# INSTITUTIONS AND MARKETS IN A DYNAMIC WORLD[*]

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## I INTRODUCTION

This article concerns the rote of institutions and policies and their relationship with market processes in open economies characterized by various forms of technological change.

The approach which is most familiar to the contemporary economic discipline essentially consists of a proses of reduction of institutional and policy issues to exceptions, anomalies and particular cases of a general framework centred around the equilibrium conditions of the economic system postulated by the theory. The impact of policies and institutions is evaluated on the grounds of a yardstick-the equilibrium which the economy would achieve if left to itself-under very special and sometimes rather awkward hypotheses, whose properties, nonetheless, are such as to yield "optimal" outcomes. In this well worked-out and widely-accepted strategy, any normative issue, phenômenon or behaviour is compared with that fundamental yardstick and, *by différence,* one also defines the rote and impact of policies. Thus, the economist commonly uses concepts like "externalities", "market failures", "limited information", "imperfect markets", etc., to categorize the most common "sub-optimal" features of the empirical world as compared with the theoretical model. In a very peculiar overlapping of positive and normative: judgements, these "imperfections" of the real world also delimit the domain of institutional intervention, which-it is claimed-should make the world more similar to the theory. Generally, the economics profession likewise treats in a similar fashion the problems related to technological and economic change, assessing, for example, the degree of "market failure" associated with technological uncertainty, the "market imperfection" stemming from property rights on innovation, etc.

The leap from the core theoretical model on which welfare conclusions are generally based to the properties of actual economic systems is a tremendous one: yet, the correspondence between the fundamental hypotheses of the model (on behaviours, technology, interactions between the agents, etc.) and the "stylized facts" of the world is often treated rather casually, and sometimes with the irritation that discussions on methodological issues provoke among the practitioners of the discipline[1]. Yet, in the history of the economic discipline this has not always been so.

Two to three centuries ago, when political economy was emerging as an autonomous discipline, more or less contemporary to the emergence of a "market society"[2] and of a

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[1] Notably, the "Founding Fathers" of modern General Equilibrium Analysis are generally well aware of the gap between the cote theory and the interpretation of empirical economic phenomena. However, one finds much less caution amongst the "normal scientists"-in a Kuhian sense-of the discipline: compare, for example, Hahn (1984) with a random sample of articles in the main economic journals.

[2] Cf. Polanyi (1944) and (1971). See also Hirschman (1982).

capitalist mode of production, one of the intellectual concerns was the status, function and social implications of the free pursuit of private interests and their relationship with other forms of social coordination. Adam Smith's Invisible Hand related to a fundamental conjecture on the mechanisms of impersonal coordination occurring in decentralized markets. Yet, it was clear among classical writers that strictly non-economic variables and institutions established particular rules of interaction and "meta-codes" of behaviours which were necessary conditions for a satisfactory collective outcome of individual self-seeking attitudes, in terms of collective welfare and dynamic performance of the economy.[3] However, those background conditions which allow the consistency of individual behaviours and their dynamic progressiveness (in a sense, the factors accounting for the "moral" and political constitution of relatively efficient market societies) generally remained a concern of political thinkers, philosophers, sociologists and anthropologists (from the Scottish social thinkers to Hegel and Tocqueville and, later, Weber, Polanyi and Luhmann) but steadily disappeared from the explicit attention of economics.

In tune with some insights of early political economists and drawing from a few more recent contributions, we are going to suggest a framework of analysis of institutions which is in its essence *non-reductionist.* The heuristics of this second class of approaches we are thinking of are based on four fundamental hypotheses, namely (a) behaviours (and their outcomes) cannot adequately be represented by the simple and universel rationality of the *homo oeconomicus* postulated by the prevailing economic theory; (b) markets and economic processes occurring within them are themselves institutional setups specific to historical periods, cultures, countries, etc.; (c) there are particular combinations between *lato sensu* institutions and market processes which efficiently "match" in terms of some (but most likely not all) performance yardsticks; (d) non-market variables (including, of course, policies in the strict sense) are a permanent feature of the *constitution* of the economic system and an essentiel part of the ways the economic machine is "tuned" and evolves.[4]

Innovation, change, transformation represent almost a crucial experiment for the relative adequacy of the "reductionist" and "nonreductionist" approaches. For exemple, is the prevailing frame of economic thought capable of accounting for the process of technological innovation? Can we elaborate non-trivial propositions, on both positive and normative levels, regarding the role and effect of policies in relation to economic change? What accounts for the Tact that different countries show systematically different capabilities of innovating and economically exploiting the innovations?

By way of an introduction, consider two rather well-known exemples against which the achievements and limitations of the "reductionist" and "non-reductionist" approaches can be assessed.

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[3] Cf., for example, Adam Smith's *Theory of Moral Sentiments* (1976) and the discussion in Cropsey (1957). (For fascinating analyses of the "economic anthropology" of the modem economy, see Dumont, 1977, and Hirschman, 1977.) Other challenging (and very different) analyses of the functions and characteristics of the economic domain within the general social fabric are the classic work of de Tocqueville (1969) and, by contemporary authors, Luhmann (1975) and Hirsch (1976). These are only few examples of several ambitious attempts of modern social sciences to answer two fundamental questions which have puzzled Western thought at least since the eighteenth century, namely (a) under what conditions is the free pursuit of private interests consistent with the orderly reproduction of society and what kinds of social organization does it produce; and conversely (b) what are the forms of social organization and norms which allow an orderly expansion of the economy? However, contemporary economic discipline has been conspicuously absent from the debate. (For one of the few cases of dialogue between economics and other social disciplines on these challenges, see the review by Hahn of the cited work of Hirsch, in Hahn, 1984.)

[4] These issues are discussed at greater length, with different perspectives, in Nelson and Winter (1982); Boyer and Mistral (1983); and Dosi and Orsenigo (1985).

To illustrate, consider one of the most famous explanations of the différences in the growth record of developed economies, namely the so-called "growth accounting exercises.[5] For this purpose, one uses all the variables strictly consistent with the "proper" economic model (the primary endowments of each economy and their change through time), some variables which in the theoretical model would be considered "imperfections" (economies of scale, etc.) and some spurious variables which can be squeezed into economies with some considerable unease (the "endowment of education", etc.). Here, one can see the reductionist programme at its best: paraphrasing Kindleberger, one tries to account for the degree to which the higher efficiency of the "endowment" École Politechnique in France compensates for the louver throughput of French coal mines, or the ways the Italien entrepreneurship compensates for the lower endowments of "capital" or "civil service competence"....[6] Yet, one is left with a large unexplained residual, sometimes called "technical change". In actual fact, the questions one begins with remain mostly unanswered: why the disappointing British economic performance or the impressive Japanese growth? Why did Italy not become another Japan? Is the U.S. technological and economic performance getting weaker? And so on.

