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Markets, institutions and technical change in open economies: Some policy implications

Every theory is bound to simplify the variety and complexity of the phenomena that it tries to explain. Indeed, as suggested by modern epistemology, the smaller the number of states-of-the-world that a theory allows, the higher its analytical power (Popper (1968)). However, the adequacy of different abstractions and simplifications also depends on the choice of the phenomena that one wants to explain.

In this respect, the preceding chapters entailed a critique of the dominant approaches to technical change and international trade, with regard to the facts analysed and the assumptions made. There is a subtle – but none the less crucial – border between abstraction and trivialisation; between risking highly improbable predictions about the state-of-the-world and ruling out *ex hypothesi* the possibility of the state-of-the-world that the theory might not explain. On analytical grounds the evidence we discussed and the interpretations we suggested, imply that any model based on technology as freely available information, on maximising behaviour, on equilibrium and on relative factor scarcities can provide, at best, only a partial account of open economic systems, characterised by complex and varied mechanisms of technological learning, uncertainty, reproducibility of capital inputs, non-decreasing returns, bounded rationality and evolutionary processes.

Not surprisingly, the difference between the two approaches also extends to the normative. The most familiar intellectual strategy consists essentially of a reduction of the policy issues to exceptions, anomalies, particular cases of a general framework centered around the equilibrium conditions of the economic system, as postulated by the theory. The impact of policies and institutions is evaluated then on the grounds of a yardstick – the equilibrium which the economic system would achieve

if left to itself, under very special and sometimes rather awkward hypotheses, the properties of which yield 'optimal' outcomes. In this perspective, any normative issue, phenomenon or behaviour is compared with the fundamental yardstick, defining the role and impact of economic policies. Thus, economists commonly use such concepts as 'externalities', 'market failures', 'limited information', 'imperfect markets', etc., to categorise the most common 'sub-optimal' features of the empirical world as compared with the theoretical model. In a peculiar reversal of positive and normative judgements, these real world 'imperfections' also delimit the domain of institutional intervention, the effects of which are designed to make the real world more similar to the theory.

The problems related to technological and economic change have generally been treated in a similar fashion: assessing, for example, the degree of 'market failure' associated with technological uncertainty, or the 'market imperfection' stemming from property rights on innovation. The methodology is appealing in its generality, simple enough to be treated in its basic form with undergraduate mathematics, incorporates many common-sense beliefs about the benefits of decentralised markets, and last, but not least, is dominant enough in the professional community to make its acceptance widespread and general.

The leap from the theoretical model on which the welfare theorems are based to the properties of actual economic systems is clearly a large one. Yet the correspondence between the fundamental hypotheses of the model (on behaviours, technology, interactions between the agents, etc.) and the real features of any particular economy is generally treated rather casually.

In contrast, the analyses of the preceding chapters yield the following conclusions which are fundamentally non-reductionist:[1]

1. Behaviours cannot be reduced to the simple and universal rationality of maximising agents.
2. Markets and economic processes occurring within them are institutional set-ups specific to historical periods, cultures and countries.
3. Non-market variables (including policies in the strict sense) are a permanent feature of the constitution of the economic system, and an essential part of the ways in which the economic machine is tuned and evolves.
4. There are particular combinations of institutional variables and decentralised market processes that efficiently fit, or appear to be matched, in terms of some performance yardstick.[2]

A discussion of normative issues, once out of the safe surroundings of market imperfections and anomalies, will, as Nelson and Winter have

warned: 'be complex and messy. It is unlikely that one will be able to prove many sweeping normative theorems of the sort that are now contained in our advanced treatises and elementary text'.[3] However, the complexity and possible messiness has to be faced, and tackled, in order to take seriously the normative side of the analysis of technical change, trade and growth undertaken in the preceding chapters. Questions such as: what are 'the architectures', what is 'the pattern of organisation of individuals', in Stiglitz's terminology,[4] that are conducive to technological innovation? What is the role of policy in explaining the different national innovative performances identified in Chapter 4? Is it true that decentralised market processes always yield technological dynamism? What kind of performance yardstick can we use in a continuously changing world? And many more come to mind.

The agenda of normative issues is thus long and would lead us to many entangled questions at the core of the economic discipline. The aim here is more limited. In Section 8.1 we hypothesise on the role of different institutions (which we shall define), different organisational set-ups and different policies in relation to technical change. In Section 8.2 we discuss the implications of the openness of most economies for allocative processes, technological dynamism and growth possibilities. In doing so we shall suggest some performance criteria on which to judge the outcome of market processes in open economies. Finally, in Section 8.3 we present some broad conclusions on the relationship between institutions, technical change, and international regimes of growth.

8.1 Markets and institutions in the innovative process

The variety of the modes and effects of technological progress in different sectors, as analysed in Chapter 4, implies in a parallel variety of institutional arrangements that one can observe in modern non-centrally planned economies, with different degrees of involvement of public agencies in each sector, different market structures, and different patterns of interaction in each sector between private profit-motivated agents. In the following, we shall discuss both the effects of broadly defined institutions and explicitly defined public actions – i.e. 'policies' – in terms of technical change and international competitiveness.

Before getting into a more detailed analysis of the regularities in the observed institutional and policy patterns across countries and across technologies, let us put forward two general propositions: first, the institutional organisation of industries and markets does matter in terms

of performance outcomes, no matter how defined; and second, each institutional set-up is partly endogenous to the competitive process and partly determined in the country-specific context.

By institutional set-up, we mean three things: (i) the forms of organisation of the interactions between agents (hundreds of agents bartering in the village market, or General Motors and Ford competing on the US market are two very different forms of interaction); (ii) the fundamental rules of behaviour that agents embody towards their competitors, customers, suppliers, employees, government officials, etc.; and (iii) the forms and degrees of direct exercise of discretionary power by non-market actors, who contribute to the organisation of the patterns of allocation, the rules of behaviour and the performance of market processes (clearly policies come under this heading).

Institutions shaping economic behaviour

As we discussed in Chapter 4, the behaviour of agents is most adequately represented by routines, strategies, metarules and search processes (see the seminal work of Nelson and Winter, 1982). Behaviours cannot be entirely deduced from the economic structure (taken to include the asymmetries in technological capabilities, the nature of the technology, the patterns of economic signals, etc.). A specific case concerns the adjustment processes each firm undertakes in a changing environment.

