l. The institutional embeddedness of economic change: an appraisal of the 'evolutionary' and `regulationist' research programmes

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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 individuel agents, within and outside the economic grena? And what are institutions in the first place? How do they tome about and how do they change? What are the relationships between 'agency' and structure? And also, nearer economic concerns, what is the yole 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 with understanding economic change as a historical, institutionally embedded process.

This is what we shah attempt to do in this work, by discussing the links, overlapps, 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 of what we mean by those terms and of where we put the boundaries of different theories are in order. We shah introduce these, in a rather telegraphic fashion, in Sections 2-4. In Section 5 we sketch, as an illustration, interpretations of the 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 we 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 in Section 6. Finally, in Section 7 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.

2. EVOLUTIONARY THEORIES: SOME DEFINITIONS

For the purposes of this work we will 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 Hodgson (1993), Dosi and Nelson *(1994),* Nelson (1995), and Silverberg and Verspagen (1995a))

l. As Sidney Winter used to summarize it, the methodological imperative is dynamics first! That is, the explanation of why something exists tests intimately 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 micro founded, 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, and new organizational set-ups. Hence, also, the continuous appearance of various forms of novelty in the system.
6. Related to the last point, while (imperfect) adaptation and discovery generate variety (possibly in seemingly random fashion), 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]

This is not the place to review the growing number of contributions which share some or all of these seven broad methodological building blocks[3].

Suffice it te' 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): sec among others Dosi *et al.* (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 (1995a).

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 *et al.* (1987), Nakicenovic and Grübler (1992), and 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, sec 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 fins quite well the evolutionary conjectures outlined above (again, just as examples, sec Pavitt (1984), Utterback and Suarez (1992), Klepper (1993), Malerba and Orsenigo (1994), Winter (1984), and Dosi *et al.* (1995)).

Fifth, one is starting te' explore learning itself as an evolutionary process at the levels of both individuals and organizations (limiting ourselves te' economic applications, sec Marengo (1992), Marengo and Tordjman (1996), Lindgren (1992), Dosi *et al.* (1995b),

Levinthal (1990), Warglien (1995), and Palmer *et* al. (1994)). This links also with a wide tradition of studies in the fields of organizational economics which is impossible to review here (but sec the remarks in Winter 1986 and 1995).

Finally, there is a good overlap between the evolutionary perspective as we have defined it and various types of `self-organization' models (sec Lesourne (1991)), and also with the expanding field of evolutionary games (sec for example Young (1993), Kandori *et al.* (1993), and Kaniovski and Young (1994)). Short of any detailed discussion of analogies and differences (which will be briefly mentioned 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 organizations (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 subcategories will be made in the following when necessary.

The proposition that in a 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, and so on). But, clearly, the tricky issue is *in which sense* they count.

Simplifying to the extreme, two archetypical, opposing views can be found in all this 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 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 différent fashions, that institutions 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, for example, Granovetter (1985), and also Marchand Olsen (1989) and 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. The first 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 forwardlooking rationality or myopic adaptation). Conversely, under the former view, the existence of an institution is 'explained' relying much more heavily on the institutions that preceeded it and the mechanisms which led to the transition. One is also entitled to ask why people embedded in certain institutions behave the way they do (that is, how institutions shape their specific 'rationality' and equally specific perceptions of their interests).

The second dichotomy regards the degrees of intentionality of institutional constructions, that is, whether they are purposefully built according to some sort of collective *constitutional* activity or, conversely, are mainly the outcome of an unintentional *self-organization* process.

The third 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 1.1, one may identify différent *gradations of* institutionalism, ranging from *weak* forms retaining a lot of the canonic microfoundations to *strong 352 Innovation, Organization and Economic Dynamics*

forms wherein institutions have much more life of their own and also much more influence on what microentities think and do.

