issues appear at all levels of description. For example, the emergence and development of each industry ought to be seen as a co-evolutionary process between technologies corporate organisations and supporting institutions (Nelson (1994)). Analogously, the origins of organisational routines (cf. above) is intimately a co-evolutionary process, shaped by diverse and probably conflicting selection criteria (i.e. problem-solving vs. governance requirements).

A *second* (and related) item which is high on the research agenda regards the *transition across different socio-economic regimes* of growth: for example, at which level can such transitions be

¹⁴A co-evolutionary view runs against, for example, “technological determinism” (i.e. technology proceeds exclusively according to its inner logics, and institutions ought simply to adjust, with varying lags) but also to “social determinism” (e.g. technology is purely a “social construction”). On the contrary, the co-evolutionary view does accept that technological change and social change have their own inner logics (possibly conflicting with each other) and does attempt to explain e.g. the emerging trajectories of technical change as the outcome of such a coupling.

Table 2. Levels of Analysis.

		Objects of analysis (some still to be explored)	Examples of “analytical styles”
Level 0	From “macroeconomics” to microeconomics	<ul style="list-style-type: none"> (i) Nature and origins of routines and, generally, behavioural norms (ii) Learning processes (iii) Mechanisms of expectation formation (iv) Nature and evolution of <i>micro</i> organizations (e.g. business firms) (v) ‘Embedding’ mechanisms of individual behaviours into the institutional context (vi) The evolution of criteria of actions and ‘visions of the world’ 	From H.Simon to Holland et al. (1986) microanalytic part of Nelson and Winter (1982); Cohen and Bacdayan (1994); Egidi (1994); organisational economics on “competences”, etc.; Coriat (1994a); Dosi et al. (1994); Marengo (1992); Warglien (1995); Marengo and Tordjman (1995); possible economic applications of Fontana and Buss (1994); and a lot to be done ...
Level 1	From microeconomics to aggregate properties	<ul style="list-style-type: none"> (i) Generic properties of growth fuelled by technical change (ii) Industrial evolution (iii) Self-organizing properties of labour markets (iv) The dynamics of consumption patterns 	Explicit microfounded models with aggregate emergent statistical properties: e.g. Nelson and Winter (1982); Silverberg and Verspagen (1994); Lesourne (1991) Dosi et al. (1995)
Level 2	Aggregate dynamics	<ul style="list-style-type: none"> (i) Functional relations among aggregate variables (ii) Socio-economic regimes: consistency conditions among processes of economic adjustment and institutions 	More ‘stylized’ but (hopefully) institutionally richer macro models (not necessarily microfounded): from Keynesian/Kaldorian models to Boyer (1988a/b)... Gordon (1994); Silverberg (1987)
Level 3	“Co-evolution”...	<ul style="list-style-type: none"> (i) Co-evolutionary patterns between technologies, corporate organizations and broader institutions (ii) Coupled institutional dynamics... (iii) ‘Political discretionality’ and institutional inertias 	... A lot of appreciative theorizing from historians... relatively little modeling (but cf. the suggestion in Nelson (1994) on industrial dynamics)... a vast <i>regulation</i> -inspired empirical literature (cf. Boyer and Saillard (1995))
Level 4	“Grand history”	General interpretative conjectures on long-term historical patterns from Karl Marx to ... Schumpeter... to Freeman and Perez (1988) ... to Aglietta (1982) and Boyer and Mistral (1978) (just to name the perspectives discussed in this work) ... !!

detected? (which probably will be conditional on the type of transition one is talking about). What are the effects of “higher level” changes (e.g. in the institutional set-ups or in the policy environment) upon micro-economic behaviour? And, conversely, under what circumstances non-average micro-behaviours become ‘autocatalytic’ and eventually induce higher-level phase transitions? What kind of co-evolutionary processes do particular classes of transitions entail?; etc.