Take as illustration a firm producing any one particular product. The signals that the firm receives are of three kinds:

(a) the technological opportunities (and expected economic benefits) associated with technical change in that and other products;
(b) the rate of growth of demand in that and other products; and
(c) the changes in costs, prices, quantities and profitabilities in its markets (and possibly 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 for the most promising growth opportunities; call it growth (or, in analogy with the earlier, more macroeconomic, definition, 'Keynesian') adjustment. The third one refers to price/quantity changes on the grounds of an unchanged technology. Let us call it Ricardian or classical adjustment. Most firms will choose varying combinations of all three adjustment processes. However, these will be 'open-exit' choices, the outcome of which cannot be deduced from either the knowledge of the state-of-the-world and/or an unchanging rationality principle.

In our view, the behavioural regularities in the strategies of the economic agents are both the result of selection processes of the environment, and the outcome of norms, attitudes and dominant behaviour which contain an irreducible extra-economic element. This applies to both intertemporal comparisons within the same country and, even more so, to intercountry comparisons. Think, for example, of the specific vision of the world that led to the 'entrepreneurship' strategies in some of the most successful late-coming industrialisers, such as Germany in the last century or Japan more recently. Even if the nature of the economic context might go a long way in explaining such performances, it does not explain the whole 'performance'. More institutional explanations (in the broad sociological sense, including established behaviours and fundamental cultural features) are required in order to account for the emphasis in these countries upon processes of growth and Schumpeterian adjustments, instead of short-term profitability.

Here we see a first fundamental role of non-market variables (including strictly political ones), that are instrumental in shaping and selecting the rules of behaviour and interactions of the economic agents. Policies, implicit social rules, dominant forms of organisation of 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, are of paramount importance in determining the combination and the direction of microeconomic adjustment processes, for any given set of economic signals and structural conditions.

Institutions organising externalities

Another (and related) set of non-market variables often influencing technological dynamism is the pattern of externalities and unintentional outcomes of market processes. As argued in this book, untraded interdependencies between sectors, technologies and firms are of primary importance in the process of technological change. Technological complementarities, untraded technological interdependencies and information flows which do not entirely correspond to the flows of commodities, common infrastructures, various sorts of dynamic economies of scale, all represent a structured set of technological externalities that are truly a collective asset of groups of firms/industries. In other words, technological bottlenecks and opportunities, experiences and skills embodied in

people and organisations, capabilities overflowing from one economic activity to another, will tend to organise context conditions which:

(a) are country-specific, region-specific or even company-specific;
(b) are a fundamental ingredient in the innovation process; and
(c) determine different incentives/stimuli/constraints to the innovation process for any given set of strictly economic signals (i.e. relative prices, income distribution, etc.).

These untraded interdependencies and context conditions are the outcome of decentralised (but irreversible) processes of environmental organisation (one obvious example is the 'Silicon Valley') and/or the result of explicit strategies of public and private institutions (it is in this sense that 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.).

In general, technology-related externalities and dynamic increasing returns (Arthur, 1985, 1988; David, 1985), are at the core of every complex economic system: jointly with other externalities linked with indivisibilities or with the asymmetric distribution of information and capabilities (see Stiglitz, 1982, 1984; Nalebuff and Stiglitz, 1983). People learn through their successes and mistakes, and make choices on the grounds of incomplete knowledge about the future, the actions of others, and the outcome of their own actions.[5] In many ways the pattern of Schumpeterian competition, discussed in Chapter 4 and analysed in detail by Nelson and Winter (1982), can be interpreted as a process of (Darwinian) selection and (Lamarkian) construction of specific institutions (firms, markets, rules, etc.) which also organise innovative efforts and establish mechanisms of incentives/penalties/rewards for the activities of technological search. One can now see the endogenous features of these institutions: market structures, forms of corporate organisation, particular routines and forms of expertise – of which particular firms are carriers – are linked with innovation and competition through positive feedbacks (see Nelson and Winter, 1982; Momigliano, 1985; Dosi, 1984; and Chapter 4 above). Successes and failures change both market structures and the forms of interaction between the agents.

Take the case of the computer industry by way of illustration. The increasing size and large market share of IBM over the past thirty years can be explained by its cumulative success. In turn, at any given time, firm's size, capabilities, etc., contribute to explaining the innovative performance of the industry as a whole. Without IBM, the innovative record, the particular kind of 'market discipline' and the technological and market expectations would have been different. Conversely, in a

market with a firm such as IBM, the 'selection criteria' of the environment are to some extent the decisions of IBM itself.[6]

However, there are aspects of these institutional set-ups that are not directly endogenous to the competitive process of any one industry. Obvious examples are the effects of the regulatory framework (anti-trust, pollution, etc.) upon market structure and industrial change (for a discussion of the US case, see Nelson and Winter, 1982; and Nelson, 1984). Moreover, there are important consequences of the relationships between the main social actors. Schumpeter had this same phenomenon in mind when he emphasised interactions within the triad comprising the inventor, the banker and the entrepreneur. One should, in addition, consider two other major actors, namely the government and the workforce.

To sum up, institutions are a necessary part of the organisation of economic processes in general, and innovative activities in particular. These institutions are partly the result of endogenous processes of learning and market selection, and partly the outcome of broader factors related to the general socio-economic tuning of the economic system, specific to countries and historical periods. The nature of the institutions affects economic performance, and in particular the innovative record of industries and countries.

Institutions supporting technological progress

Within the great variety of institutional set-ups, can one identify some regularities across industries and across countries? In order to provide some tentative answers, let us distinguish between 'normal' technical progress along trajectories defined by an established paradigm, and 'extraordinary' technological advances related to the emergence of radically new paradigms (more can be found on both in Nelson, 1988).

As regards the latter, one of us has tried to show elsewhere (Dosi, 1984; Dosi and Orsenigo, 1988) that market processes are generally rather weak in directing the emergence and selection of radical technological discontinuities. When the process of innovation is highly exploratory, its direct responsiveness to economic signals is rather weak and – especially in this century – the linkages with strictly scientific knowledge are quite strong. Non-market organisations play an important role, providing the necessary conditions for new scientific developments and performing as ex-ante selectors of the explored technological paradigm within a much wider set of potential ones. One can cite, for example, the case of the semiconductor and computer technologies and the influence of both military agencies and big electrical corporations in

the early days of the development of these radically new technologies.[7] Somewhat similar cases can be found in the early developments of synthetic chemistry. Non-economic stimuli, conditions and 'selectors' are also prevalent in the development of bioengineering and new material technologies. In the processes of search and selection of new technological paradigms, the institutional and scientific context and existing public policy are fundamental, since they affect (a) the bridging mechanisms between pure science and technological developments;[8] (b) the criteria and capabilities of search by the economic agents; and (c) the constraints, incentives and uncertainty facing would-be innovators.