Table 1.1 Weak and strong varieties of institutionalism

	'Weak' Institutionalism	'Strong' Institutionalism
(1) Role of institutions	Parameterize system variables; contain menu of strategies	
(2) `Primitives' of the theory	(Perfectly or boundedly) rational self-seeking agents;	institutions as derived

entities

(3) Mechanisms of institution-formulation: Mainly intentional, 'constitutional', processes

(4) Efficiency properties: Institutions perform useful coordinating and governance functions; may be considered equilibria in some selection space

Also 'embed' cognitive and behavioural patterns; shape identities of actors

Institutions as `primitives'; forms of 'rationality' and perceptions of self-interest as derived entities

Mainly unintentional self-organization processes

Institutions as `carriers of history'; reproduce path-dependently, often irrespectively of this functional efficiency

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 plain that *routines* - which play a prominent role in evolutionary theorizing of economic behaviours - are shaped by the history of the organizations 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 a firm from Victorian Manchester are likely to be quite différent from those of American multidivisional corporations analysed by Alfred Chandler; that differences in the institutional contexts contribute to explaining 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 (see, 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, bas received little attention on its own (with the exception of those institutions more directly linked with innovative activities and notwithstanding the suggestions in Lundvall (1992) aiming to provide a broader institutional meaning for 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 such as 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 INSTITUTIONALIST 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, 1988b and 1990), Coriat (1991), Jessop (1990), and 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 socioeconomic regimes.[5]

For our purposes here, let us define diffèrent regimes of accumulation in ternis 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 govemance of industrial conflict; the existence and nature of union representation; the systems of wage formation; and so on.
2. The forms of *competition* in the product markets (whether nearly-competitive or oligopolist: the related mechanism of price formation; and so on).
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* (that is, the composition and changes in the baskets of consumption and their différences across social groups).
5. The forms of *state intervention* in the economy (for example, monetary and fiscal policies; 'state as arbiter' versus state as an active player with respect to social conflict, income distribution, welfare and so on).
6. The organization of the *international system* of exchanges (for example, the rules of international trade; the presence/absence of a single hegemonic power; the patterns of specialization; and so on).

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; the assessment of the conditions of their viability and eventual crises; the specific realizations of a dominant regime in différent 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 the nineteenth 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 great extent the *long term*, influenced by Marxism and the

French historical tradition of the *Annales*, and the emphasis is macroinstitutional: it is centred, 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, and so on.

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 types 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 (for example, 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 ascendency, 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 (for example, 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 `Verdoôrn-Kaldor law' apply to productivity growth? How sensitive are investments to profits as opposed to 'accelerator' effects? and so on). 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 (1993)) 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 as 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 patterns during the period after World War II.

5. SOME DIFFERENT THEORETICAL STORIES ON GROWTH, IN GENERAL, AND THE POST WAR PERIOD, IN PARTICULAR

It is revealing to compare the bare bones 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 a 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 différent behavioural rules and strategies (concerning, for example, pricing, investment, and so on) would then determine their differential revealed

performances (in terms, for example, of their profitability, market shares, or survival probabilities) and hence their ability to grow in the next 'period'. Aggregate growth, in this view, is essentially driven by technological advances. Similarly, the eye of the analyst is naturally led to look for the origins, nature and accessability of technological opportunities; the ease with which firms can imitate each other (that is, appropriability conditions); the ways firms are able to store and augment their knowledge (that is, the relationships between organizational 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 chape 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; and so on.

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 history-contingent specifications from the start). 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'lwelfare state or is it a laisser-faire one?, and so on) 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 organization of the socio-economic fabric. Hence, consistent matching fosters 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 is easily acknowledged that technological innovation is a major determinant of the division of labour and work organization; 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; and so on. 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 différence (which might be just a matter of emphasis or might be much more; sec below) emerges when handling the interpretation of specific historical circumstances. Compare, as an illustration, Nelson and Wright (1992) and Aglietta (1982) on American performance in this century (notwithstanding the only partial overlap between the two, with the former focused on technological performance and the latter, more broadly, on growth patterns). In brief, the Nelson-Wright story reconstructs the origins of American leadership after World War II, tracing it back te,

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 analysed 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 *et al. (1990),* Verspagen *(1993),* Amendola *et al. (1993),* and 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 economics 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 organization of product markets (which, combined with the wage dynamics described above, 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: the exhaustion of the potential for economies of scale; *inflationary* pressures amplified by wage formation mechanism; the entry of new competitors destabilizing cosy oligopolistic arrangements; increasing social conflict favoured by near-full-employment conditions; the collapse of the Bretton Woods regime; and so on,