A *third* priority item, in our view, concerns what could be called, in a shorthand, the *relationships between emergence and embeddedness*, or, putting it another way, the role of “bottom-up” processes shaping/generating higher-level entities (or at least aggregate statistical patterns) vs. “top-down” processes by which higher level entities (e.g. institutions, established mechanisms of interaction, etc.) shape/generate ‘lower level’ behaviours. One of the claims underlying this whole paper is that the links work both ways and that one ought to account for “macrofoundation of the micro” as well as “microfoundations of the macro” . . . But how does one get beyond suggestive metaphors and elaborates more rigorous – albeit highly simplified – models which nonetheless capture the intuition? (Note that what we mean is something more than a feedback between a system-level state variable – say, a price or a market share –, and the argument of an individual decision algorithm – say, pricing or investment rules –: somewhat deeper, we think it is not beyond reach to develop models whereby *micro decision algorithms themselves* are *shaped by macro states* and, conversely, possibly non-linear interactions among the former change collective interaction rules/constraints/perceived payoffs/perceived opportunities . . .). But in turn, all this involves difficult issues concerning, again, coordination; relative time-scales of change; relative invariances of ‘structures’ and conditions of their stability

Fourth, we suggest that the nature of *learning processes*, too, ought to deserve a priority attention. As Lundvall emphasizes (in this volume) the *objects of learning* (“know what”, “know why”, “know how”, “know who” . . .) are likely to discriminate among classes of learning processes. And, certainly, the *competence gap* between the intrinsic complexity of any one cognition/decision problem at hand and the pre-existing abilities of (individual or collective) agents fundamentally shapes learning processes (for a discussion, cf. Dosi and Egidi (1991)). But, in turn, it is only a weird twist of contemporary economic thought that gives credibility to the idea that incrementalist procedures, either based on sophisticated hypothesis testing (such as in Bayesian models) or stimulus-response reinforcements are the general paradigm of learning (note that this applies to ‘evolutionary games’, but also to most evolutionary models in general)

that one has developed so far.¹⁵

As a way forward, we suggest, possibly building upon preliminary (and still very rudimentary) attempts by e.g. Marengo (1992), Egidi (1994), Cohen and Bacdayan (1994), Marengo and Tordjman (1995) and also Dosi et al. (1994), a priority task is to account for the formation and collective establishment of *cognitive categories, problem-solving procedures* (. . . routines ?? . . .) and *expectations about the identities and behaviours of other social actors* . . .¹⁶

Yes, all this is an enormous task. Very fascinating and extremely difficult. The way we see it pursued, it involves tight and troublesome interchanges between empirical investigations, “appreciative theorizing” and formal modeling efforts. It is likely to involve also major adjustments in the building blocks of institutionalist/evolutionary theories themselves.

Probably, we witness now a rare window of opportunity for fulfilling the promise of making economics an “evolutionary/institutionalist discipline”. The blame for failing to do so will fall mainly on ourselves, well before the sectarian attitudes of chair committees or international journal editors . . .

¹⁵Incidentally, “Bayesian” and “Pavlovian” learning have most characteristics in common since both claim (i) what Sarage would have called a “small world” hypothesis (the notional set of events and response strategies is given from the start); and (ii) there is a striking transparence of the links between actions and consequences. Hence, ultimately, the difference between the two just rests on what the theorist assumes the agent to consciously know, without much influence on the ultimate outcomes. So, for example, it is easy for biologists overwhelmed by economists’ fascination to build models of rats who behave in equilibrium “as . . . if” understanding strategies involving first-order conditions and Lagrange multipliers, or conversely, respectable economists claiming ‘Pavlovian’ convergence to sophisticated Rational Expectation equilibria.

¹⁶By way of a comparison, recall that even in the most sophisticated state-of-the-art accounts, in economics, of behaviours and interactions (even under conditions of imperfect information) agents are assumed to *obviously* have the correct ‘transparent’ understanding of the causal links of the environment, to *obviously* know how to solve the technical problems at hand . . .