Thus, when new technologies emerge, the relative success of various countries will depend on the successful coordination between the scientific infrastructure and technological capabilities; the nature of its 'bridging institutions'; strictly economic conditions (relative prices, nature and size of the markets, availability/scarcity of raw materials, etc.); and the nature of the dominant rules of behaviour, strategies and forms of organisation of the economic actors. All these variables are, to different 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 educational system upon scientific and technological capabilities, the effect of taxation policies on the emergence of new firms, etc.).

As regards 'normal' technical progress, one is immediately struck by the great variety in the organisational patterns of innovative activities and in the degree of direct public involvement. First, there is a technology and country-specificity of the balance between what is coordinated and organised through the visible hand of corporate structures and what is left to the invisible hand of the markets. Interestingly, many of the observed patterns bear some close correspondence with the intersectoral taxonomy discussed in Chapter 4.

In science-based industries, Schumpeterian competition tends to result in large oligopolies which also internalise considerable innovative capabilities (e.g. computers, semiconductors, synthetic chemicals, etc.). Similarly, in production-intensive industries, the 'visible hand' of large corporations puts the organisation of technological advances at the core of their strategic behaviour (e.g. automobiles, most other consumer durables, etc.). In the case of specialised suppliers, technological advances are generally organised through the matching between their own specific technological skills and intensive (often arms-length and untraded) relationships with users or component producers. Finally, only in supplier-dominated sectors do the mechanisms of organisation and coordination of technological progress appear to retain some significant similarities with the classical view of the 'invisible hand': technological advances are generally available on the market in the form of new capital goods; there are many firms with generally weak strategic interactions, etc.

Second, there are significant intersectoral differences in the balance between public institutions and private organisations in the process of innovation (cf. Nelson, 1984). Some sectors rely mainly on an endogenous process of technological advance, while others depend heavily on public sources. One could even suggest the following empirical generalisation: the stronger the role of the visible hand of oligopolistic organisations, the weaker the requirement for strictly public institutions in economic coordination and technological advance. And vice versa: the nearer an activity is to 'pure competition', the greater the need for strictly institutional forms of organisation of its 'externalities' and technological advances. Agriculture is a well-known case in point. Historically, a significant part of its technological advance, at least in the United States, has been provided by government-sponsored research (cf. Nelson, 1984). Conversely, many oligopoly-dominated manufacturing sectors have produced, endogenously, a good part of their technological advance, and have appeared to coordinate their price/quantity adjustments rather well.

Some normative implications

The foregoing discussion suggests that, in contemporary mixed economies, non-market agencies have been major actors in the emergence of new technological paradigms. At the same time, the conditions of technological opportunity and appropriability have guaranteed sustained rates of 'normal' technical progress endogenously generated through the visible hand of (mainly) manufacturing oligopolistic corporations. Every Western government has intervened, in forms and degrees that depend on the sectors and countries, so as to strengthen the incentives to innovate (both in terms of 'normal' innovations and paradigm changes). Confronted with this variety of organisations, degrees and forms of public intervention, can one make any normative statement linking institutional forms, degrees of public involvement and economic performance? Certainly a big change in emphasis from traditional welfare analysis is required.[9] In the changing and complex world that we are analysing here, one can hardly reach definite conclusions on 'optimal' set-ups. At best, one can define some trade-offs involved in each organisational configuration.

First, we know that in the innovative process undertaken by profit-motivated agents there is necessarily 'market failure', in a static sense. Varying degrees of appropriability are the necessary incentive to innovate, but imply at the same time 'excess profits' and 'sub-optimal' allocation of resources. Best-practice techniques and better products diffuse through the economy after a lapse of time, and the gap between the technological frontier and the inframarginal techniques also measures the static inefficiency of any pattern of allocation of resources.[10]

Elsewhere (Dosi, 1984, 1988; Dosi and Orsenigo, 1988), one of us has argued that these widespread asymmetries in technological capabilities and economic performance result in an equally uneven pattern of economic signals facing economic agents. The asymmetries in capabilities are a direct consequence of the cumulative, idiosyncratic and partly appropriable nature of technological advances. Thus, a situation of high technological opportunity, associated with a high degree of appropriability, will act as a powerful incentive to innovate, for a company at or near the technological frontier. At the same time, such a situation will be a powerful negative signal (an entry barrier) for a company with a lower technological capability.

On normative grounds, one would like to have 'small' asymmetries from a short-term allocative point of view, and a sustained incentive to innovate, from a dynamic point of view. This is a difficult balance and there is no reason to believe that market selection does the trick. As the explorations of these trade-offs by Nelson and Winter (1982) show, dynamic efficiency and the evolution of market structure are rather sensitive to the initial conditions, and to technology-related features. Even in the definition of performance, one encounters difficulties: for example, is the 'maximum' rate of innovation the most desirable one? How far is one ready to depart from static efficiency in order to achieve a faster rate of innovation?, etc.

A second normative puzzle concerns the multiplicity of organisational set-ups which correspond to quite similar performance outcomes (both in terms of static efficiency and innovative records). For example, comparing Europe, Japan and the United States, one sometimes observes significant differences (even within the same sector) in market structure, forms of state involvement, behavioural rules of the companies and yet, sometimes, somewhat similar performance.[11]

A third normative issue is the method through which each society builds its technological capabilities, and translates them into innovative, entrepreneurial behaviour. Again, one can observe rather wide international variance in both the 'supply of entrepreneurship', and the ways

in which it is formed institutionally. The difference between the 'organised entrepreneurship' of Japanese firms, and the self-made-man archetype in the United States, is a typical example; or between the formalised 'production' of technological/managerial capabilities in France (the Ecole Polytechnique, etc.) and the anarchic Italian pattern. Noble (1977) provides a suggestive description of the growth of American technocracy, which highlights the enormous changes that contemporary economies have undergone since the times of the 'classical' protestant capitalist studied by Weber in *Protestant Ethic and the Spirit of Capitalism*. Yet, we need many more international studies on the mechanisms of formation of managers/technocrats/entrepreneurs in order to understand the supply of this crucial factor in innovative activities in the various countries.