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 *explanations* of the same phenomena? As we shall see, it is our conjecture that 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 différence in the `building blocks' of the basic stories outlined above relates to différent levels of observation and différent 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 *et al.* (1994a), Silverberg and Verspagen (1994) and the (far too modest!) overview in Silverberg and Verspagen (1995a)). Similarly, at 'meso' level - that is, that of single industries - evolutionary models have proved to be quite capable of interpreting statistical phenomena such as skewed distributions of firms by size, 'life cycle' patterns of evolution, inter-sectoral differences in industrial structures grounded in different 'technological regimes', and so on (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. Similarly, the degree 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 we have here a potentially fruitful complementarity concerning two différent 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 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 establishing the microeconomic conditions under which it emerges in the aggregate as a stable relation: for example 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 différent structural forms?

Similarly, with respect to wage formation mechanisms, the `structural forms' in the regulation account tend to postulate aggregate invariances, say in the elasticities of wages to unemployment, prices and productivity. Conversely, evolution-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 saine 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', historybased, specifications. Jokingly, we illustrate all this with the parallel 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 illustrates, first, the consistency in principle between the différent levels of description; second, the fact that a good deal of higher-level properties (for example, concerning cells' self-maintenance) can be understood as emerging properties from lower-level 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 ahistorical 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, and so on) evolutionary approaches and more top-down (aggregate, albeit institutionally richer) regulation ones is likely to be a formidable but analytically promising challenge.' Not only would it help to rigorously define the bridges between micro behaviours and entities at different levels of aggregation, but it would also highlight potential conflicts of interpretation which are currently often confused by level-of-description issues. Having said that, a few unresolved questions and areas of possible conflict come to mind.

The Descriptive Counterparts of Socio-Economic Regimes

We have already mentioned earlier that, in a sense, the regulation approach sets 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 statistical* identification of these regimes. Some work has been done in this direction, concerning especially long-term wage dynamics, but also labour productivity and demand formation (for surveys, see Chapter 10 by C. Leroy, Chapter 22 by M. Juillard and Chapter 23 by B. Amable in Boyer and Saillard (1995), and also Boyer (1988b)). However, a lot remains to be done - difficult as it is. For example, if phases of development and crises are traced back to the properties of underlying regimes, how are they revealed by the dynamics of statistical aggregates? And which ones? And at which level of aggregation? (for example, 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?

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 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 the 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 te, different degrees of difficulty). First, holding constant the system parameters concerning, for example, notional technological opportunities, one may ask what happens to aggregate dynamics if one changes behavioural routines (an early example is in Chiaromonte *et al.* (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

(for example, centralized versus pairwise forms of interaction; price-based competition versus selection based on multidimensional product attributes; bank-based versus market-based access to finance; and so on). In fact a major claim of both evolutionary and regulation theories is that markets are themselves institutional constructions whose organizational details deeply affect collective outcomes. However one knows very little of how markets actually work[8] and even less does one have taxonomies of sort of 'archetypes' of markets which can thereafter be stylized and formally explored. Third, one might allow for routines themselves to be learnt in different institutional environments 9. That would imply, in turn, the identification of distinct learning procedures in différent environments. Fourth (and harder), it might be time to explore in an evolutionary perspective other domains of economic activity (for example, the labour market, financial markets, the endogenous dynamics of consumer preferences, and so on).

Some Possible Misunderstandings: Microfoundations, Representative Agents and Methodological Individualism

In the argument se, far, an implicit assumption has been that the degrees of 'bottom-up-ness' or 'top-down-ness' (including the presence and details of interactions among lower-level entities with 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 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 a worker at factory X, a shareholder of company Y which owns that factory, and a 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 purs 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 Joneses, 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 at the workplace against the very practices that these same companies try to implement, and buy Japanese products even when that endangers 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', and so on). 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 Joneses (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 to 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 acknowledgment by the agents of the principles which govem 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 modelling) 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 te, be dispelled. The requirement of microfoundations of aggregate statements (that is, foundations in what a multitude of agents actually 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, first, that any collective state of the system 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,t^0 but we strongly deny the second. So for example, we are perfectly happy with 'microfoundations' which are themselves macrofounded, that is, where what 'people think and do' is *deeply but imperfectly* shaped by the organization and states of the system itself.