References

- Abramovitz, M. (1989). *Thinking About Growth*, Cambridge/New York, Cambridge University Press.
- Aglietta, M. (1974). *Accumulation et régulation du capitalisme en longue période. L'exemple des Etats-Unis (1870-1970)*, Thèse, Paris, October.
- Aglietta, M. (1982). *Regulation and Crisis of Capitalism*, New York, Monthly Review Press.
- Aglietta, M. (1993). "La finance au Japon, Changements de structures et adaptations des comportements". Communication au colloque; Mode de régulation au Japon et Relations Internationales: de l'histoire longue aux transformations récentes" in: *Japon in Extensio, Revue*, No. 33, 1994.
- Amendola, G., G. Dosi and E. Papagni (1993). "The Dynamics of International Competitiveness", *Weltwirtschaftliches Archiv*.
- Aoki, M. (1995). "Unintended fit: Organisational Evolution and Government Design of Institutions in Japan", Working Paper, Department of Economics, Stanford University.
- Arthur, B., Y. Ermoliev and Y. Kaniovski (1987). "Path-Dependent Processes and the Emergence of Macrostructures", *European Journal of Operations Research*, (30)294-303.
- Basalla, G. (1988). *The Evolution of Technology*, Cambridge, Cambridge University Press.
- Basle, M., Mazier, J., and J.F. Vidal (1984). "Quand les crise durent ... ", *Economica*, Paris.
- Bowles, S. and H. Gintis (1993). "The Revenge of Homo Economicus: Contested Exchange and the Revival of Political Economy", *Journal of Economic Perspectives*, (7)83-102.
- Boyer, R. (1978). La crise: une mise en perspective historique" in: *Critique de l'Economie Politique, Revue*, Paris.
- Boyer, R. and J. Mistral (1978). *Accumulation, Inflation et Crise*, Paris, PUF.
- Boyer, R. (1986a). *La Théorie de la Régulation, une analyse critique*, La Découverte, Paris.
- Boyer, R. (1986b). *La flexibilité du travail en Europe*, La Decouverte, Paris.
- Boyer, R. (1987). "Regulation", in: *The New Palgrave*, London, Macmillan.
- Boyer, R. (1988a). "Technical Change and the Theory of 'Registration'", in: Dosi et. al. (1988).
- Boyer, R. (1988b). "Formalizing Growth Regimes", in: Dosi et. al. (1988)
- Boyer, R. (1990). *The Regulation School. A Critical Introduction*, New York, Columbia University Press.
- Boyer, R. and A. Orléan (1991a). "Les transformations des conventions salariales entre théorie et histoire. D'Henry Ford au fordisme". *Revue Economique*, 42(2)233-272, Mars.
- Boyer, R. and A. Orléan (1992). "How Do Conventions Evolve?", *Journal of Evolutionary Economics*,
- Boyer, R. and Y. Saillard (eds.) (1995). *Theorie de la Regulation. L'état des savoir*, Paris, La Decouvert.
- Caroli, E. (1995). *Formation, Institutions et Croissance Economique*, These IEP, Paris.
- CEPREMAP, (1977). *Approches de l'inflation: l'exemple francais*, Convention de recherches, No. 22, mimeo, December.
- Chiaromonte, F., G. Dosi and L. Orsenigo (1992). "Innovative Learning and Institutions in the Process of Development: On the Microfoundations of Growth Regimes", in R. Thomson (ed.) *Learning and Technological Change*, London, Macmillan.
- Chiaromonte, F. and G. Dosi (1993). "Heterogeneity, Competition and Macroeconomic Dynamics", *Structural Change and Economic Dynamics*, (4)39-6.