A fourth normative issue concerns the possible trade-off between allocative efficiency and flexibility, or, more generally speaking, between fitting into a particular state-of-the-world and the capability to cope with other (and unpredictable) environments. One can detect here an analogy with biological evolution. Extreme optimisation within a given environment might well imply a 'dinosaur syndrome' and inflexibility to change. Conversely, high adaptability is likely to involve waste, 'slack' and sub-optimal use of resources. In Pavitt (1984d) the possible trade-offs between efficiency and innovativeness are discussed in relation to the internal organisation of the firm. In Dosi (1988) and Soete and Dosi (1983) the (technology-specific) trade-offs between flexibility and economies of scale are analysed, suggesting that microelectronics-based production processes change the intensity of such a trade-off by increasing flexibility and lowering the minimum throughputs which allow for automated processes. However, the trade-off does not disappear. The very existence of technological paradigms and trajectories, with their local and cumulative forms of learning, imply irreversible processes with 'lock-in' companies and industries in particular forms of technological expertise (Arthur, 1985, 1988).

There is a requirement for variety in capabilities, behavioural rules, and allocative processes which will allow for greater adaptability to uncertainty and change. Eliasson (1984) has shown that disequilibrium – in a static allocative sense – is associated with a smoother absorption of external shocks.[12] To put it another way, one of the greatest strengths that capitalism has shown is its capability of continuously producing redundant resources, of exploring an 'excessive' number of technological trajectories, of producing a wasteful number of technological/organisational 'genotypes'. Contrary to common beliefs, any advantage of contemporary mixed economies as compared to centrally planned

ones, reflects the fact that the former do not achieve an equilibrium of the Arrow–Debreu kind, but are highly imperfect and always characterised by allocative inefficiencies and technological slacks.[13]

The policy questions are consequently – and not surprisingly – complex. How can sufficient 'variety' be continuously generated? To what extent can ex-ante strategies and institutional engineering channel technological evolution? These issues become even more entangled in open economies. It is to this 'openness' issue that we now turn.

8.2 Economic signals and technological dynamism in open economies

It is generally agreed that, under conditions of non-decreasing returns, absence of externalities and given rates of macroeconomic activity, the patterns of allocation stemming from international trade will generally be efficient. In other words, there are gains from trade for all partners based on comparative advantages. We will call this performance criterion allocative (or Ricardian) efficiency. However, we know from Chapters 4, 5 and 6 that the above conditions under which the link between comparative advantages and gains-from-trade holds, are unlikely to occur.

We observe intercountry differences in relative prices, relative productivities and relative gaps/leads in technology, which tend to lead to Ricardian adjustments (see Chapters 6 and 7), induced by the search for the maximum-profitabilities/minimum-cost employments for investments. However, this is not sufficient to allow us to conclude that all trading partners will gain in the short run and, even more so, in the long run.

A first question regards the effect that the pattern of allocation – induced by comparative advantages (and, thus, relative intersectoral profitabilities) on the basis of given technologies – will have on technological dynamism and long-term macroeconomic rates of activity. As before, we shall call the performance criterion related to innovative dynamism 'Schumpeterian efficiency' and that related to the maximum rate of growth consistent with the foreign-balance constraint 'growth' or 'Keynesian' efficiency.

There is nothing in the mechanism leading to Ricardian efficiency (as defined above) that also guarantees the fulfilment of the other criteria of efficiency. The easiest way to see the efficiency gains in a Ricardian (or, for that matter, neo-classical) world is to imagine that each nation, before trade, operates at full-employment rates of activity, and that there are no Keynesian adjustment processes (see Chapter 7) linking

absolute advantages, market shares and macroeconomic rates of activity in the transition from autarky to trade.[14] (The latter hypothesis is clearly at the core of the neo-classical model which requires market clearing.) With all the other restrictive assumptions mentioned above, one can easily see the full operation of the theorem of comparative advantage: each trading partner gains from trade, since it gets more commodities of a certain kind from abroad than it would otherwise be able to manufacture domestically, without forgoing any production and consumption of the commodities in which it specialises. It can also be seen how gains from trade of this kind are of a 'once-and-for-all', static nature.

Let us now relax both assumptions and ask what the effect of any given pattern of specialisation might be on the technological capabilities of each country, and what the outcome would be, in the short and long run, in terms of macroeconomic rates of activities, whenever one allows for 'Keynesian' adjustments. It might be useful to recall some of our conclusions from Chapters 4 and 5, in particular the cumulative, (partly) appropriable and local nature of technological advances; the widespread existence of static and dynamic economies of scale; the influence that technological gaps between firms and between countries have upon the economic signals agents face; and the importance of country-specific and area-specific untraded interdependencies. These factors taken together allow for the possibility of significant trade-offs between statics and dynamics. As conjectured by Kaldor (1980), if different commodities or sectors present significant differences in their 'dynamic potential' (in terms of economies of scale, technical progress, possibilities of division of labour, learning-by-doing, etc.), specialisations which are efficient in terms of comparisons of given sets of input coefficients may in the long run become either virtuous or vicious circles of technological advance.

This is more than a special case related to infant industries. It is the general condition of an economic system that technological opportunities vary across products and across sectors. More precisely, within each technology and each sector the technological capabilities of each firm and each country are associated with the actual process of production and innovation in the area. Thus, the mechanisms regarding international specialisation 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 differs widely between technologies and sectors. This is another aspect of the irreversibility of economic processes: present allocative choices influence the direction and rate of the future evolution of technological coefficients. Whenever we abandon the idea of technology as a set of blueprints and we conceive technical progress as a joint

product with manufacturing, it is possible to imagine an economic system which is dynamically better off than otherwise (in terms of productivity, innovativeness, etc.), if it evolves in disequilibrium vis-à-vis Ricardian conditions of allocative efficiency.

It is rather easy to see how a trade-off between 'allocative efficiency' and 'Schumpeterian efficiency' can emerge. The patterns of specialisation (with their properties of Ricardian efficiency) are determined, for each country, by the relative size of the sector-specific technology gaps (or leads) (see Chapter 6). Whenever the gap is highest in the most dynamic technologies (i.e. those characterised by the highest technological opportunities), allocative efficiency will conflict directly with Schumpeterian efficiency. We would suggest that the likelihood of such trade-offs between Ricardian and Schumpeterian efficiencies is proportional to the distance of each country from the technological frontier in the newest, most dynamic and most pervasive technologies.[15]

A similar argument applies to the trade-offs between Ricardian and growth efficiency. As already mentioned, the analysis of the outcome of the transition from autarky to trade focusses only on the adjustments in relative prices and relative quantities, and is based on the assumption of unchanged rates of macroeconomic activity. However, as we saw in Chapter 6 the main adjustment mechanism links absolute advantages, world-market shares, and, through that, domestic levels of manufacturing output (Chapter 7).