As an illustration consider the following toy model. Take a competitive world (as similar as possible to a Temporary General Equilibrium, of pure exchange - in order to make things simple). Suppose the state of the system, s(O) at time t(O) is defined by a price vector p(O) and allocations $w_i(0)$ to each agent i,(w_igS2(0)). 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) this yields well-defined transition laws to the price sequence p(1), p(2) . . . and S2(1), S2(2) . . . (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( ) and S2( ), 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, and so on. 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 itself.l t 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 socioeconomic fabric rests on the development and implementation of organizational routines. However, as we discuss at much greater length in Coriat and Dosi (1995), most organizational routines entail a double nature: on the one hand, they store and reproduce problem-solving competences, while, at the same time, they are also mechanisms of governance of potentially conflictual relations.

As it happens, the evolutionary appioach has focused 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 intelligence), but it has largely neglected the dimensions of power and control intertwined into the routines themselves.[12]

Almost the opposite applies to the regulation approach, which has tended to 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 Renault (or GM or United Biscuits ...) behaves' is inclined to account for operating procedures, mechanisms of knowledge accumulation, learning strategies, and so on leaving in the background phenomena like the conflict between different social groups, the links that particular organizational rules bear with income distribution and the exercise of power (well beyond their knowledge content), and so on. 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 Biscuits cakes, and they have got to do it well, and better over time. The risks of one-sided accounts are particularly great 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 related to this 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 1.1) are not so bad after all.

7. SOME CONCLUSIONS: TOWARDS 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 1.2, they run from a sort of 'nanoeconomics', wherein the abandonment of any magic of a perfect and invariant rationality forces a dialogue with cognitive and social psychology, organization theory, and sociology, all the way to grand historical conjectures on the long-term destinies of contemporary forms of socio-economic organization. Even a quick look at the table highlights the enormous gaps between what we know 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.

Table 1.2 Levels of analysis

	Objects of analysis (some still to be explored)	Examples of 'analytical styles'
Level 0- From nanoeconomics to micro-economics generally, behavioural norms	(i) Nature and origins of routines and, microanalytic part of Nelson and Winter (ii) Learning processes (1982); Cohen and Bacdayan (1994); Egidi (iii) Mechanisms of expectation formation (1994); organizational economic 'competences', and so on; Coriat (1994b); Dosi *et al.* (1994b); Marengo (1992); Warglien (1995); Marengo and Tordjman (1996); Possible economic applications of Fontana and Buss (1994a and b); and a lot to be done	From H. Simon to Holland *et al.* (1986);
	(iv) Nature and evolution of microorganizations (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'	
Level 1 - From microeconomics to aggregate properties	(i) Generic properties of growth fuelled by technical changes emergent statistical properties, for example, (ii) Industrial evolution	Explicit microfounded models with aggregate Nelson and Winter (1982); Silverberg and Verspagen (1994); Lesourne (1991); Dosi *et al.* (1995) (iv) The dynamics of consumption patterns
	(iii) Self-organizing properties of labour markets	
Level 2 - Aggregate dynamics	(i) Functional relations among aggregate variables	More 'stylized' but (hopefully) institutionally richer macro models (necessarily micro founded): from Keynesian/Kaldorian models to Boyer (1988a/b) and Silverberg (1987)
	(ii) Socio-economic regimes: consistency conditions among processes of economic adjustment and institutions	
Level 3-`Co-evolution'	(i) Co-evolutionary patterns between technologies, corporate organizations and broader institutions	A lot of appreciative theorizing from historians but relatively litde modelling (but see the suggestion in Nelson (1994) on industrial dynamics); a vast regulation-inspired empirical literature (cf. Boyer and Saillard (1995))
	(ii) Coupled institutional dynamics	
	(iii) 'Political discretionality' and institutional inertias	
Level 4-'Grand history'	General interpretative conjectures on long-term	From Karl Marx to ... Schumpeter ... to
historical patterns	Freeman and Perez (1988) ... to Aglietta (1982) and Boyer and Mistral (1978)	Qust to name the perspectives discussed in the work)

A first one concerns co-evolutionary processes. The essence of the co-evolutionary point is that what happens in each partly autonomous demain of the system (for example, 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 or description in order te demarcate that broad area covering, for example, the interactions between the forms of economic organization, 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 coevolutionary process between technologies, corporate organizations and supporting institutions (Nelson (1994)). Analogously, the origins of organizational routines (cf. above) is intimately a co-evolutionary process, shaped by diverse and probably conflicting selection criteria (that is, problem-solving versus governance requirements).