- Commons, J.R. (1934). *Institutional: Its Place in Political Economy*, University of Wisconsin Press, Madison.
- Cohen, M. and Bacdayan (1994). "Organizational Routines As Stored Procedural Memory: Evidence From a Laboratory Study", *Organization Sciences*, 5554-5.
- Coriat, B. (1982). *L'atelier et le Chronometre*, Bourgeois, Paris.
- Coriat, B. (1990). *L'atelier et le Robot*, Bourgeois, Paris.
- Coriat, B. (1991-94). *Penser à l'Envers - Travail et Organisation dans la firme Japonaise*, C. Bourgeois; 2nd revised edition Bourgeois/Choix 1994.
- Coriat, B. (1993). "L'hypothèse du Compagnie-isme" in: *Mondes en Developpement Revue*, No. 4, Paris.
- Coriat, B. (1994). "La Theorie de la Regulation. Origines, Specificités, Enjeux", in: *Future Anterieur*, Paris, L'Harmattan; special issue of *Théorie de la Régulation et critique de la Raison Economique*.
- Coriat, B. (1994a). "Variety, Routines and Networks: The metamorphosis of the Fordist Firms", *Industrial and Corporate Change*, 4(1), Oxford University Press.
- Coriat, B. and G. Dosi (1995). "Learning How to Govern and Learning How to Solve Problems. On the Coevolution of Competences, Conflicts and Organisational Routines", IIASA Working Paper, WP-95-06, Laxenburg, Austria; forthcoming in: A. Chandler, P. Hagström and Ö. Sölvell (eds.), *The Dynamic Firm*, Oxford, Oxford University Press.
- Coriat, B. and O. Weinstein (1995). *Les nouvelles Théories de l'Entreprise*, in: Hachette, Paris.
- Conlisk, J. (1989). "An Aggregate Model of Technical Change", *Quarterly Journal of Economics*, (104)787-821.
- David, P. (1975). *Technical Choice, Innovation and Economic Growth*, Cambridge, Cambridge University Press.
- David, P.A. (1985). "Clio and the Economics of QWERTY", *American Economic Review. Papers and Proceedings*, (75)332-7.
- David, P.A. (1992). "Heroes, Herds and Hysteresis in Technological Change: Thomas Edison and the Battle of the Systems", *Industrial and Corporate Change*, (1)139-180.
- David, P.A. (1994). "Why Are Institutions the Carriers of History?", *Structural Change and Economic Dynamics*.
- Day, R. and G. Eliasson (eds.) (1986). *The Dynamics of Market Economics*, Amsterdam, North Holland.
- Delorme, R. and C. André (1983). *L'Etat et l'Economie*, Seuil, Paris.
- DiMaggio, P.J. and W.W. Powell (1991). "The iron cage revisited: Institutional Isomorphism and Collective Rationality in Organisational Fields", in: W.W. Powell and P.J. DiMaggio (eds.) *The New Institutionalism in Organisational Analysis*, Chicago, University of Chicago Press.
- Dosi, G. (1982). "Technical paradigms and technical trajectories, the Determinants and Directions of Technical Change and the Transformation of the Economy", *Research Policy*, March.
- Dosi, G. (1984). *Technical Change and Industrial Transformation*, Macmillan, London.
- Dosi, G. (1988). "Sources, Procedures and Microeconomic Effects of Innovation", *Journal of Economic Literature*, (26)126-173.
- Dosi, G., C. Freeman, R.R.Nelson, G. Silverberg, L. Soete (eds.) (1988) *Technical Change and Economic Theory*, London, Francis Pinter; New York, Columbia University Press.

- Dosi, G., K. Pavitt and L. Soete (1990). *The Economics of Technological Change and International Trade*, Brighton, Wheatsheaf and New York, New York University Press.
- Dosi, G. (1991). "Perspectives on Evolutionary Theory", *Science and Public Policy*, 18353-361.
- Dosi, G. and L. Marengo (1993). "Some Elements of An Evolutionary Theory of Organisational Competences", in: R.W. England (1994).
- Dosi, G., S. Fabiani, R. Aversi and M. Meacci (1994). "The Dynamics of International Differentiation: A Multi-Country Evolutionary Model", *Industrial and Corporate Change*, (3)225-242.
- Dosi, G., C. Freeman and S. Fabiani (1994). "The Process of Economic Development: Introducing Some Stylized Facts and Theories on Technologies, Firms and Institutions", *Industrial and Corporate Change*, (3)1-46.
- Dosi, G., L. Marengo, A. Bassanini and M. Valente (1994). "Norms as Emergent Properties of Adaptive Learning. The Case of Economic Routines", Working Paper, WP-94 -73, Laxenburg, Austria.
- Dosi, G. and R.R. Nelson (1994). "An Introduction to Evolutionary Theories in Economics", *Journal of Evolutionary Economics*, 4: 153-172.
- Dosi, G. (1995). "Hierarchies, Markets and Power: Some Foundational Issues on the Nature of Contemporary Economic Organisations", *Industrial and Corporate Change*, 4: 1-19.
- Dosi, G., O. Marsili, L. Orsenigo and R. Salvatore (1995). "Learning, Market Selection and the Evolution of Industrial Structures", *Small Business Economics*, forthcoming.
- Dupuy, J.P. (1980). "Convention et Common Knowledge", *Revue économique*, 40(2)381-400.
- Dupuy, J.P., F. Emard-Duvernay, O. Favereau, A. Orlean, R. Salais, and L. Thevenot (1989). "L'économie des conventions", *Revue économique*, 40(2).
- Eggertsson, T. (1990). *Economic Behaviour and Institutions*, Cambridge University Press, Cambridge.
- Egidi, M. (1994). *Routines, Hierarchies of Problems, Procedural Behaviour: Some Evidence from Experiments*, IIASA Working Paper WP-94-58, Laxenburg, Austria.
- Eliasson, G. (1986). "Micro-Heterogeneity of Firms and Stability of Industrial Growth", in: England, R.W. (Ed.) (1994). *Evolutionary Concepts in Contemporary Economics*, Ann Arbor, University of Michigan Press.
- Fagerberg, J. (1994). "Technology and International Differences in Growth Rates", *Journal of Economic Literature*, (32)1147-1175.
- Favereau, O. (1986). "La formalisation du rôle des conventions dans l'allocation des ressources", in: R. Salais (ed.) *Le travail. Marchés, règles, conventions*, INSEE-Economica, Paris.
- Fontana, W. and L. Buss (1994). "The Arrival of the Fittest: Toward a Theory of Biological Organisation", *Bulletin of Mathematical Biology*, 1-64.
- Fontana, W. and L. Buss (1994a). "What Would Be Conserved If the 'Tape Were Run Twice!'. *Proc. Nat. Acad. Sci., USA*.
- Freeman, C. (1982). *The Economics of Industrial Innovation*, 2nd edition, Francis Pinter, London.
- Freeman, C. and C. Perez (1988). "Structural Crises of Adjustment", in: Dosi et. al.
- Freeman, C. (1994). "The Economics of Technical Change", *Cambridge Journal of Economics*, 18463-514.
- Granstrand, O. (ed) (1994). *The Economics of Technology*, Amsterdam, Elsevier/North Holland.
- Grandstad, G. and P. Selle (1995), "Cultural Theory and the New Institutionalism", *Journal of Theoretical Politics*, (7)5-27.

