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Introduction

The existence of profound relationships of some sorts between innovation, industrialization and economic development is now generally acknowledged in both economic history and economic theory. However, the conditions which foster technological learning and its successful incorporation into the economy and in particular the role of institutions and policies continues to be more controversial. This chapter addresses these issues and tries to offer a framework for the interpretation of the ways activities of "institutional engineering" and policies shape technological catching-up and industrial development.

Let us start from a first simple empirical observation show that no example can be found in history of a process of development nested in an environment even vaguely resembling the institution-free tale of economic interactions that one finds in a good deal of contemporary economic theory. On the contrary, all historical experiences of sustained economic growth – starting at least from the English "Industrial Revolution" – find their enabling conditions in a rich set of complementary institutions, shared behavioural norms and public policies (more in Reinert 2006). Indeed, the paramount importance of institutions and social norms appears to be a rather universal property of every form of collective organization we are aware of. Moreover, much more narrowly, discretionary public policies have been major ingredients of national development strategies, especially in catching-up countries, throughout the history of modern capitalism (Amsden 1989, Freeman 2004, Mazzoleni and Nelson 2005, Peres 2006, Stiglitz 2001, Reinert 2007, but also much earlier Veblen 1915).

Complementary evidence at the level of single industries and firms highlight the variety of institutions governing the access to innovative opportunities, the mechanisms market selection mechanisms and the evolution of industrial structures (Nelson 1994). Together, note the bi-directional relation between the evolution of industrial structures themselves (including distributions of different firms' characteristics such as innovative competences, ownership, behavioural traits, etc.) and the patterns of technological learning. Different rates of learning influence the ability of firms to survive and expand and thus affect industrial structures. Conversely any particular structure - with its associated distribution of corporate features - influences and constrains what and how fast firms are able and willing to learn. In turn, industrial structures – with the patterns of specialization that they entail – are the carriers of particular trajectories of learning in the various countries which co-evolve with distinct, institutionally nested, national systems of innovation and production.

On all this there is an extremely robust historical evidence; together there are very sound theoretical reasons supporting the notion that institutions and policies always matter in all processes of technological learning and economic coordination and change. In this chapter, we focus precisely on such theoretical foundations for "institution engineering" and policies and, building on them, we discuss possible menus of policy instruments.

The "market omnipotence": a misleading point of departure

Conventionally, one would start from the very general question when are public policies required from the point of view of the theory and, as known, the standard answer would be "when there are market failures" of some kind. However, albeit quite common, the "market failure" language tends to be quite misleading in that, in order to evaluate the necessity and efficacy of any policy, it takes as a yardstick those conditions under which standard normative ("welfare") theorems hold. The problem with such a framework is not that "market failures" are not relevant. Quite the contrary: the problem is that hardly any empirical set-up bears a significant resemblance with the "yardstick" - in terms of e.g. market completeness, perfectness of competition, knowledge possessed by economic agents, stationarity of technologies and preferences, "rationality" in decision-making, etc. (the list is indeed very long!). In a profound sense, when judged with standard canons, the whole world can be seen as a huge market failure!

Indeed, this is implicitly recognized in any serious policy discussion, where the argument about policy almost never is about whether the situation at hand is actually "optimal", but rather about whether the problems with the incumbent institutional set-up are sufficiently severe to warrant active policy measures. In all that, most often the demand for "proofs for failures" mainly plays as a device to put the burden of the evidence away from the believers in the dogma that in general "more market is always better than less...".

Believing in "market omnipotence" entails misleading policy conclusions: it disregards the importance of non-market institutions and, moreover, it neglects the complementarities between market and non market mechanisms of economic governance. The interpretation presented here is consistent with institutional approaches endorsing the notion that markets do not exist or operate apart from the rules and institutions that establish them and that "the institutional structure of the economy creates a distinct pattern of constraints and incentives", which defines the interests of the actors as well as shaping and channelling their behaviours (Zysman 1994, pp. 1-2). And this holds

particularly true when considering the interaction between markets dynamics and innovative activities as a fundamental source of economic change and growth.

In much of the contemporary writings by economists, it is almost taken for granted that modern economies need to be largely structured through markets, and that good institutions support the effective operation of such an economy. But it is not clear that economists presently have a good conception of what "effective operation" of a "market" economy involves, particularly if the performance we are trying to understand involves economic growth, which virtually all scholars recognize as being largely driven by innovation. As Schumpeter argued long ago, the standard neoclassical theory of market organization and behaviour is not capable of dealing with the phenomena of innovation. It also is clear that, once one pays attention to the activities that support innovation, a number of non-market organizations (like universities, and Government R and D support programs) are involved, as well as market organizations. There is the task, therefore, of developing a theory of innovation driven economic growth, and the activities involved, that recognizes the key roles played by non-market structures as well as those conventionally seen as market ones (more in Nelson 2006).

Attentive to the empirical realities of markets and non-market institutions which govern production, exchanges and economic coordination in modern economies, in the following we shall discuss both issues of (i) the boundaries between market and non-market forms of economic organization, and (ii) embeddedness of markets themselves into complementary non-market institutions.

The boundaries between market and non-market institutions

Which types of social activities are subject to (i) decentralized production and (ii) money-mediated exchanges, and which ones are not? There is an impressive range from the economically banal to the morally outrageous. "Strategic" goods? Pharmaceuticals? "Natural" monopolies? Public utilities? Education? Childcare? Retirement benefits? Health care? Human organs? Blood? Husbands and wives? Political votes? Children? Court rulings?

In another work one of us (Nelson 2005) discusses precisely the *governance structure* of a few goods and services wherein their provision has often relied, in part or entirely, on non-market mechanisms.