Under these circumstances, the growth efficiency of specialisation based on comparative advantage would always hold, if we assumed identical income elasticities across countries and across commodities, and similar and high price elasticities. However, such differences in elasticities underlie many empirical studies on both domestic demand patterns and long-term trade flows.[16] As a first approximation, let us therefore suppose that price elasticities of world demand of the traded commodities for the corresponding world industry as a whole, are relatively low;[17] and commodities present a relatively wide range of income elasticities which are commodity specific and country specific. We may illustrate the case with the help of an example similar to the one presented in Chapter 6, p. 165.

Suppose that both England and Portugal in autarky conditions have less than full employment rates of macroeconomic activity. National expenditure in both countries is composed of wine and cloth. Moreover, the share in consumption of wine relative to cloth in real terms is stable. Suppose, that in both countries a greater share of expenditure goes to cloth and that the share of wine in the basket of consumption is particularly low for England, since English people notoriously are very sober and do not like to drink more than a glass a day, no matter what

the price of wine. Under competitive conditions, we maintain the behavioural assumption that economic agents will tend to move towards those activities yielding the highest profit rates. England will specialise in cloth and Portugal in wine. The constancy-of-activity-rate assumption, however, is hard to maintain. Either country will undergo a relative real growth of aggregate income (as measured in terms of embodied labour, i.e. working hours) compared to the other.[18]

Two opposite approaches to this issue exist in economic theory. The neo-classical approach maintains that international specialisation induces simply an efficient reallocation of resources, while the rates of activity remain – in 'normal' conditions – at full employment levels. Thus, the Portuguese and English levels of income are the full employment ones and the burden of adjustment rests upon the movement of prices and consumption coefficients. Consumption coefficients are then fully endogenous variables, changes in which depend on the theory of utility, consumers' preferences and substitution in consumption. The classical Keynesian approach, on the other hand, suggests that the main adjustment mechanism operates through variations in income. In other words, the constancy-of-activity assumption has to be abandoned and variations in real incomes will adjust activity rates to the flows of imports and exports.

The agnosticism one often finds in the trade and balance-of-payments literature in the choice between the two approaches is – in our view – not really justified. The choice depends on alternative theories of consumption patterns. Following the argument in the preceding chapters about the limited price-related substitution in consumption and the way patterns of demand are essentially related to income levels, long-run trends in income distribution and institutional and social factors, it will be obvious to the reader that we favour the Keynesian approach. In a sense, the classical economists' view of fixed baskets of consumption was a rough, yet workable approximation of the general existence of Engel's curves of consumption for individual commodities.[19] Unfortunately, the same classical economists often forgot the full implications of this view when analysing open-economy situations.

If the constancy-of-activity-rates assumption cannot be maintained, then patterns of specialisation which may be efficient when the assumption holds, may not be so in terms of activity rates of one or some of the trading patterns. We can easily derive from this statement its dynamic counterpart: specialisation which is efficient if the economic systems were to move on a steady growth path, may well not be so in terms of possibilities of growth consistent with the foreign account: for instance, when the income elasticities of world demand are different and the price elasticities too low to compensate for possible imbalances in

product markets. We would argue that this is the general empirical case.

Limited price induced substitution between commodities and relatively stable evolution in the baskets of consumption may well imply painful trade-offs between microeconomic mechanisms leading to Ricardian efficiency,[20] and those patterns of production which could yield comparatively higher rates of macroeconomic activity compatible with the foreign-balance constraint.

Under conditions of non-decreasing (often increasing) returns, there is no straightforward way in which markets can relate the varying growth and Schumpeterian efficiencies 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 that a decreasing number of people in the world want to buy. Putting the same argument in a language more familiar to the economist, the widespread possibility of trade-offs between Ricardian, Schumpeterian and growth efficiencies arises from the fact that the general case is one of non-convexity of production and consumption possibility sets and non-ergodicity of technological advances.[21]

Table 8.1 illustrates from a microeconomic point of view the different criteria of efficiency which relate to the different economic signals economic agents face.[22] Suppose that there are three commodities, *A*, *B* and *C*. On the grounds of a straightforward static allocative efficiency, microeconomic units seeking the highest rate of profit will choose commodity *C*. However, from the point of view of the country to which the firm belongs, commodities *B* or *A* should be chosen, since they yield the highest dynamism in terms of demand and in terms of technical change, respectively.

The choice of any one of these three commodities corresponds, from a microeconomic point of view, to three different strategies and adjustment processes. The choice of *C* implies a 'classical adjustment' whereby

Table 8.1 An illustration of the trade-offs between 'Ricardian' efficiency, growth efficiency and Schumpeterian efficiency of specialisation

	A(%)	*B*(%)	*C*(%)
1. Short-term obtainable rate of profit	2	5	10
2. Rate of profit of world leaders	20	10	10
3. Rate of growth of world demand	15	20	1
4. Levels of technological opportunity (approximated by the long-term rate of productivity growth)	10	5	3

the strategic criterion is simply the rate of profit on the grounds of techniques readily available to the firm. The choice of *B* implies a growth strategy whereby the strategic criterion of choice is based on the rate of growth of the world market. Finally, the choice of commodity *A* stands for Schumpeterian adjustment, whereby a path of technological imitation/innovation is undertaken in order to reap the differential profits associated with technological leadership in that commodity.[23] Clearly, the more pronounced the trade-offs, the more strategies will be structurally constrained: for example, profit-motivated agents will hardly invest in a growth efficient and Schumpeter efficient commodity, whenever the expected rate of profit within a reasonable future is negative.

Conversely, Table 8.2 illustrates 'virtuous circle' conditions, whereby the 'Schumpeterian' incentive to innovation/imitation is linked in a straightforward manner to profitability signals and growth opportunities. Under these circumstances, no trade-offs between static and dynamic efficiencies emerge: the competitive process delivers signals which are also efficient in terms of innovation and growth. The search for maximum profitability also fosters technological dynamism. These trade-offs between allocative efficiency, growth and technological dynamism may well become one of the crucial determinants of the emergence of vicious and virtuous circles in national patterns of growth. This conclusion is similar to many of the analyses in development theory. However, its determinants do not bear any direct relationship with phenomena specific to developing countries (such as the supposed 'market failures' aspects). For our purposes, developed and developing countries could be placed on some kind of continuum, according to their distance from the technological frontier, and the long-term outcome of the allocative patterns generated endogenously in the market.