- Granovetter, M. (1985). "Economic Action and Social Structure: The Problem of Embeddedness", *American Journal of Sociology*, **91**: 481-510.
- Hamilton, G.G. and R.C. Feenstra (1995). "Variety of Hierarchies and Markets: An Introduction", *Industrial and Corporate Change*, **4**: 51-91.
- Hanusch, H. (1988) (Ed.). *Evolutionary Economics*, Cambridge University Press.
- Hayek, F. (1937). "Economic and Knowledge", *Economica*, **4**.
- Hodgson, G. (1988). *Economics and Institutions*, Cambridge, Polity Press; Philadelphia, PA, University of Pennsylvania Press.
- Hodgson, G. (1993). *Economics and Evolution*, Cambridge, Polity Press; Ann Arbor, MI, Michigan University Press.
- Holland, J.H., K.J. Holyoak, R.E. Nisbett and P.R. Thagaro (1986). *Induction*, Cambridge, MA, MIT Press.
- Jessop, B. (1989). "Regulation Theories in Retrospect and Prospect", *Economics et Sociétés*, **(4)**7-62.
- Kaniovski, Y. and P. Young (1994). "Learning Dynamics in Games with Stochastic Perturbations", IIASA Working Paper, WP-94-30; forthcoming in *Games and Economic Behaviour*, 1995.
- Klepper, S. (1993). "Entry, Exit, Growth and Innovation over the Product Cycle", Carnegie-Mellon University, Working Paper.
- Kuran, T. (1991). "Cognitive Limitations and Preference Evolution", *Journal of Institutional and Theoretical Economics*.
- Lane, D. (1993). "Artificial Worlds and Economics", Parts I and II, *Journal of Evolutionary Economics*, **3**: 89-107 and 177-197.
- Langlois, R.N. (ed.) (1986). *Economics As a Process. Essays in the New Institutional Economics*, Cambridge/New York, Cambridge University Press.
- Lesourne, J. (1991). *Ordre et Désordre*, Economica, Paris.
- Levinthal, D. (1990). "Organisational Adaptation and Environmental Selection. Interrelated Processes of Change", *Organisation Science*, **(2)**140-145.
- Lewis, D.K. (1969). *Convention: A Philosophical Study*. Cambridge, Harvard University Press, 213p.
- Lindgren, R. (1992). "Evolutionary Phenomena in Simple Dynamics", in: C.G. Langton (ed.) *Artificial Life II. Proc. Interdisciplinary Workshop on the Synthesis and Simulation of Living Systems* at Los Alamos, February 1990, Addison-Wesley, Redwood City, pp. 295-312.
- Lordon, F. (1993). Endogenous Structural Change and Crisis in a Multiple Time-Scales Growth Model, CEPREMAP Working Paper 9324, Paris.
- Lundvall, B.A. (ed.)(1992). *National Systems of Innovation*, London, Francis Pinter.
- Malerba, F. and L. Orsenigo (1994). "The Dynamics and Evolution of Industries", Laxenburg, Austria, IIASA, Working Paper, WP-94-120.
- March, J.G. and J.P. Olsen (1989). *Rediscovering Institutions. The Organizational Basis of Policies*, New York, Free Press.
- Marengo, L. (1992). "Coordination and Organisational Learning in the Firm", *Journal of Evolutionary Economics*, **(2)**313-326.
- Marengo, L. and H. Tordjman (1995). "Speculation, Heterogeneity and Learning: A Model of Exchange Rate Dynamics", IIASA Working Paper, WP-95-17, Laxenburg, Austria.