The second example, even more fundamental and nearer to the concerns of this paper, concerns technical change. It is well recognized in the economic literature that the very existence of innovation *requires* a "market failure" in the static allocative sense: in decentralized markets, the incentive to innovate needs some kind of asymmetric information and super-normal profits.

Certainly, in the history of economic thought, there are "heretic" attempts to investigate the phenomena of innovation and change as central features of modern economic systems-notably Schumpeter (1961) and (1975)-and in contemporary economics-Nelson and Winter (1982).

However, in a curious paradox, most policy analyses remain based on a theoretical yardstick-the efficiency properties of decentralized processes of allocation under very special and generally stationary conditions-which seems strikingly inappropriate for dealing with innately dynamic phenomena such as technical change over time and across countries.[7]

In what follows here, we will suggest some propositions on the relationship between technical change and market processes (Section II) and explore the role of policies and institutions in both closed and open economies under all those circumstances when change and transformation are permanent and fundamental features of the system (Section III).

## II SEVEN PROPOSITIONS ON TECHNICAL CHANGE, MARKETS AND INSTITUTIONS

*Proposition 1*

Building on the works on technical change, among others, of Freeman (1974); Nelson and Winter (1977); Nelson (1982); and Rosenberg (1976), we have tried to show elsewhere that the process of technological change is an activity characterized by partly tacit knowledge and highly selective heuristics. Technical progress generally proceeds along rather precise "trajectories", linked by major discontinuities associated with the emergence of new "technological paradigms".[8] Whenever new paradigms emerge, the material technology, the

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[5] Cf. Denison (1967). For a discussion of the same example within an analysis of economic methodology, cf. Salvati (1985).
[6] Cf. Salvati (1985).
[7] See, for example, standard industrial economics textbooks. A similar observation is discussed in Silva (1984).
[8] Cf. Dosi (1984) and Dosi and Orsenigo (1985) for a more analytical discussion of this and the following points.

relevant tasks which are meant to be fulfilled, the heuristics ("where to go" and "where not to go"), the required knowledge skills and equipment, the relevant dimensions of "progress", all contextually change.

 *Technology, far from being a free good, inuolues a fundamental learning aspect, characterized-following* Nelson and Winter *(1982)-by varying degrees of cumulativeness, opportunity, appropriability.* This is our first proposition. Both appropriability and cumulativeness of technical change are affected by the degrees of *tacitness* and the degrees of *formal understanding* of each technology (see Nelson and Winter, *1982).* The more a technology is tacit (i.e., it involves idiosyncratic capabilities-e.g., the experience-based skills of designing particular machines for particular conditions of use, etc.), the higher the difficulty in transmitting it in the form of blueprints or even to imitate it without a painstaking process of informal learning. (For a discussion of the underlying theory of production, see Winter, *1982.)* An implication is that, at any point in time, différent companies and countries are likely to be characterized by différent technical coefficients and product technologies. These différences do not essentially relate to différent factor combinations along a single production function, but to proper technological gaps/leads in relation to a given trajectory of technological progress. In another work,[9] we discuss some empirical evidence on the subject: even within the group of OECD countries, the general case is (i) relatively wide international gaps in labour productivity and innovative capabilities, and (ü) the absence of any significant relationship between these gaps and international différences in the capital/output ratios. This is to say that différences in input coefficients generally represent différent techniques which can often be unequivocally ranked irrespective of relative prices. The process of development is strictly associated with the inter- and intra-national diffusion of "superior" techniques (see Nelson, *1968).* Thus, at each point in time, there are, in general, one or very few "best practice" techniques of production which correspond to the "technological frontier". Relatedly, the description of the production structure in the short term, by means of fixed coefficients, is a reasonable approximation to the *irreuersibility properties* of evolutionary economic processes that occur in real time.


*Proposition 2*

A fundamental implication of such a view of technology and technical change is that there are *widespread asymmetries in the technological capabilities, input efficiencies and product performances between firms and between countries;* these asymmetries correspond to *equiülly uneven patterns of economic signals facing the economic agents.* This is our second proposition. The asymmetries in capabilities are a direct consequence of the cumulative idiosyncratic and partly appropriable nature of technological advances. The more cumulative are technological advances at firm-level, the higher the likelihood of "success breeding success" *(cf.* Nelson and Winter, 1982, for a formalization). Moreover, the higher the opportunity for technological progress, *ceteris paribus,* the higher the possibility of relatively bigger "technological gaps" between successful innovators and laggard firms. In general, the evolution over lime of these asymmetries will depend on the relative rates of innovation and of diffusion and, thus, on the degrees of innovative opportunity, cumuiativeness and appropriability which characterizes any one particular technology. Notably, the standard textbook case of industries composed of technologically identical firms is the limiting case in which innovation stops and thus evolutionary dynamics ceases to be relevant.

These features of technical change also determine the nature of the economic signals that

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[9] See Dosi, Pavitt and Soete (1988).

firms face, so that, for example, a high technological opportunity, associated with a high degree of appropriability of technological innovation may well perform as a powerful incentive to innovate (related to high expected profitabilities and market shares) for a company which is on or near the technological frontier, being at the same time a powerful *negative* signal (an entry barrier) for a company with relatively lower technological capability.

*Proposition 3*

In a world characterized by technical change and transformation, the behaviours of the agents are most adequately represented by routines, strategies, meta-rules, search processes (see the seminal work of Nelson and Winter, 1982). That is to say that in an environment which is complex, changing and uncertain, firms do not and cannot adopt maximizing behaviours (and, in many circumstances, might not find if dynamically efficient to try to do so, even if they could).[10] This is our third proposition.

Moreover, behaviours cannot be entirely deduced from the sole knowledge of a generic self-seeking goal of the agent and of the economic structure (taken to include the asymmetries in technological capabilities, the nature of the technology, the patterns of economic signals, etc.).

A specific but very important case concerns the nature of the adjustment processes each firm undertakes in a changing environment. As an illustration, take a firm producing any one particular product. The "signals" that the firm receives, in an extreme synthesis, are of three kinds, namely (i) the technological opportunities (and expected economic benefits) associated with technical change in that and other products; (ii) the rate of growth of demand in that and other products; (iii) the changes in costs, prices, quantities, profitabilities in its markets (and also other markets). These signals loosely correspond to three notional adjustment strategies. The first one relates to innovation/imitation/technological upgrading. Let us call it "Schumpeterian adjustment". The second one relates to the search of the most promising growth opportunities. Call it "growth adjustment". The third one refers to price/quantity changes on the basis of an *unchanged* technology. Let us – improperly – call it "Ricardian" or "classical" adjustment.

Clearly, most firms will choose varying combinations of all three adjustment processes. However, the fundamental point is that we have here "open-exit" alternatives (that is, alternatives subject to discretionary decisions) whose outcome cannot be deduced from either the knowledge of the state-of-the-world and/or of an unchanging rationality principle.