Technological leaders will tend to find the pattern of their intersectoral profitability signals pointing in the direction of activities which also lead to the highest demand growth, and the highest potential for future product and process innovations. Conversely, countries well behind the

Table 8.2 An illustration of 'virtuous circle' conditions

	A(%)	*B*(%)	*C*(%)
1. Short-term obtainable rate of profit	20	10	5
2. Rate of profit of leaders	20	10	10
3. Rate of growth of world demand	15	10	1
4. Long-term rate of productivity growth	10	5	3

technological frontier may be 'dynamically penalised' by their present pattern of intersectoral allocative efficiency. This property contributes, in our view, to the relative stability of the 'pecking order' between countries in terms of technological innovativeness and international competitiveness, and the relatively ordered ways in which this 'pecking order' changes in the long term (see also Chapter 4). The interaction between present economic signals, patterns of specialisation and dynamics of the sectoral technology gaps provides the basis for cumulative processes.

Major changes in the international distribution of innovative activities and in the international competitiveness of each economy, can, however, be associated with the emergence of new technological paradigms. This occurrence reshapes the pattern of technological advantages/disadvantages between countries, often demands different organisational and institutional set-ups and sometimes presents a unique 'window of opportunity' in Perez's words (Perez and Soete, 1988) for the emergence of new technological and economic leaders.

The foregoing arguments can be summarised as follows. Markets characterised by decentralised decision-making fulfil two fundamental functions. First, they provide a mechanism for coordination between individual economic decisions and, in doing so, they reallocate resources in ways, which – under the conditions specified by the theory – present properties of (varying degrees of) efficiency. 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.

As soon as these second functions of markets are taken into account in the theoretical picture, their efficiency properties become blurred and complicated to assess, even in a closed economy: allocative efficiency in a static sense may conflict with dynamic efficiency in terms of incentives to technological progress. Overlapping with, and adding to, the 'Schumpeterian trade-off' of the closed-economy case, there is the possibility of a static versus dynamic trade-off originating from the pattern of economic signals in the international market. In a way, the open-economy case induces a structural distortion in the pattern of signals that would have been generated under autarky. In doing so, they may either overrule the domestic 'Schumpeterian trade-offs' or amplify them. The hypothesis we suggested above is that this depends on the relative distance of each country vis-à-vis the technological frontier in those technologies showing the highest opportunities of innovation and demand growth.

8.3 Technological and economic dynamism: the role of policies

The framework of this book shows that institutions are crucial variables that vary according to sector, country and historical phases of development. These are both 'micro' institutions, e.g. complex corporate structures embodying specific capabilities, rules of behaviours and rationalities; modes of institutional organisation of market interactions, etc., and 'macro' institutions, such as strictly public agencies. Institutional factors appear to shape the constitution, behavioural rules, patterns of adjustment and context conditions under which economic mechanisms operate. There is no really meaningful way of either separating the strictly economic variables from their institutional framework, or assuming that strictly economic variables overdetermine their institutional contexts to such an extent that the latter tend to converge to a unique pattern. It is therefore impossible to reduce all extra-economic elements to 'interferences' or 'exceptional corrections' to a supposedly optimally performing, self-contained and well-tuned economic machine.[24]

As illustrated above, complex normative issues emerge in relation to the trade-offs between different criteria of efficiency or the degree of consistency between institutional set-ups, the nature of the technologies and economic processes.

Let us start with a first classification of the variables upon which institutions and policies may act, with particular reference to technological progress. They can be categorised as follows:

(a) the capability of the scientific/technological system of providing major innovative advances and of organising the technological 'context' conditions;
(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 organisational advances;
(c) the pattern of signals which depend on interfirm and international 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 profitability among their behavioural considerations;
(d) the forms of organisation within and between markets: e.g. the relationship between financial structures and industry, the form of industrial relations, the varying balance between cooperation and

competition, the degree and forms of corporate internalisation of transactions, etc.;

(e) the main behavioural regularities characterising agents, within the degrees of freedom allowed for by the pattern of technological asymmetries and economic signals: e.g. the strategies affecting the mix between Ricardian and Schumpeterian adjustments; and

(f) the incentives/stimuli/constraints facing agents in their adjustment and innovative processes: e.g. the degree of private appropriability of the benefits of innovations, the intensity of competitive threats, etc.

Ideally, one would like to develop some 'policy taxonomy' grouping these various categories according to the degrees of technological and economic development of the various countries, as well as according to the stage of development of the various technological paradigms, and to ask whether we can make some useful generalisation.

There are two issues here: a positive one and a normative one. On descriptive grounds there is little doubt that all market economies have (and have had for a long time) various mixtures of policies affecting all the above groups of variables. The analytical task is to make sense of the intertemporal, cross-sectoral and cross-country differences. Conversely, on more normative grounds, one should be able to justify the requirement for policies in relation to some performance yardstick.

The discussion of the patterns of technical change provides two broad grounds for a normative approach. First, 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'. The normative counterpart of this intrinsic feature of the innovative process does not, however, regard the question as *if* but *how* and *to what degree* policies should affect innovative activities.

Second, the existence of possible trade-offs between 'static' efficiency, on the one hand, and growth and Schumpeterian efficiencies, on the other (sometimes amplified by the way technological gaps feed back into market signals in the international market) highlights a wide realm for institutional intervention.

Clearly, in a transforming world, the performance criteria and the link between policies and performance are fuzzy and uncertain. Take, again, the example of the cluster of new microelectronics technologies. Despite rapid growth of world demand, innovation and productivity growth in these sectors, pointing to the dominance of 'growth' and 'Schumpeterian efficiency', one is confronted with complex normative issues. For example, how far should one country depart from static

efficiency, whenever the latter conflicts with the dynamic criteria of performance, in order to pursue these new technologies? When is private appropriability too low, so that it hinders private innovative incentives? To what extent, and in what manner, can public efforts efficiently substitute for decentralised innovative processes? Even if varying degrees of intervention are required, what are the most conducive institutional arrangements? Relatively little research has been done in these areas. Yet, even after detailed historical and cross-country investigations, one might have to come up with, at best, sets of possible combinations between policies, institutional arrangements and performances, without any claim to having identified the 'optimal' configuration.

In the light of our discussions in Section 8.2 above, the structural need for policies affecting the pattern of economic signals (including relative prices and relative profitabilities), emerging from the international market, will be greater, the greater the distance of any one country from the technological frontier. Conversely, endogenous market mechanisms will 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 happens to be advocated and fully exploited only by the leading countries.

Furthermore, as regards the time profile of technological developments, a distinction can be made between policies related to the emergence of new technological paradigms, and policies to sustain technological activities along relatively established paths. In the former case, policies should provide a satisfactory flow of scientific advances, establish 'bridging institutions' between scientific developments and their economic exploitation, develop conducive financial structures to support the trial-and-error procedures generally involved in the search for new technological break-throughs, and act as 'focussing devices' in the selection processes of the direction of technological development.[25]

As regards 'normal' technical progress, important policy tasks are the maintenance of a relatively fluid supply of techno-scientific advances, coupled with 'balanced' conditions of private appropriability of the benefits of innovating (e.g. through patent policies, etc.). Countries well below the technological frontier may also find it necessary to act directly on both the technological capabilities of domestic companies, and on the appropriability features of the related technologies, in so far as they function as an entry barrier for catching-up companies and countries.