- Metcalfe, S. (1992). Variety, Structure and Change. An Evolutionary Perspective on the Competitive Process”, *Revue d’Economie Industrielle*, (65)46–61.
- Mokyr, J. (1990). *The Lever of Riches*, Oxford, Oxford University Press.
- Nakicenovic, N. and A. Grübler (eds.) (1992). *Diffusion of Technologies and Social Behaviour*, Berlin/Heidelberg/New York, Springer Verlag.
- R. Nelson and S. Winter (1982). *An Evolutionary Theory of Economic Change*, Bellkap Press of Harvard University Press, Cambridge (Mass.).
- Nelson, R.R. (1987). *Understanding Technical Change As An Evolutionary Process*, North Holland.
- Nelson, R.R. and G. Wright (1992) “The Rise and Fall of American Technological Leadership: The Post-War Era in Historical Perspective”, *Journal of Economic Literature*, (30)1931–1964.
- Nelson, R.R. (ed.) (1993). *National Innovation Systems. A Comparative Study*, Oxford/New York, Oxford University Press.
- Nelson, R. (1995). “Recent Evolutionary Theorizing about Economic Change”, *Journal of Economic Literature*, 33: 48–90.
- North, D. (1990). *Institutions, Institutional Change and Economic Performance*, Cambridge, Cambridge University Press.
- North, D. (1991). “Institutions”, *Journal of Economic Perspectives*, (5)97–112.
- Orlean, A. (ed.) (1994). *L’economie des conventions*, PUF, Paris.
- Palmer, R.G., W.B. Arthur, J.H. Holland, B. LeBaron and P. Taylor (1994), “Artificial Economic Life: A Simple Model of a Stockmarket”, *Physica D*, (75)264–274.
- Patel, P. and K. Pavitt (1994). “Uneven (and Divergent) Technological Accumulation among advanced Countries: Evidence and a Framework of Explanation”, *Industrial and Corporate Change*, (3)759–.
- Pavitt, K. (1984). “Sectoral Patterns of Innovation: Toward a Taxonomy and a Theory”, *Research Policy*, 13343–375.
- Reynaud, B. (1992). *Le Salaire, La Régie et le Marché*, C. Bourgois (ed.), Paris.
- Reynaud, B. (1992). *Le Salaire, La regle et Le Marché*, C. Bourgois (ed.), Paris.
- Reynaud, B. (1992). *Les nouvelles Théories du Salaire*, La Découverte, Collection Repères, Paris.
- Rosenberg, N. (1976). *Perspectives on Technology*, Cambridge, Cambridge University Press.
- Rosenberg, N. (1982). *Inside the Blackbox*, Cambridge, Cambridge University Press.
- P. Saviotti and S. Metcalfe (eds.) (1991). *Evolutionary Economics*, London/Chur, Harwood Academic Press.
- Schwartz, M. and M. Thompson (1990). *Divided We Stand. Redefining Politics, Technology and Social Choice*, Brighton, Harvester Wheatsheaf.
- Silverberg, G. (1987). “Technical Progress, Capitala Accumulation and Effective Demand: A Self-Organization Model”, in: D. Batten, J. Casti and B. Johansson (eds.), *Economic Evolution and Structural Adjustment*, Berlin/New York, Springer Verlag.
- Silverberg, G., G. Dosi and L. Orsenigo (1988). “Innovation, Diversity and Diffusion. A Self-Organisation Model”, *Economic Journal*, (98)1032–1054.
- Silverberg G. and L. Soete (eds.) (1993). *The Economics of Growth and Technical Change: Technologies, Nations, Agents*, Aldershot, Edward Elgar.