Notably, a maximization approach would not lead us very far in explaining the choices. Even if we knew that the considered firm will choose the option which maximizes the integral of the expected discounted profits, for a given time horizon, the analytical content of such a statement would be practically nil: the indeterminacy about the ways technological and market expectations are formed, and about the time horizon and the intertemporal preferences, is another way of describing our theoretical ignorance. A more fruitful approach, in our view, considers the behavioural regularities (the "routines" and "meta-routines", à *la* Nelson-Winter) in relation to (i) the nature of the signals and (ii) the technological assets firms possess (in terms of technological capabilities, knowledge, expertise, etc.) which-among other things-determine different capabilities of "seeing" and reacting to any given set of signals. Clearly, the structure of the industry and the nature of the technology constraints the set of feasible behavioural rules: for example, investment and R&D commitments will be

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[10] *Cf.* Nelson and Winter (1982); Heiner (1983); Dosi (1984); Dosi and Orsenigo (1985).

constrained by the ability to finance them; the adjustments in prices/quantities/market shares will be constrained by minimum profitability requirements, etc. However, the crucial point is that, within these structural and technological constraints, there are varying spaces for *discretionary choices,* related to the propensities to accumulate, to take risks, to trade-off present profits for market shares, to commit more or less resources to innovative search, to search in some directions and not in others, etc.[11]

This applies to both intertemporal comparisons within the same country or, even more so, to inter-country comparisons. In a purely anecdotal way, the reader is invited to think of the specific *weltanschauung* which informed the strategies of the entrepreneurship in some of the most successful latecoming industrializers, such as Germany in the last century (Veblen, 1915) and Japan in this one (Johnson, 1982). Even if the nature of the economic context might go a long way towards the explanation of such performances, it does not exhaust it. More institutional explanations (in the broad sociological sense, including established behaviours and fundamental cultural traits) are required in order to account for the relative emphasis in the most successful countries upon processes of "growth adjustment" and "Schumpeterian adjustments" as compared to simple short-term allocative efficiency. If this is so, one must relate to this socio-institutional level of analysis any proper investigation of statements-which are part of the conventional wisdom of practical economists-such as "... the trouble with British industry is that it is led by accountants, while German firms are led by engineers...", etc. Or, one certainly realizes by reading a work like Dore's *British Factory, Japanese Factory*[12] that the différence in economic performances stemming from différent institutional contexts is much greater than, and irreducible to, the set of economic signais markets deliver. Another related example-almost entirely neglected among economists, with the outstanding exception of Hirschman (1970)-is the economic importance of loyalty:[13] to trivialize, it is intuitive that such commonplace notions as Japanese mechanisms of loyalty to the company and to the state, the Italian sole loyalty to their families and lack of collective loyalties, or, at a more general level, the general perception of the "moral boundaries" in behaviours toward competitors, customers, suppliers, government officiais, etc., must have a profound influence on the adjustment processes the economic agents undertake.

Evidence of this "institutional constitution of markets" emerges indirectly also from the highly simplified context of so-called "experimental markets": even under quasi-laboratory conditions, "the institutional organisation of a market has been an important treatment variable. The mechanics of how buyers and sellers get together can substantially influence market performance. That is, *for the same underlying incentives,* the market performance is affected by a change of institutions".[14] There is no reason to believe that this does not *a fortiori* apFly to thé much more complex real markets. In general, these phenomena hint at suggestions present among 'the early analyses of "market societies", from Locke, Ferguson and Smith to Hegel, about the "moral" and "ethical" preconditions of modern economies. An interpretation of the différent ethical constitutions or, at least, a taxonomy is still to come. Yet,

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[11] On these points, see Metcalfe (1985, p. 4), who discusses the "differences in the capacity and willingness of the firm to expand market share and accumulate productive capacity with respect to current products and processes". The analysis of these strategic choices is-as known-also the domain of game-theoretical approaches to oligopolistic interactions. Our view is that they certainly highlight some important features of strategic interdependencies; however, they are subject to the same objections to the "maximization" representation of behaviours, mentioned above: simply they move the problem one step backward (how are the "rules of the games" established? How are expectations formed? etc.). For some comments, see Dosi, Orsenigo and Silverberg (1986).

[12] Cf. Dore (1973). We owe this observation to M. Salvati.

[13] 0n the issue, see also Pizzorno (1985).

[14] Plott (1982, p. 1489), our emphasis.

we see here a first fundamental role of non-market institutions (including strictly political ones) in that they are instrumental in *shaping and selecting* the fundamental rules of behaviour and interactions of the economic agents: policies, implicit social rules, dominant forms of organizing the links within and between the various groups of economic agents (e.g., between firms and banks, between management and workers, etc.), levels and forms of industrial conflict, have a paramount importance in determining the relative mix and the direction of microeconomic adjustment processes, for any *given* set of economic signals and structural conditions.[15]

The importance of this point also from a normative perspective should be clear: it might not be enough to influence the patterns of signals if microeconomic strategies are biased in directions conflicting with the policy objectives (e.g., if the fundamental strategic rules of private agents are heavily biased against "Schumpeterian adjustments", public incentives might not be very effective in promoting a sufficient rate of innovation: see also below).

*Proposition 4*

Another (and related) aspect of the role of non-market variables in economic performance and technological dynamism refers to the *patterns andorganization* of *externalities and the unintentional outcomes of marketprocesses.* In economic theory, externalities are generally considered a fastidious source of non-convexity while strongly counter-intentional outcomes disturb the rationality assumptions of the theory. However, *untraded interdependencies* betwe:;n sectors, technologies, firms have a primary importance in the process of technological change (see, among others, Freeman, 1974; Rosenberg, 1976 and 1982; Dosi, Pavitt and Soete, 1988). For example, knowledge and expertise about continuous chemical processes may allow technological innovations in food processing even when the latter do not involve any chemical inputs; "arms-length" relationships between producers and users of industrial equipment are often a fundamental element in the innovative process even if sometimes no economic transaction is involved; the production of bicycles originally drew technological knowledge from the production of shotguns, even though neither product is **an** output or an input in the other activity. Technological complementarities, untraded technological interdependencies and information flows which do not entirely correspond to the flows of commodities, ail represent a structured set of technological externalities which is in *a collective* asset of groups of firms/industries within countries/regions and/or tends to be internalized within individual companies (see, for example, Teece, 1982). In other words, technological bottlenecks and opportunities, experiences and skills embodied in people and organizations, capabilities and "memories" overftowing from one economic activity to another, etc., tend to organize *context conditions* which (i) are country-specific, region-specific or even company-specific; (ii) are a fundamental ingredient in the innovative process;

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[15] Notably, somewhat similar conclusions can be reached through the exploration of the properties of markets still characterized by maximizing agents, who, however, have only limited information about the outcomes of different courses of action: then, it can be shown, the institutional architecture of the system shapes choices, outcomes and economic performances (see Sah and Stiglitz, 1985). Moreover, even in the unlikely world of rational expectations, one can show the necessity both of "social norms (in particular business practices) imposing some restrictions and coherence on the individual decisions and [of] information generated by institutions external to the market" (Frydman, 1982, p. 662). *A fortiori,* institutions which shape behaviours, patterns of interactions and expectation formation are *required* in the more complex environments-characterized by technical change, multi-level decision processes, etc.-discussed here. (On the relationship between expectation formation, behaviours and institutional specializations of the economic agents, see also Kaldor, 1972.)

and, (iii) as such, determine différent opportunities/stimuli/constraints to the innovation process for any given set of strictly economic signais. This is our fourth proposition.