A second (and related) item which is high on the research agenda considers the transition across différent socio-economic regimes of growth: for example, at which level can such transitions be detected? (This will probably be conditional on the type of transition one is talking about.) What are the effects of 'higherlevel' changes (for example, in the institutional set-ups or in the policy environment) upon microeconomic behaviour? And, conversely, under what circumstances do non-average microbehaviours become 'autocatalytic' and eventually induce higher-level phase transitions? What kind of co-evolutionary processes do particular classes of transitions entail?

A third priority item, in our view, concerns what could be called, in 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) versus 'top-down' processes by which higher-level entities (for example, institutions, established mechanisms of interaction, etc.) shape/generate 'lower level' behaviours. One of the claims underlying this whole chapter 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 elaborate 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 macre, 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 priority attention. As Lundvall (in this volume) emphasizes 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, among others, Marengo (1992), Egidi (1994), Cohen and Bacdayan (1994), Marengo and Tordjman (1996) and also Dosi *et al.* (1994c), 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 modelling efforts. It is likely also to involve major adjustments in the building blocks of institutionalist/evolutionary theories themselves.

We are probably now witnessing 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, rather than the sectarian attitudes of chair committees or international journal editors.

NOTES

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1. Note, however, that there are a few 'aggregate' (that is, non-microfounded) models which are nonetheless 'evolutionary' in spirit (for a survey, see Silverberg and Verspagen (1995)).
2. On the notions of 'emergence' and 'metastability' cf. the discussion in Lane (1993).
3. Note 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.
4. To repeat, this is not meant to be a thorough review but just an approximate roadmap. Moreover, at least a partial overlap with the evolutionary archetype can be found in quite diverse fields of economic theory: sec for example Aoki (1995) and Stiglitz (1994).
5. A related perspective, which it 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.
6. Note that we do not mean only formal, mathematically expressed, `models', but also rigorous, albeit verbally expressed, theory-based propositions about whatever phenomena.
7. Broad historical interpretations building upon *a(ato sensu* evolutionary micrceconomics, such as Freeman and Perez (1988), might be considered as another point of departure of ibis dialogue.
8. A noticeable exception is Kirman and Vignes (1992) on the fish market in Marseille (!).
9. A simple adaptive learning mechanism nested in a macro model is presented in Silverberg and Verspagen (1995b). Much more constructive models of behavioural learning are in Marengo (1992), Marengo and Tordjman (1996) and Dosi *et al.* (1994c), but they are far from any macro model. Moreover, they, too, lack experiments on différent institutional specifications.
Note that, here, by routines we specifically mean those rules of thumb concerning such things as pricing, R&D, investments, and so on. It is a fundamental point of evolutionary theories that différent techniques are intimately associated also with différent 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).
10. We also want to emphasize the fact that we share the requirement *in principle,* even if it might tum out that in many circumstances the micro-macro link 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).
11. We have repeatedly stressed 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 out view, on the contrary, it is precisely imperfect adaptation which is an important source of dynamics.
12. This notwithstanding the acknowledgment of their importance: cf. for example, Nelson and Winter's definition of routines as truces among conflicting interests (Nelson and Winter (1982)).
13. In turn, as known, once the problem is posed in these terms it can be formally handled by means, for example, of '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 (1992)). 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).

14. A co-evolutionary view runs against, for example, 'technological determinism' (that is, technology proceeds exclùsively according to its inner logics, and institutions ought simply to adjust, with varying lags) but also `social determinism' (for example, 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, for example, the emerging trajectories of technical change as the outcome of such a coupling.

15. Incidentally, 'Bayesian' and `Pavlovian' learning have most characteristics in common since both claim (i) what Savage would have called a 'small world' hypothesis (the notional set of events and response strategies is given from the start); and (ü) there is a striking transparence of the links between actions and consequences. Hence, ultimately, the différence between the two just tests 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.