Public policies affect also the fundamental 'rationalities' of the agents (including the ways their expectations and objectives are formed). As an illustration, consider the role of military spending. In addition to its effects upon the composition of demand and the pattern of economic

signals, military spending is also likely to shape firms' strategies and managerial outlooks. Almost certainly, public agencies tend to be perceived as a 'guarantee of last resort',[26] while the skills of detecting and influencing procurement authorities are likely to become more important than the capabilities of understanding and anticipating market trends in competitive environments. Clearly, this is only one – possibly the most straightforward – example of a set of influences that the political structure exerts upon the behavioural constitution of market processes.

In reality, in all major Western countries a relatively high degree of intervention takes place. Whereas in terms of financial transfer to the industrial sector, significant differences can be detected between the European countries, the United States and Japan,[27] all countries affect, through their policies, the economic signals, the capabilities of agents, the environmental incentives and the context conditions. What appear to differ significantly across countries are the institutional arrangements and underlying philosophy of intervention.

Regarding the latter, one can identify two extreme archetypes. The first is characterised by a 'liberal' view of public policies, more or less loosely underpinned by neo-classical economics. Typically, intervention is justified on three grounds here, namely a regulatory level (anti-trust laws, etc.); the correction of assumed 'distortions' of market mechanisms (e.g. 'unfair' competition from abroad, etc.); and the existence of 'market failures' (e.g. R&D support, etc.).

In addition, public procurement, including military expenditure, is not meant as an instrument of industrial policy and therefore need not be justified on economic grounds. This view appears to characterise, to different degrees, the United States and a limited number of European countries (above all, the United Kingdom). At the opposite extreme, there is an 'instrumentalist' view of market processes, to which one does not attach any optimality feature: markets are simply viewed in relation to their (varying) effectiveness in pursuing exogenously defined objectives (e.g. the technological modernisation of a country, income growth, national power, etc.). As a consequence, policy instruments are also chosen without much respect for the short-term prescriptions of economic theory. This view appears to characterise Japan, possibly France, and certainly pre-War Germany.

Against this background it is interesting to observe the choice of policies for technological innovation by the major Western countries in the most recent period. At one extreme, consider the example of Japan, especially in relation to the cluster of electronics technologies. Japan appears to have acted comprehensively on all the levels discussed above. In particular, it appears to have succeeded in a difficult 'fine tuning' between 'signal policies' which, as such, risk *shelving* and protecting positions that are inefficient from an allocative point of view, and competition policies which stifle the adjustment processes. In this respect, the Japanese case is almost an archetype: heavy discretionary manipulation of the signal structure (by means of formal and informal protection against imports and foreign investments; an investment policy of financial institutions consistent with growth and dynamic efficiency) recreated the '*vacuum environment*' that is generally enjoyed only by the technological leader(s). However, this has been matched by a pattern of fierce oligopolistic rivalry between Japanese companies, and heavy export orientation, which fostered technological dynamism and prevented any exploitation of protection in terms of collusive monopolistic pricing.

It is tempting to compare this Japanese experience with other, less successful ones, such as those of many European countries, which relied heavily upon one single instrument, i.e. financial transfers (especially R&D subsidies and transfers on capital accounts), leaving to the endogenous working of the international market both the determination of the signals and the response capabilities of individual firms. Certainly there are country-specific features of the Japanese example which are hardly transferable. But the Japanese case, in its striking outcome, points to the general possibility of reshaping patterns of 'comparative advantage' as they would notionally emerge from the endogenous evolution of international markets. At the end of the Second World War, no economist would ever have suggested that electronics would be one of Japan's comparative advantages. Now it certainly is.

The use of comparative advantage criteria as the final grounds for normative prescriptions is a luxury that only countries on the technological frontier can afford: *rebus sic stantibus*, it will not be long before Japanese economists preach Ricardo, Heckscher–Ohlin and general equilibrium analysis, while it might also not be too long before Americans rediscover Hamilton, List and Ferrier. The more general point will be clear. Historically, a successful catching-up effort in terms of per capita income and wages has always been contextual to technological catching-up in the new and most dynamic technologies, irrespective of the initial patterns of comparative advantages, specialisation and market-generated signals.[28]

8.4 Some conclusions

In a world characterised by technical change, technological leads shape the pattern of intersectoral and interproduct profitability signals and,

thus, also the pattern 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 technological innovativeness.

In the last resort, this happens because the effects of a multiplicity of signals (related to profitability, long-term demand growth and technological opportunities, on microeconomic processes of adjustments) are likely to be asymmetric, entail dynamic increasing returns, and various sorts of what economists call 'path-dependencies', 'non-convexities', and 'externalities'. Whenever trade-offs between different notions of efficiency arise, 'sub-optimal' or 'perverse' macroeconomic outcomes may emerge, if profit-oriented agents privilege processes of allocation biased in the direction of what we call 'static' or Ricardian efficiency. Since the future pattern of technological advantages/disadvantages is also related to present allocative patterns, one is confronted here with a set of dynamic processes which Kaldor called 'circular causation'. Economic signals related to intersectoral profitabilities – which lead in a straightforward manner to comparative advantage and relative specialisation – check the allocative efficiency of the various productive uses, but may also play a more ambiguous or even perverse role in relation to long-term macroeconomic growth.

The 'vicious' or 'virtuous' circular processes discussed above concern the very nature of allocative mechanisms, in so far as each economy is characterised by technical change showing varying degrees of sector-specific opportunity, cumulativeness, appropriability, dynamic technological externalities, and local and idiosyncratic learning.

Furthermore, it was argued that institutional factors – including, of course, policies – are part of the constitution of economic processes: i.e. the ways in which economic activities are organised and coordinated, technical change is generated and used, the dominant behavioural regularities emerge, etc. This clearly is another domain for policies.