These untraded interdependencies and context conditions are, to différent degrees, the *unintentional outcome* of decentralized (but irreversible) processes of environmental organization (one obvious example is the "Silicon Valley") and/or the result of explicit strategies of public and private institutions (in this sense one can interpret, for example, the strategies of vertical and horizontal integration of electrical oligopolies into microelectronics technologies or the efforts of various governments to create "science parks", etc.).

*Proposition 5*

We mentioned above our hypothesis that techmcal change is organized by "technological paradigms". It is useful to distinguish between that "normal" technical progress which proceeds along the trajectories defined by **an** established paradigm and those "extraordinary" technological advances which relate to the emergence of radically new paradigms. As regards the latter, we try to show elsewhere (Dosi, 1984, and Dosi and Orsenigo, 1985) that market processes are generally rather weak in directing the emergence and selection of these radical technological discontinuities. When the process of innovation is highly exploratory, its direct responsiveness to economic signais is looser and-especially in this century-the linkages with strictly scientific knowledge are greater.

Then, institutional factors play a direct role, providing the necessary conditions for new scientific developments and performing as *ex ante* selectors of the explored technological paradigms from within a much wider set of potential ones. One can cite, for example, the cases of semiconductors and computer technologies and the influence of both military/space agencies and big electrical corporations in the early days of the development of these new technological paradigms.[16] Somewhat similar cases can be found in the early developments of synthetic chemistry (especially in Germany). In a less apparent way, strictly non-economic stimuli and "selectors" act in the present development of new technologies, such as bioengineering or new materials.

In general, the features of the process of search and selection of new technological paradigms is such that the *institutional and scientific contexts and public policies are fundamental insofar as they affect (a) the bridging mechanisms between pure science and technological developments; (b) the criteria and capabilities of search by the economic agents;* and *(c) the constraints, incentives and uncertainty facing would-be innovators.* This is our fifth proposition.

Its counterpart on an international level is that when new technologies emerge, the relative success of the various countries depends on the successful matching between (a) one country's scientific context and technological capabilities *(cf.* Propositions 2 and 4 above); (b) the nature of ils "bridging institutions"; (c) its strictly economic conditions (relative prices, nature and size of the markets, availability/scarcity of raw materials, etc.); (d) the nature of the dominant rules of behaviour, strategies, forms of organization of the economic actors *(cf.* Proposition 3 above).

Ciearly, all these sets of variables are, to différent degrees, affected by public policies, either directly (e.g., procurement policies or R&D subsidies which obviously influence the economic signals facing individual firms), or indirectly (e.g., through the influence of the education system upon scientific and technological capabilities, etc.).

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[16] On these points, *cf.* Dosi (1984).

In particular, as regards the "normal" functioning of markets and industries and the "normal" technological activities (as opposed to the extraordinary ones related to the emergence of new technological paradigms), it must be noticed that each sector embodies a différent balance between institutions and markets. This appears to be true in two senses.

First, there is a technology- and country-specificity of the balance between what is coordinated and organized through the visible hand of corporate structures and what is left to the invisible hand of the markets (for discussions on the issue, *cf.* Marris and Mueller, 1980; Williamson, 1979 and 1981; Chandler, 1966 and 1977; and Teece, 1982).

Second, there is an analogous différentiation in the balance between public institutions and private organization in the process of innovation *(cf.* Nelson, 1984). For example, some sectors rely on an endogenous process of technological advances (e.g., several manufacturing sectors) while others depend heavily on public sources of innovation (e.g., agriculture).[17]

If anything, one could suggest the following empirical generalization: other things being equal, the higher the role of the *visible* hand of oligopolistic organizations, the lower the requirement for strictly public institutions in the processes of economic coordination and technological advance and, *vice versa,* the nearer one activity is to the economist's model of "pure competition", the higher also appears to be its need for strictly institutional organization of its "externalities" and technological advances. Agriculture is a case in point: historically a significant part of its technological advances, in the U.S.A., Europe and, also, in the Third World, has been provided by government-sponsored research *(cf.* Nelson, 1984) and even its price-quantity adjustments have been increasingly regulated, both in the U.S.A. and in Europe, by institutional intervention. Conversely, oligopoly-dominated manufacturing produces a good part of its "normal" technological advances endogenously and, apart from major crises, seems to coordinate rather well its price/quantity adjustments.

*Proposition 6*

We have so far focused on the relationship between *lato sensu* institutional factors, economic processes and technological change without much attention to the consequences induced by the very fact that all economies are, more or less, open economies: they trade with each other and, by doing so, undergo changes in the economic signals each of them faces. One of the few conclusions on which the economic profession agrees is that, under conditions of non-increasing returns, absence of externalities and for given rates of macroeconomic activity, the patterns of allocation stemming from international trade are generally efficient. In other words, there are generally gains from trade for all partners based on "comparative advantages". Let us call this *allocative* (or "Ricardian") *efficiency,* to mean the likely outcome of short-term adjustment processes (essentially linked to relative prices and relative profitabilities) on the grounds of *given* technologies and given levels of macroeconomic activity. However, the fundamental question concerns the effect that such a pattern of allocation has upon technological dynamism and upon long-term macroeconomic rates of activity. Let us call the performance criterion related to the former, *Schumpeterian efficiency,* and that related to the latter, *growth efficiency.* Now, the crucial point is that there is nothing in the mechanisms leading to Ricardian efficiency which guarantees also the fulfilment of the other two criteria of efficiency.

The reasons for possible trade-offs amongst these différent efficiency criteria is a consequence of the features of technological change mentioned above (for a more detailed

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[17] For sectoral analyses of the sources and uses of innovations, see Scherer (1982) and Pavitt (1984).

discussion, see Dosi, Pavitt and Soete, 1988), namely (a) the cumulative, (partly) appropriable and local nature of technological advances (Atkinson and Stiglitz, 1969; David, 1975; and Arthur, 1985); (b) the widespread existence of static and dynamic economies of scale; (c) the influence that technological gaps between firms and between countries have upon the economic signals faced by the economic agents; (d) the importance of country-specific and area-specific untraded interdependencies.