16. By 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, and to *obviousty* 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 regulation du capitalisme en longue période. L'exemple des Etats-Unis (1870-1970),* thesis, 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 regulation au Japon et Relations Internationales: de l'histoire longue aux transformations recentes', *Japon in Extenso, 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., J. Mazier 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', *Critique de l'Economie Politique, Revue,* Paris.

Boyer, R. (1986a), *La Théorie de la Regulation, une analyse critique,* Paris: La Découverte.

Boyer, R. (1986b), La *Théorie du travail en Europe,* Paris: La Découverte.

Boyer, R. (1987), 'Regulation', in *The New Palgrave,* London: Macmillan.

Boyer, R. (1988a), 'Technical change and the theory of "Regulation"', 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 J. Mistral (1978), *Accumulation, inflation et crise,* Paris: Puf.
Boyer, R. and A. Orlean (1991), `Les transformations des conventions salariales entre Théorie et histoire. D'Henry Ford au fordisme', *Revue Economique,* 42(2) (Mars), 233-72.
Boyer, R. and A. Orlean (1992), 'How Do Conventions Evolve?', *Journal of Evolutionary Economics.*
Boyer, R. and Y. Saillard (eds) (1995), *Théorie de la Regulation. L'état des savoir,* Paris: La Découvert.
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. and G. Dosi (1993), 'Heterogeneity, Competition and Macroeconomic Dynamics', *Structural Change and Economic Dynamics, 4, 39-6.*
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.
Cohen, M. and P. Bacdayan (1994), 'Organizational routines as stored procedural memory: evidence from a laboratory study', *Organization Sciences,* 5, 554-68.
Commons, J.R. *(1934), Institutional Economics,* University of Wisconsin Press, Madison.
Conlisk, J. (1989), `An aggregate model of technical change', *Quarterly Journal of Economics,* 104, 787-821.
Coriat, B. (1982), *L'atelier et le Chronomètre,* Paris: Bourgeois. Coriat, B.
(1990), *L'atelier et le Robot,* Paris: Bourgeois.
Coriat, B. (1991-94), *Penser à l'Envers - Travail et Organisation dans la firme Japonaise, C.* Bourgois; 2nd revised edition Bourgois/Choix 1994.
Coriat, B. (1993), `L'hypothèse du Compagnie-isme', *Mondes en Developpement Revue,* no. 4, Paris.
Coriat, B. (1994a), `La Théorie de la Régulation. Origines, Specificites, Enjeux', in *Future Antérieur,* Paris, L'Harmattan; special issue of *Théorie de la Regulation et critique de la Raison Economique.*
Coriat, B. (1994b), '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. Hagstmm and Ô. S61vell (eds), *The Dynamic Firm,* Oxford, Oxford University Press.
Coriat, B. and O. Weinstein (1995), *Les nouvelles Theories de l'Entreprise,* Paris: Hachette.
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,* 139-80.
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,* Paris: Seuil.

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. A suggested interpretation of the Determinants and Directions of technical change and the transformation of the economy', *Research Policy,* Match.

Dosi, G. (1984), Technical Change and Industrial Transformation, London: Macmillan.

Dosi, G. (1988), `Sources, procedures and microeconomic effects of innovation', *Journal of Economic Literature, 26,* 126-73.

Dosi, G. (1991), `Perspectives on evolutionary theory', *Science and Public Policy.* 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. and M. Egidi (1991), `Substantive and procedural uncertainty. An exploration of economic behaviours in changing environments', *Journal of Evolutionarv Economics.*

Dosi. G. and L. Marengo (1994), 'Some elements of an evolutionary theory of organisational competences', in R.W. England (ed.), *Evolutionary Concepts in Contemporarv Economics,* Ann Arber: University of Michigan Press.

Dosi, G. and R.R. Nelson (1994), `An introduction to evolutionary theories in economics', *Journal of Evolutionary Economics, 4,* 153-72.

Dosi, G., K. Pavitt and L. Soete (1990), *The Economics of Technological Change and International Trade,* Brighton: Wheatsheaf; New York: New York University Press.

Dosi, G., S. Fabiani, R. Aversi and M. Meacci (1994a), `The dynamics of international differentiation: a multi-country evolutionary model', *Industrial and Corporate Change,* 3, 225-*42.*

Dosi, G., C. Freeman and S. Fabiani (1994b), '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 (1994c), 'Norms as Emergent Properties of Adaptive Learning. The Case of Economic Routines', Working Paper, WP-94 -73, Laxenburg, Austria.