A detailed understanding of the pattern of signals, of allocative responses and forms of institutional organisation of the 'economic machine', appears to be particularly important in those phases of transition from an old technological regime 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 and with it international trade flows and relative levels of per capita income. 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 are ex-ante political dreams and/or the partly unintentional outcome

of processes of evolution and selection within both the domains of economics and institutions.[29]

Notes

1. In Nelson and Winter's words: 'if the economic world is in continuing flux, as our positive theory suggests is the case, the normative properties associated with competitive equilibrium become meaningless, just as that equilibrium is meaningless a description of behaviour' (see Nelson and Winter, 1982, p. 356). Interestingly, Stiglitz, who has made major contributions to the analysis of the properties of equilibrium models characterised, in one way or another, by imperfect information, concludes that 'the notions of decentralisation associated with neo-classical theory are more akin to a description of a computer algorithm – a description of how one might efficiently go about a complicated maximisation problem that one needs to solve once and for all – than of an institutional structure which is required to adapt and respond to a series of new and changing problems' (Stiglitz, 1984, p. 35).
2. These issues have been discussed at greater length in Dosi and Orsenigo (1988).
3. Nelson and Winter (1982), p. 356.
4. Stiglitz (1984), p. 36.
5. For a broad and fascinating view of these issues by a non-economist, see Luhmann (1975).
6. For an interesting model of the pharmaceutical industry, see Grabowski and J. Vernon (1984).
7. Cf. Katz and Philips (1982), Dosi (1984).
8. Cf. Freeman (1974).
9. See also Nelson and Winter (1982), Mowery (1983), and Nelson and Soete (1988).
10. In this sense, one can interpret the measures of best-practice and average technical progress developed in Soete and Turner (1984).
11. As an illustration, take the example of two rather successful machine tool industries: the Japanese and Italian. The former is characterised by relatively large firms, often vertically integrated, and by a relatively close coordination between the government, the banks and the companies. Conversely, the Italian industry, with three or four major exceptions, is made up of small firms, linked to users and suppliers only by arms-length relationships. Alternatively, consider the semi-conductor industry in Japan and the United States: again, in the former the old electro-mechanical oligopolists have succeeded in becoming major microelectronics producers, while in the United States the industry is essentially made up of Schumpeterian new firms which have grown big through their success (see Dosi, 1984). As argued in Dosi and Orsenigo (1988), one would actually need something like a 'theory of possible worlds', that is, a theory of all feasible combinations between organisational structures, nature of technological paradigms and forms of socio-economic tuning, which yield acceptable allocative patterns and innovative dynamism.
12. Silverberg, Dosi, and Orsenigo (1988) discuss the importance of diverse

(and, possibly, *ex post*, unsuccessful) expectations and strategies for technological diffusion.

13. Interestingly, at the microeconomic level. Gardiner (1984) finds that along any technological trajectory, the designs that are 'robust' and successful in the long term, start by being full of slack and 'non-optimised'.
14. Similar assumptions were implicit in the original treatment of international trade by Ricardo:

> No extension of foreign trade will immediately increase the amount of value in a country, although it will very powerfully contribute to increasing the mass of commodities, and therefore the sum of enjoyments. As the value of all foreign goods is measured by the quantity of the produce of our land and labour, which is given in exchange for them, we should have no greater value, if, by the discovery of new markets, we obtained double the quantity of foreign goods in exchange for a given quantity of ours'. (Ricardo (1951), p. 128)

Since production techniques are given, the 'amount of value in a country' is precisely equivalent to its rates of macroeconomic activity as measured by the degree of utilisation of its labour force.

15. A similar argument applies to the implications of allocatively efficient specialisations for long-term technological learning. If learning tends to be 'local', i.e. associated with actual production and research experiences, cumulative and tacit (cf. Chapter 4), static allocative efficiency may well be a poor guide for the long-term innovative opportunities which various productive activities entail. We argued in Chapter 4 that sectors also differ in terms of opportunities for technological advances. This phenomenon, together with the likely feedbacks between incentives to allocate productive and research efforts in 'comparative-advantage' activities, imply the possibility of 'lock-in' effects along particular trajectories of production and innovation. Analytically, such an environment is described by increasing returns, non-ergodic models (see Arthur, 1985, 1988; David, 1985, 1987) and also 'local learning' models (cf. Atkinson and Stiglitz, 1969; Stiglitz, 1987). Normatively, a general implication is that decentralised processes of market allocation may either involve 'vicious' or 'virtuous' circles – whenever judged on the grounds of long-term innovative performances. Technically, this is equivalent to saying that decentralised processes of allocation *cum* increasing returns, *cum* path-dependency generally imply multiplicity of equilibria that are locally stable, but may well be normatively 'sub-optimal'.
16. Cf. the thorough discussions by Thirlwall (1980) and Lafay (1981). See also Cornwall (1977). Within the literature on development, cf. the classical work by Prebisch (1950).
17. This statement must not be confused with price elasticities for individual 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.
18. In the notional transition from autarky to trade, unchanged levels of macroeconomic activity (and employment) will be maintained only if a number of conditions are fulfilled. First, the 'production functions' of cloth and wine, as conventionally defined, have to exist. Second, these must differ in terms of input intensities, at least for some relative prices. Third, there is sufficient substitution in consumption in reaction to relative prices. And fourth, input markets display a well-above-zero price elasticity for excess demand. For the sake of an *a fortiori* argumentation of our point, one may as well accept the last assumption. However, our foregoing discussion (especially Chapter 4) implies that the first assumption is not generally corroborated by the evidence. Hence, the conclusion rests entirely on the third assumption – substitution in consumption.
19. A thorough discussion can be found in Pasinetti (1981). Cf. also Dosi (1984). For empirical evidence Deaton and Muellbauer (1980), who are not particularly suspected of any anti-neo-classical bias. More specifically in relation to trade, cf. Houthakker and Magee (1969), and on price elasticities, Stern, Francis and Schumacher (1976).
20. Blejer (1978) shows empirically that the structure of imports and exports by country presents a relatively regular evolution in relation to income per capita whenever the sectors are ranked according to the income elasticity of their products. He also shows that such a regularity cannot be found if the sectors are ranked according to their factor-intensity.
21. On this last point, see Arthur (1985) and (1988).
22. In the example that follows we abandon the hypothesis, rigorously implicit in a Ricardian world, of free competition, and we allow for oligopolistic differences in profit rates. It should be clear that this adds realism to the example, without in any sense being the cause of the trade-offs between the different efficiency criteria.
23. Note, however, that in the real world the last two are likely to be strictly associated: world demand of innovative commodities is likely to grow relatively faster.
24. One of us critically analysed these reductionist approaches with reference to the history of economic thought in Dosi (1988).
25. Cf. Rosenberg (1976).
26. We owe this observation to a discussion with H. Minsky. See also M. Kaldor (1980).
27. For some evidence, cf. Ranci (1983) and Horn (1982).
28. See also Soete, 1985.
29. See, for a somewhat similar point, Perez (1984) and Boyer (1988).