As discussed by Kaldor (1980), if différent commodities or sectors possess significant différences in their "dynamic potential" (in terms of economies of scale, technical progress, possibilities of Smithian division of labour, learningby-doing, etc.), then specializations which are efficient in terms of the comparison of a given set of input coefficients may not be so in terms of a longer-term assessment of the notional patterns of technological dynamism related to these specializations. This is more than a special case related to infant industries: it is the general condition of an economic system whereby

*technological opportunities vary across products and across sectors.* More

 precisely, within each technology and each sector the technological capabilities and learning processes of each firm and each country are generally associated with the actual process of production in that same activity. Thus, the mechanisms regarding international specialization have a dynamic effect in that they also *select* the areas where technical skills will be accumulated, (possibly) innovation undertaken, economies of scale reaped, etc. However, the potential for these effects is widely différent between technologies and sectors. This is another aspect of the irreversibility features of economic processes: present allocative choices influence the direction and rate of the future evolution of technologicàl coefficients. Whenever we abandon the idea of technology as a set of blueprints and we conceive technical progress as *a joint production* with manufacturing itself, then it is possible to imagine an economic system which is dynamically better off (in terms of productivity, innovativeness, etc.) if it always operates in disequilibrium vis-à-vis "Ricardian" conditions of allocative efficiency. On the grounds of the foregoing propositions on the nature of technology, it is possible to establish when a trade-off between "allocative efficiency" and "Schumpeterian efficiency" can emerge. "Ricardian" patterns of specialization (with their properties of allocative efficiency) are determined, for each country, by the relative size of the sector-specific technology gaps (or leads).[18] Whenever the gap is higher in the most dynamic technologies (i.e., those characterized by the highest technological opportunities), then allocative efficiency directly conflicts with dynamic efficiency. This is our sixth proposition.

Since this point has important analytical and normative implications, related to the long-term consequences of the patterns of allocation stemming from decentralized market processes, let us consider it in some detail.

By way of an introduction, the reader is invited to think of the case of increasing returns and indivisibilities; as known in the economic literature,[19] multiple equilibria are likely to emerge, without the possibility-for the analyst and *a fortiori* for the economic agents-to establish which one will be selected. As thoroughly discussed in Arthur (1985), increasing returns generally show the properties of (i) non-predictability of equilibria; (ii) non-ergodicity (the past is not "forgotten" by the future and strong hysteresis effects emerge); and (iii) potential inefficiency (a particular equilibrium, or, dynamically, a particular path might be "inferior" in terms of any welfare measure but still the system may be "locked" in it).

Somewhat similarly, trade analyses show that, with non-convexities, decentralized

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[18] *Cf.* Dosi, Pavitt and Soete (1988).

[19] See, for example, Arrow and Hahn (1971); Katz and Shapiro (1983); Arthur (1985).

processes of allocation may not lead to mutual gains from trade (see, for example, Krugman 1984; Markusen and Melvin, 1984; and Helpman and Krugman, 1985).

Now, generalize these results by considering the fact that (a) technical change always represents a form of increasing returns over time, and (b) most often, technological advances are associated with the actual process of production (see above) and, thus, cannot be treated parametrically (e.g., as exogenous shocks which switch the value of equilibria of time t to those of time (t + 1)). One is bound to account for an interaction between decisions of production at time t and technical coefficients at time (t+l), conceptually similar to the interaction between technical coefficients and levels of production of static analyses of increasing returns. The fundamental point is that, with increasing returns, the market cannot signal to the agents the unintentional outcome of their collective behaviour (think-as the clearest example-of economies of scale external to the firm and internal to the industry). Even more so, markets canne signal the (at least partly) *uncertain, unintentional* and *future* technological advances made possible/fostered/hindered by the present decentralized allocative decisions of a relatively high number of independent profit-motivated agents.[20] *A fortiori* Arthur's conclusions on non-predictability, inflexibility, non-ergodicity and potential inefficiency apply to this case, too.

As an illustration,[21] consider the case of two countries which-before trade-produce, under conditions of non-decreasing returns, two commodities, characterized by différent future opportunities of learning and technical progress. As argued earlier, suppose that learning occurs only (or primarily) together with the actual process of production. Now, allow trade to take place. The resulting patterns of specialization, as trade theory predicts, will generally entail a better allocation of resources and, thus, "gains from trade". However, one of the two countries may well be "locked" into an activity where the scope of technical progress is relatively limited. Under such circumstances, in order to have gains from trade in the long term the relative gain stemming from a better allocation of resources must exceed the productivity increases which would have been obtained by producing also (or more of) a commodity characterized by a higher technological opportunity. Conversely, for the other country the gains from a better "Ricardian" allocation of resources will sum up with the gains from relatively higher technical progress in the commodity in which it is specialized. Thus, the other country will always enjoy gains-from-trade, both in the short and the long term.

If one considers a sufficiently long time span, thus allowing for a significant technical progress to take place, it is plausible that the once-for-all gains in resource allocation coming from the decentralized search of minimum-cost opportunities of production may well fall short of the cumulative gains in productivity which would have been obtained over time with "sub-optimal" allocations (in a static sense) biased in favour of activities characterized by higher technological opportunities (for a similar point, see Pasinetti, 1981).

As an historical illustration, it is not necessary to think of developing countries: it is even possible that the technological leadership in "old" technological paradigms (and, thus, a strong "comparative advantage" in the related commodities) may be a hindrance to a quick allocation of resources to new ones. One could think, as examples, of the relative British delay in electro-mechanical technologies, as compared with Germany and the U.S.A., at the turn of the century, or the European delay in electronics technologies, as compared to Japan,

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[20] This independence concerns, of course, decision-making. However, the point is that each agent contributes to creating an "externality" for the whole of them.

[21] At the time of the second revision of this work, a paper by P. Dasgupta and J. Stiglitz on "Exercises in Learning-by-Doing", which shows some similarity with the example that follows, was presented at the Conférence on Innovation Diffusion, Venice, 17-21 Match, 1986.

in the post-war period.

As a related empirical generalization, we suggest that the *likelihood of such trade-offs between allocative and Schumpeterian efficiencies is proportional to the distance of each country from the technological frontier* in the newest and most promising technologies, where a high rate of innovation, idiosyncratic processes of learning and appropriation tend to prevent any easy endogenous process of international technological diffusion.[22]

*Proposition 7*

A somewhat similar argument applies to the possibility of trade-offs between allocative and growth efficiencies. Generally, the analysis of the outcome of the notional transition from autarky to trade is undertaken by focusing upon the adjustments in relative prices and relative quantities on the assumption of unchanged rates of macroeconomic activity.

This condition of *constancy* of the aggregate level of macroeconomic activity before and after trade, is already stated from the start by Ricardo[23] and it is maintained by modern classical reappraisals à la Sraffa-Steedman, whereby the analysis is undertaken in terms of steady-growth paths. This applies-even more so-to neoclassical trade theories, whereby the hypothesis of full-employment of all factors of production is possibly the *core* assumption of the model.

The easiest way to see this condition at work is to imagine that each trading nation operates at full employment rates of activity. In this case, whenever all the other assumptions hold, we can see the full operation of the theorem of comparative advantage: each trading partner "gains from trade" since it can get from abroad more commodities of a certain kind than it would otherwise be able to manufacture domestically without foregoing any amount of consumption of the commodities in which that country is specialized.