Dosi, G., O. Marsili, L. Orsenigo and R. Salvatore (1995), `Learning, market selection and the evolution of industrial structures', *Small Business Economics.*

Dosi, G., C. Freeman, R.R.Nelson, G. Silverberg and L. Soete (eds) (1988), *Technical Change and Economic Theory,* London: Francis Pinter: New York: Columbia University Press.

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 economique,* 40(2).

Eggertsson, T. (1990), *Economic Behaviour and Institutions,* Cambridge: Cambridge University Press.

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 R. Day and G. Eliasson (eds), *The Dynamics of Market Economics,* Amsterdam: North Holland.

England, R.W. (ed.) (1994), *Evolutionary Concepts in Contemporary Economics,* Ann Arbor: University of Michigan Press.

Fagerberg, J. (1994), 'Technology and international différences in growth rates',.*lournal of*

Economic Literature, 32, 1147-75.
Favereau, O. (1986), `La formalisation du role des conventions dans l'allocation des ressources', in R. Salais (ed.), *Le travail. Marches, règles, conventions,* Paris: INSEE-Economica.
Fontana, W. and L. Buss (1994a), "The arrival of the fittest": toward a theory of biological organisation', *Bulletin of Mathematical Biology,* 1-64.
Fontana, W. and L. Buss (1994b), 'What would be conserved if the "Tape Were Run Twice!"', *Proc, Nat. Acad. Sci.,* USA.
Freeman, C. (1982), *The Economics of/ndustrial Innovation,* 2nd edn, London: Francis Pinter.
Freeman, C. (1994), 'The economics of technical change', *Cambridge Journal of Economics,* 18, 463-514.
Freeman. C. and C. Perez (1988), `Structural crises of adjustment', in Dosi *etal.* (1988).
Granovetter, M. (1985), 'Economic action and social structure: the problem of embeddedness', *American Journal of Sociology,* 91, 481-510.
Granstrand, O. (ed.) (1994), *The Economics of Technology,* Amsterdam, Elsevier/North Holland.
Grendstad, G. and P. Selle (1995), `Cultural theory and the new institutionalism', *Journal of Theoretical Politics, (7),* 5-27.
Hamilton, G.G. and R.C. Feenstra (1995), 'Variety of hierarchies and markets: an introduction', *Industrial and Corporate Change, 4,* 51-91.
Hanusch, H. (ed.) (1988), *Evolutionary Economics,* Cambridge: Cambridge University Press.
Hayek, F. (1937), 'Economics and Knowledge', *Economica, 4.*
Hodgson, G. (1988). *Economics and Institutions,* Cambridge: Polity Press; Philadelphia: University of Pennsylvania Press.
Hodgson, G. (1993), *Economics and Evolution,* Cambridge: Polity Press; Ann Arbor: Michigan University Press.
Holland, J.H., K.J. Holyoak, R.E. Nisbett and P.R. Thagaro (1986), *Induction,* Cambridge, Mass.: MIT Press.
Jessop, B. (1990), 'Regulation theories in retrospect and prospect', *Economy and Sociery,* 19(2), 153-216.
Kandori, M., G.J. Mailath and R. Rob (1993), 'Leaming, mutation and long run equilibria in games', *Econometrica,* 61, 29-56.
Kaniovski, Y. and P. Young (1995), `Learning Dynamics in Games with Stochastic Perturbations', *Games and Economic Behaviour.*
Kirman, A.P. and A. Vignes (1992), 'Price dispersion: theoretical considerations and empirical evidence from the Marseille fish market', in K. Arrow (ed.), *Issues in Contemporary Economics, vo1.I,* London: Mcmillan.
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 oflnstitutional and Theoretical Economics.*
Lane, D. (1993), `Artificial worlds and economics', Parts I and II, *Journal of Evolutionary Economics,* 3, 89-107 and 177-97.
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,* Paris: Economica.
Levinthal, D. (1990), 'Organisational adaptation and environmental selection: interrelated processes of change', *Organisation Science, 2,* 140-5.