- Silverberg, G. and B. Verspagen (1994). "Learning, Innovation and Economic Growth. A Long-Run Model of Industrial Dynamics", *Industrial and Corporate Change*, (3)199–223.
- Silverberg, G. and B. Verspagen (1995). "Evolutionary Theorizing on Economic Growth", IIASA Working Paper WP-95-78; forthcoming in K. Dopfer (ed.), *The Evolutionary Principles of Economics*, Norwell, MA, Kluwer Ac. Publishers.
- Silverberg, G. and B. Verspagen (1995a). "From the Artificial to the Endogenous: Modelling Evolutionary Adaptation and Economic Growth", IIASA, Working Paper, WP-95- , Laxenburg, Austria.
- Solow, J.A. (1990). *The Labour Market As A Social Institution*, Basil Blackwell.
- Tordjman, H. (1993). *Dynamiques spéculations, hétérogénéité des agents et apprentissage: le cas des taux de change*. Thèse CEFI, Université d'Aix-Marseille II, Janvier 1994.
- Utterback, J. and F. Suarez (1992). "Innovation, Competition and Market Structure", *Research Policy*, (21)1–21.
- Veblen, T. (1898). "Why Is Economics Not An Evolutionary Science?", *Quarterly Journal of Economics*, (12).
- Verspagen, B. (1993). *Uneven Growth Between Independent Economics. The Evolutionary Dynamics of Growth and Technology*, Aldershot, Avebury.
- Vincenti (1990). *What Do Engineers Do and How Do They Know It?*, Baltimore, Johns Hopkins University Press.
- Warglien, M. (1995). "Hierarchical Selection and Organisational Adaptation", *Industrial and Corporate Change*, (4)161–186.
- Williamson, O.E. (1975). *Market and Hierarchies*, New York, The Free Press.
- Williamson, O.E. and W.G. Ouchi (1981). "The Markets and Hierarchies and Visible Hand Perspectives", in: A.H. van de Ven and W.F. Joice (eds.) *Perspectives on Organisational Design and Behaviour*, Wiley, New York.
- Williamson, O.E. (1985). *The Economic Institutions of Capitalism*, New York, Free Press.
- Williamson, O.E. (1990). "The Firm As A Nexus of Treaties: An Introduction", in: M. Aoki, B. Gustafsson and O.E. Williamson (eds.), *The Firm As A Nexus of Treaties*, Sage Publications, London.
- Williamson, O.W. and S.G. Winter (1991). "The Nature of the Firm: Origins, Evolution, and Development", Oxford University Press.
- Williamson, O.E. (1995). Hierarchies, Market and Power in the Economy: An Economic Perspective", *Industrial and Corporate Change*, 4: 1–19.
- Winter, S.G. (1964). "Economical Natural Selection and the Theory of the Firm", *Yale Economic Essays*.
- Winter, S.G. (1982). "An Essay on the Theory of Production", in: S.H. Hymans (ed.), *Economics and the World Around It*, Ann Arbor, University of Michigan Press.
- Winter, S.G. (1984). "Schumpeterian Competition under Alternative Technological Regimes", *Journal of Economic Behaviour and Organisation*, (5)287–320.
- Winter, S.G. (1986). The Research Program of the Behavioural Theory of the Firm: Orthodox Critiques and Evolutionary Perspectives", in: B. Gilad and S. Kaish (eds.), *Handbook of Behavioural Economics*, Greenwich, Conn. JAI Press.
- Winter, S.G. (1987a). "Natural Selection and Evolution", *New Palgrave*, 3, Macmillan.
- Winter, S.G. (1987b). "Competition and Selection", *New Palgrave*, 2, Macmillan.
- Winter, S.G. (1995). Four R's of Profitability: Rents, Resources, Routines and Replication. IIASA Working Paper, WP-95-07, Laxenburg, Austria.

Witt, U. (Ed.) (1991). *Explaining Process and Change. Approaches to Evolutionary Economics*, Ann Arbor, University of Michigan Press.

Young, P. (1993). "The Evolution of Conventions", *Econometrica*, (61)57-84.