Modern economic systems, however, do not often present full employment rates of activity. In these cases the *macroeconomic* efficiency of specialization based on comparative advantages depends on the income intensity (and, dynamically, on income elasticities) of the various commodities in world income. As a first approximation, let us suppose that:

(a) price elasticities, in the generality of the traded commodities for the corresponding world industry as a whole, are relatively low;[24]

(b) commodities present a relatively wide range of income elasticities which are *commodity-specific* and *country-specific.*

Let us also add that, in general, price-related substitution in consumption is limited and the patterns of demand are essentially related to income levels, long-run trends in income distribution and institutional and social factors (more on this point is in Pasinetti, 1981).

Now, under conditions of non-decreasing returns, there is no straightforward way in which markets can relate the varying future growthefficiencies of the various commodities to relative-profitability signals for the microeconomic agents. In other words, microeconomic units may well find it relatively profitable to produce commodities which a decreasing

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[22] For an analysis also of the forces that, on the contrary, tend to induce technological diffusion and convergence between countries, *cf.* Dosi, Pavitt and Soete (1988). See also Perez (1983) and Metcalte and Soete (1984).

[23] Cf. Ricardo (1951, p. 129).

[24] This statement must not be confused with price elasticities for individua) countries which might well be higher. In other words, relatively small price changes may induce significant changes in the international competitiveness of individual countries even when the overall world demand for the corresponding commodity shows a very low price elasticity. There is, however, an essential "beggar-my-neighbour" element in this process.

number of people on the world market wants to buy. The reader may think, as extreme examples, of the dynamic outcomes of patterns of comparative advantages in "inferior" commodities (say, jute, mechanical typewriters or black and white TVs) as compared to income-dynamic ones (say, synthetic fibres, word processors, or colour TVs).

A limited price-induced substitution between commodities and a relatively stable evolution in the baskets of consumption may well imply painful trade-offs between microeconomic mechanisms leading to Ricardian efficiency and those patterns of production which could yield comparatively higher rates of macroeconomic activity compatible with the foreign balance constraint (via higher foreign-trade multipliers).[25]

This is our seventh proposition.

Possible trade-offs between allocative, Schumpeterian and growth efficiencies have nothing to do with exceptional cases of "infant industry" conditions, but are structurally at the core of the signalling and allocative mechanisms of our economic system.[26]

Remarkably, markets may well work efficiently, deliver ail the information they can and even discount contingencies for future states of the world to which probabilities can notionally be attached (although, empirically, these markets rarely exist). What markets *canne* do is to deliver information about or discount the possibility of future states of the world whose occurrence is itself an "externality" resulting unintentionally from the interaction of present decisions of behaviourally unrelated agents. As we saw, this is precisely one of the characteristics of these particular "increasing returns" over time which are associated with technological learning. In this respect, conflicts between short-term allocative efficiency and Schumpeterian efficiency, as defined earlier, could emerge even if markets were complete (in a neoclassical sense: if all contingencies about future *states of nature* could be discounted).[27]

Somewhat similarly, the possibility of conflict between allocative efficiency and growth efficiency is not associated with any "market imperfection". On the contrary, it is due to the fact that, lacking both generalized substitution in consumption with respect to prices and homotheticity of the patterns of demand in income -as we believe to be the general case-there is no general way in which markets can transform "information" about long-term trends in income elasticities of the various commodities into economic incentives for competitive producers who tend to treat the states of the world parametrically.

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[25] Again, for a more thorough discussion along these lines, we must refer to Dosi, Pavitt and Soete (1988). There, and in Cimoli, Dosi and Soete (1986), we formalize a two-country model with "Ricardian" processes of inter-commodity specialization and "Keynesian adjustments" in the rates of macroeconomic activity under a foreign balance constraint, showing also that, *ceteris paribus,* the rates of growth of any one economy consistent with the foreign accounts will be higher, the higher the income intensity (i.e., dynamically, the income elasticity) of the commodities in which that country is specialized. Under certain conditions, this property is approximated by the Kaldor-Thirlwall foreign trade multiplier, whereby the rate of growth of each economy is determined by the world income elasticity of its exports compared to the domestic income elasticity of its imports (see Thirlwall, 1980).

[26] A way of restating Propositions 6 and 7 which is possibly more familiar to the economist is by saying that the *general case,* in our view, is the non-convexity of production- and consumption-possibility sets (more rigorously, their *non-existence,* except perhaps in the very small). In general, the conclusions we draw from Propositions 6 and 7 are consistent with and broadly similar to the analyses of international competitiveness of Cohen *et al.* (1984) and of Mistral (1982).

[27] It is conceivable, if implausible, to discount states of nature such as "tomorrow it will tain". This is clearly very différent from the possibility of trading guesses about states of the world which, in turn, depend on one's own expectations on what all the others are doing, let alone all the problems related to the indivisibilities and public-good ïeatures of technological knowledge (Keynes's "beauty contest" parable somewhat resembles this set of "market failures" relaied to interdependencies between expectations, behaviours and states-ot-the-world; sec also Schelting, 1978).

Incidentally, one might notice that both these sources of conflict between static (allocative) efficiency and the two criteria of dynamic efficiency hint at the possible advantages of oligopoly as compared to free competition. In world oligopolistic markets the "dynamic externalities" associated with technical learning-through-production can be (partly) appropriated by individual firms. Thus, current allocative decisions may take account, to différent degrees, of their effects upon future technological advances. Similarly, for oligopolistic agents the slope of and the movements over time in demand schedules matter and so present patterns of allocation may account for différent expected income elasticities of demand. To give an example, a few European electrical companies (such as Philips and Siemens) decided in the early 'seventies to increase their involvement in microelectronics, despite heavy losses (i.e., despite "allocative inefficiency" and "comparative disadvantage"). Amongst the motivations, there were the expected very high rates of growth of the market and the technological capabilities which could have been acquired and would perform as an "internalized externality" for technologically-related productions. One could not expect the same behaviour from competitive producers.

The trade-offs that we have discussed between allocative efficiency, growth efficiency and technological dynamism may clearly be one of the determinants of the emergence of vicious and virtuous circles in national patterns of growth. Notably, this conclusion is similar to those which are well established in development theory. Howcver, its determinants do not bear any direct relationship with phenomena specific to developing countries (such as several kinds of supposed "market failures"). For our purposes here, developed and developing countries could be placed on some kind of continuum, according to their distance from the technological frontiers and to the différences between their patterns of production and the long-term patterns of world demand.

Whenever any one country happens to present its highest technological lead (or the lowest technological gap) in new technological paradigms, then its pattern of intersectoral profitability signals points in the directions of activities which generally also present the highest demand growth and the highest potential of future product- and process-innovations. Conversely, countries well behind the technological frontiers may be "dynamically penalized" by their present patterns of intersectoral allocative efficiency. This property, in our view, contributes to explain the relative stability of the "pecking order" between countries in terms of technological innovativeness and international competitiveness and also the relatively ordered ways in which this "pecking order" changes in the long term. The interaction between present economic signals, patterns of specializations and dynamics of the sectoral technology gaps provides the basis for cumulative processes. Significantly, major changes in the international competitiveness of each economy are often associated with the emergence of new technological paradigms. This occurrence reshapes the patterns of technological advantages/disadvantages between countries, often demands différent organizational and institutional set-ups and sometimes presents a unique opportunity for the emergence of new techrological and economic leaders.