Lewis, D.K. (1969), *Convention: A Philosophical Study*, Cambridge, Mass.: Harvard University Press.
Lindgren, R. (1992), 'Evolutionary phenomena in simple dynamics', in C.G. Langton (ed.), *Artificial Life 11.*, Redwood City: Addison-Wesley.
Lordon, F. (1993), 'Endogenous Structural Change and Crisis in a Multiple TimeScales Growth Model', CEPREMAP Working Paper 9324, Paris.
Lundvall, B.-Â. (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.
Match, 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, 313-26.
Marengo, L. and H. Tordjman (1996), 'Speculation, Heterogeneity and Learning: A Model of Exchange Rate Dynamics', Kyklos.
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.
Nelson, R.R. (1987), *Understanding Technical Change As An Evolutionary Process*, Amsterdam: North Holland.
Nelson, R.R. (ed.) (1993), *National Innovation Systems: A Comparative Study*, Oxford/New York: Oxford University Press.
Nelson, R.R. (1994),' The co-evolution of technology, industrial structure, and supporting institutions', *Industrial and Corporate Change*, 3, 47-63.
Nelson, R. (1995), 'Recent evolutionary theorizing about economic change', *Journal of Economic Literature*, 33, 48-90.
Nelson, R. and S. Winter (1982), *An Evolutionary Theory of Economic Change*, Cambridge, Mass.: Bellkap Press of Harvard University Press.
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*, 30,1931-64.
North, D. (1990), *Institutions, Institutional Change and Economic Performance*, Cambridge: Cambridge University Press.
North, D. (1991), `Institutions', *Journal of Economic Perspectives*, 75, 264-74. Orlean, A. (ed.) (1994), *L'économie des conventions*, Paris: PUF.
Palmer, R.G., W.B. Arthur, J.H. Holland, B. LéBaron and P. Taylor (1994), 'Artificial economic life: a simple model of a stockmarket', *Physica D*, 75, 264-74.
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, I. (1984), `Sectoral patterns of innovation: toward a taxonomy and a theory', *Research Policy*, 13, 343-75.
Reynaud, B. (1992), *Le Salaire, La règle et Le Marché, C.* Bourgois: Paris.
Reynaud, B. (1992c), *Les nouvelles Théories du Salaire*, Paris: La Découverte, Collection Repères.
Rosenberg, N. (1976), *Perspectives on Technology*, Cambridge: Cambridge University Press.

Rosenberg, N. (1982), *Inside the Black Box,* Cambridge: Cambridge University Press. Saviotti, P. and S. Metcalfe (eds) (1991), *Evolutionary Economies,* London/Chur: Harwood Academic Press.
Schwartz, M. and M. Thompson (1990), *Divided We Stand: Redefining Polities, Technology and Social Choice,* Brighton: Harvester Wheatsheaf.
Silverberg, G. (1987), 'Technical progress, capital 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. 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 (1995a), 'Evolutionary Theorizing on Economic Growth', IIASA Working Paper WP-95-78j; forthcoming in K. Dopfer (ed.), *The Evolutionary Principles of Economics,* Kluwer.
Silverberg, G. and B. Verspagen (1995b), 'From the Artificial te the Endogenous: Modelling Evolutionary Adaptation and Economic Growth', IIASA, Working Paper, WP-95-, Laxenburg, Austria.
Silverberg, G., G. Dosi and L. Orsenigo (1988), `Innovation, diversity and diffusion: a self-organisation model', *Economic Journal,* 98, 1032-54.
Solow, J.A. (1990), *The Labour Market as a Social Institution,* Basil Blackwell. Stiglitz, J.E. (1994), 'Economic growth *revisited', Industrial and Corporate Change, 3,* 65-110.
Tordjman, H. (1993), *Dynamiques spéculations, hétérogénéité des agents et apprentissage: le cas des taux de change,* Thèse CEFI, Universite 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, W. (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-$6.
Williamson, O.E. (1975), *Market and Hierarchies,* New York: Free Press. 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 Trearies,* London: Sage.
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,* New York: Wiley.
Williamson, O.E. (1995), 'Hierarchies, market and power in the economy: an economic perspective', *Industrial and Corporate Change, 4,* 21-50.
Williamson, O.W. and S.G. Winter (1991), *The Nature of the Firm: Origins, Evolution, and Development,* Oxford University Press.
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, 59-84.