More generally, we may restate the foregoing argument in the following way. Markets characterized by decentralized decision-making fulfil two fundamental functions. First, they provide a mechanism of coordination between individual economic decisions and, in doing so, they reallocate resources in ways, which-under the conditions specified by the theoryhave efficiency properties of varying degrees. Second, whenever we allow technological progress to take place (with its features of search, uncertainty, etc.), markets provide an incentive to innovate through the possibility of private appropriation of some economic benefit stemming from technical progress itself. Relatedly, they provide a selection environment for the innovations. It is remarkable that as soon as these second functions of markets are considered

in the theoretical picture, their efficiency properties become more blurred and complicated to assess, even in a closed economy context: allocative efficiency in a static sense may conflict with dynamic efficiency in terms of incentives to technological progress. It is not the purpose of this work to analyse in depth these "Schumpeterian trade-offs", which are discussed by Nelson (1981) and Nelson and Winter (1982). Overlapping with, and adding to, the "Schumpeterian trade-offs" of the closed economy case, there is-we argued here-the possibility of a statics vs. dynamics trade-off originating from the patterns of economic signais in the international market. In a way, the open economy case induces *a structural distortion* upon that pattern of signals which would have been generated in autarky conditions. In doing so, they may either overrule upon the domestic "Schumpeterian trade-offs" or amplify them. The substantive hypothesis, we suggested, is that this depends on the relative distance of each country vis-à-vis the technological frontiers in those technological paradigms showing the highest opportunities of innovation and demand growth.

## III ECONOMIC AND TECHNOLOGICAL DYNAMISM: THE *ROLE OF* INSTITUTIONS AND *POLICIES*

The seven propositions discussed above jointly highlight a picture of the process of coordination of economic activities and generation of technological advances whereby institutions (both "micro" institutions, e.g., complex corporate structures embodying specific capabilities, rules of behaviours, "rationalities", modes of institutional organization of market interactions, etc.; and "macro" institutions, such as strictly public agencies) enter as a set of crucial factors irreducible to simple economic mechanisms. On the contrary, *lato* sensu institutional factors appear to shape the *constitution of behavioural rules, learning processes, patterns of enuironmental selection, context conditions* under which economic mechanisms operate-in general, and *a fortiori* with reference to technological change. To put it another way, there appears to be no meaningful possibility of (a) separating the strictly economic variables from their institutional context and then assessing the former in relation to their performance outcome, neglecting the latter; (b) assuming that strictly economic variables overdetermine their institutional contexts to such an extent that the latter tend to converge to a unique pattern; (c) simply reducing all extra economic elements to either interferences or exceptional corrections to a supposedly "optimallyperforming", self-contained and well-tuned economic machine. That is to say that, if the propositions suggested above are correct, then also any assessment of the role of policies based on the "reductionist" approach is bound to be, at best, incomplete.[28]

In these circumstances, complex normative issues emerge in relation to the definition and assessment of the efficiency of various combinations between institutional set-ups, nature of the technologies and economic processes. Here, we are simply going to suggest some conjectures and methodological remarks.

First, let us start from a classification of the variables upon which policies may act-in general and with particular reference to technological progress. On the grounds of the

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[28] Remarkably, somewhat similar conclusions can be implicitly reached by the exploration of the properties and heuristic limitations of general equilibrium models with externalities, indivisibilities, limited and/or market dependent information (cf., for example, Hahn, 1984 and 1985; Kornai, 1971; and Stiglitz, 1984). The institutional "architecture" of the system must be accounted for as one of the determinants of the performance of the system (Stiglitz, 1984). Once we recognize that (a) externalities, uncertainty, increasing returns, eta *are general* and *permanent* features of economies characterized by change in general and technical change in particular, and (b) institutions are necessary to explain economic performance at any time and the relative order of economic change over tinte, (hen, in ouf view, not much is left to interpretative powers of the "reductionist" research programme.

foregoing discussion they can be categorized as:

(a) the capability of the scientific/technological system of providing major innovative advances and of organizing the technological *context conditions* (ranging from infrastructure to the ways the différent varieties of externalities are organized);

(b) the *capabilities of the economic* agents, in terms of the technology they embody, the effectiveness and speed with which they search for new technological and organizational advances, etc.;

(c) the patterns of *signals* (which, as we saw, depend also on inter-firm and inter-national technological asymmetries, and, in turn, shape the boundaries of the set of possible microeconomic responses that are economically feasible for agents which-irrespective of their precise strategies-have profitabiïity among their behavioural considerations);

(d) the *forms of organization* within and between markets (e.g., the relationship between financial structures and industry, the forms of industrial relations, the varying balance between cooperation and competition, the degree and forms of corporate internalization of transactions, etc.);

(e) the incentives/stimuli/constraints facing the agents in their adjustment and innovative processes (e.g., the degree of private appropriability of the benefits *of* innovating, the intensity *of* competitive threats, the cost and profitability of innovation, etc.).

These categories, we suggest, allow a taxonomy of policies according to their implications in terms of the corresponding groups of variables. Our general conjectures are that (i) ail major Western countries indeed present relatively high degrees of intervention -whether consciously conceived as industrial policies or not-that affect ail the above variables; (ü) probably, if one simply considers the impact of various forms of financial transfer and public procurement, no striking différence is likely to be detected between most OECD countries (possibly with a relatively lower importance in Japan); and (iii) what primarily difTerentiates the various countries are the instruments, the institutional arrangements and the philosophy of intervention. As an illustration, consider the case of Japanese policies, especially in relation to electronics technologies. Interestingly, Japan appears to have acted comprehensively upon ail the variables categorized in our taxonomy above. A heavy discretionary intervention upon the structure of signais (by means of formal and informal protection against imports and foreign investments and through an investment policy of financial institutions consistent with growth and Schumpeterian efficiencies) recreated the "vaeuum erlvironment" that is generally enjoyed only by the technological leader(s). However, this was matched by a pattern of fierce oligopolistic rivalry between Japanese companies and a heavy export orientation which fostered technological dynamism and prevented any exploitation of protection simply in ter- ms of collusive monopolistic pricing.

It is tempting to compare this Japanese experience with others, much less successful, such as the European ones, which heavily relied upon one single instrument, financial transfers (especially R&D subsidies and transfers on capital account), leaving to the endogenous working of the international market both the determination of the patterns of signais and the response capabilities of individual firms. Certainly, there are country-specific features of the Japanese example which are hardly transférable. However, that case, in its striking outcome, points at a general possibility of reshaping the patterns of "comparative advantages" as they emerge from the endogenous evolution of the international markets.

There is a general point here. Historically, a successful catching-up effort in terms of per capita income and wages has always been accompanied by technological catching-up in the new and most dynamic technological paradigms, irrespective of the initial patterns of comparative advantages, specializations and market-generated signals.

Second, from a normative point of view, the foregoing discussion highlights the general role that policies and/or institutions play in technological change. The innovative process *necessarily* embodies a complex and differentiated mixture of private appropriation and public-good aspects (see Nelson, 1981 and 1984) and involves an unavoidable "market failure", to use the language familiar to economists. Thus, the normative counterpart of this phenomenon does not regard if but how and *to what degree* policies should affect the innovative activities. Moreover, the existence of possible trade-offs between ."static" efficiency, on the one hand, and growth/"Schumpeterian" efficiencies, on the other, sometimes amplified by the ways technological gaps feed back on market signals in the international market, implies that policies affecting also economic signals may be required-on whatever welfare criterion is chosen (e.g., income growth, innovativeness, employment, etc.)-in a much wider set of cases than those prescribed by traditional "infant industry" arguments.

Our conjecture is that, *ceteris paribus,* the structural need for policies affecting *also* the patterns of economic signals (including relative prices and relative profitabilities) as they emerge from the international market will be greater, the higher the distance of any one country from the technological frontier. Conversely, endogenous market mechanisms tend to behave in a "virtuous" manner for those countries that happen to be on the frontier, especially in the newest/most promising technologies. This is broadly confirmed by historical experience: unconditional free trade often happened to be advocated and fully exploited only by the leading countries.

Third, as regards the time-profile of technological developments, a fundamental divide can be traced between policies related to the *emergence of* new technological paradigms and policies apt to sustain technological activities along relativèly established paths. In the former case, policies should (i) provide a satisfactory flow of scientific advances; (ii) establish "bridging institutions" between scientific developments and their economic exploitation; (iii) develop conducive financial structures to support the trialand-error procedures generally involved in the search for new technological paradigms; and (iv) act as "focusing devices"[29] in the process of selection of the directions of technological development. As regards "normal" technical progress, important policy tasks appear to be the maintenance of a relatively fluid supply of techno-scientific advances, coupled with "balanced" conditions of private appropriability of the benefits of innovating. Conversely, countries well below the technological frontier may find it necessary also to act directly upon both the capability levels of the domestic companies and *against* the appropriability features of the related technologies insofar as they perform as an *entry barrier* for laggard companies/countries.

Fourth, there is a fundamental policy dimension which relates to context conditions, the organization of externalities and infrastructures. These are likely to be particularly important in the process of transition between différent technological regimes (différent clusters of technological paradigms), whereby the new set-ups involve new patterns of intersectoral flows of commodities and information, new common infrastructures (think of the role of motorways in relation to the automotive industries or the role of telecommunications in relation to electronics), and a différent set of untraded interdependencies between companies and sectors.

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[29] *Cf.* Rosenberg (1976).

Fifth, public policies, whether intentionally or not, affect the fundamental "rationalities" of the agents, the ways their expectations and objectives are formed. By means of an illustration, one may think of the role of military spending. In addition to obvious effects upon the composition of demand and the pattern of economic signais, anothur indirect, but equally important, implication regards the way it is likely to shape the strategies and the managerial outlooks: almost certainly, public agencies tend to be perceived as a "guarantee of last resort",[30] while the skills of detecting and influencing procurement authorities are likely to become dominant upon the capabilities of understanding and anticipating market trends in competitive environments. Clearly, this is only one-possibly the most straightforwardexample of a set of influences that the political structures exert upon the *behavioural constitution* of market processes.[31]

## IV SOME CONCLUSIONS

In a world characterized by technical change (both "continuous" change along defined technological trajectories and "discontinuous" ones related to the emergence of new technological paradigms), technological lags and leads shape the patterns of intersectoral and interproduct profitability signais and, thus, also the patterns of microeconomic allocation. The latter, however, may affect the long-term macroeconomic dynamism of each country, in terms of both rates of growth of income consistent with the foreign balance constraint and of technological innovativeness. In the last resort, this happens because the effects of a multiplicity of signais (related to profitability, long-term demand growth and technological opportunities) upon microeconomic processes of adjustments are likely to be *asymmetric.* Whenever trade-offs between différent notions of efficiency arise, "sub-optimal" or "perverse" macroeconomic outcomes may emerge. Since the *future* pattern of technological advantages/disadvantages is also related to the *present* allocative patterns, we cari sec at work here dynamic processes which Kaldor calls of "circular causation": economic signals related to intersectoral profitabilities-which lead in a straightforward manner to "comparative advantages" and relative specializations-certainly control and check the allocative efficiency of the various productive employments, but may also play a more ambiguous or even perverse role in relation to long-term macroeconomic trends.

The ("vicious" or "virtuous") circular processes we have discussed concern the very nature of allocative mechanisms, insofar as the economy is characterized by technical change showing varying degrees of sector-specific opportunity, cumulativeness, appropriability, dynamic technological externalities and local and idiosyncratic learning.

This defines also a fundamental domain for policies.

Moreover, we argued, institutional factors-including, of course, policies-are part of the very *constitution* of economie processes, i.e., the ways economic activities are organized and coordinated, technical change is generated and used, the dominant behavioural regularities emerge, etc. This is another fundamental domain for policies.

A detailed understanding of, and intervention upon, patterns of signais, rules of allocative responses and forms of institutional organization of the "economic machine" are particularly

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[30] We owe this observation to a discussion with H. Minsky.
[31] Another important example, analysed by Zysman (1983), concerns the effects of countryspecific institutional organizations of the financial markets upon the allocation of resources and the industrial attitudes toward risk, growth, innovation, etc.

important in those phases of transition from a technological regime (based on old technological paradigms) to a new one. These historical periods define a new set of opportunities and threats for each country: the patterns of international generation and diffusion of technologies become more fluid as do, consequently, the international trade flows and the relative levels of per capita income.

The contemporary economy-we believe-is undergoing such a change, in the transition toward an electronics-based technological regime. In the process, comparative advantages become the self-fulfilling prophecy of a successful set of institutional actions and private strategies: *ex post,* technological and economic success makes "optimal" from the point of view of the economist what *ex ante* is a political dream.

One decade after the Second World War, no economist would have suggested that electronics was one of the Japanese comparative advantages. Now it certainly is. If one would have taken the relative allocative efficiency of the different industrial sectors thirty years ago as the ground for normative prescriptions, Japan would still probably be exporting silk tics. In a sense, the use of comparative-advantage criteria as the final and soie ground for normative prescriptions is a luxury that only countries on the technological frontier can afford: *rebus sic stantibus,* it will not take long before Japanese economists will learn and preach Ricardo or even Heckscher-Ohlin while it may well be that the Americans and the Europeans will rediscover Hamilton, List and Ferrier.

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