Clearly the question of the determination of market boundaries applies to both developed and developing countries but is particularly crucial in emerging and ex-centrally planned economies where the boundaries between market and non-market institutions have still to be clearly defined. Far from the fury of market fundamentalism, our basic view there is that non-market institutions (ranging from public agencies to professional associations, from trade unions to community structures) are at the core of the very constitution of the whole socio-economic fabric. Their role goes well beyond the enforcement of property rights. Rather, they offer the main governance structure in many activities where market exchanges are socially inappropriate or simply ineffective. At the same time, they shape and constrain the behaviour of economic agents toward competitors, customers, suppliers, employees, government officials, etc. In that, they are also instrumental in curbing the "self-destruction perils" flagged long ago by Polanyi (1957) and Hirshman (1982).

Moreover, notice that even when one encounters a prevailing "market form" of governance, the latter is embedded in a rich thread of non-market institutions. Pharmaceutical is a very good case to the point. Here in all countries with an effective, for-profit pharmaceutical industry, one finds government programs that support biomedical research, generally at universities and public labs. Together, the university parts of these programs are associated also with scientific training for people who after finishing their education, go on to work in pharmaceutical companies. Moreover, in virtually all countries, public funds and programs play a major role in the procurement of pharmaceuticals. And, finally, in virtually all countries there are various forms of regulation of pharmaceutical which go well beyond textbook guarantee of property rights and integrity of exchanges.

Or consider aircraft and airline services. In all countries that have a major aircraft production, government funds play a significant role in R&D. And in most countries both the airports and the traffic control system are not only funded but run by government agencies. Even in the simple case of trucking and the use of automobiles, the public sector plays a major role: it builds and maintains roads, regulates safety and inspects vehicles, while a large share of the police is traffic police...

Indeed, even when the conditions which allow markets to work reasonably well are fulfilled – in terms of distribution of information, norms of interaction, etc. – we propose that their role should be evaluated not only in terms of allocative efficiency (whatever that means in ever-changing economies) but also as environments which continuously allow the experimentation of new products, new techniques of production, new organizational forms. In this perspective, markets, when they work, operate as (imperfect) mechanisms of selection. Also at this level, the ways the

institutional architecture organizes the interactions amongst economic agents, and the ways policies regulate behaviors and forms of competition have a paramount importance.

The generation, adoption and economic exploitation of knowledge: a baseline for catch-up

While the importance of institutions and policies is ubiquitous in all process of economic coordination and change, this is particularly so with respect to the generation and use of information and knowledge. As we know since the early works of Nelson (1959) and Arrow (1962) they are in many respects similar to a "public good" in that the use of information is:

- non-rival (the fact that one uses it does not prevent the others from using it too);
- non-excludable (were it not for institutional provisions such as patent-based monopoly rights of exploitation).

Moreover, the generation of information is subject to:

- sunk, upfront costs of production, and basically zero cost of reproduction;
- if anything, there are increasing returns to its use, in the sense that the more we use it the easier it is, and, dynamically, the higher is the likelihood of learning and producing ourselves "better", "novel", in some sense "innovative" further pieces of information.

One should note that these very properties of information intrinsically entail phenomena of market failures, to use the jargon just criticized above (also in that marginal prices are of no guidance to efficient market allocation and equilibria might even fail to exist).

Further insights may be gained by distinguishing between sheer information and knowledge. Knowledge includes (i) the pre-existing cognitive categories which allow information to be interpreted and put to use; (ii) search and problem-solving heuristics irreducible to well defined algorithms.

All forms of knowledge have a significant tacit aspect, highly complementary to codified information, which makes them person- or organization-embodied and rather sticky in their transmission. Indeed, this is one of the fundamental reasons why technological catching-up by developing countries remains a challenging task even in an era of globalization and free-information flows.

It happens that all processes of generation of new scientific and technological knowledge as well as of technological imitation and adaptation involve a rich variety of complementary actors, often including business firms but, together, public training and research institutions, "communities of practice", technical societies, trade unions, among others.

In a fundamental sense, institutions and policies shaping technological learning have to do with the construction of *national systems of innovation* (Nelson 1993; more specifically on development see Cimoli and Dosi 1995). *First*, in such a process firms are a crucial (although not exclusive) repositories of knowledge, to a large extent embodied in their operational routines, and modified through time by their higher level rules of behaviours and strategies (such as their search behaviours and their decisions concerning vertical integration and horizontal diversification, etc.). *Second*, firms themselves are nested in networks of linkages with other firms and also with other non-profit organizations (such as public agencies etc.). These networks, or lack of them, enhance or limit the opportunities facing each firm to improve their problem-solving capabilities. *Third*, national systems entail also a broader notion of embeddedness of microeconomic behaviours into a set of social relationships, rules and political constraints. Even at a strictly micro level, the momentum associated with single technological learning paths is itself a largely social activity driven by the commitments (and the interests) of a multiplicity of actors – of course the business firms concerned, but also financial investors, educational institutions, regulatory bodies, etc. -.

Indeed, institutions can be seen as the social technologies (Nelson and Sampat 2001) mastering externalities and matching/mismatching patterns between innovative activities, underlying incentives structures, investment activities, labor training, and socially distributed skills. In turn, the institutions governing such externalities and complementarities do so also governing interaction rules among agents, shaping their beliefs and the information they may access, their "ethos" and behavioural rules (For a more detailed discussion, see Hoff and Stiglitz 2001).

The process of catch-up involves innovation in an essential way. The innovating activities that drive the process of course differ from the innovating that is the focus of a good deal of research and technological learning in advanced economies. The new technologies, and new practices more generally, that are being taken on board, while new to the country catching-up, generally are well established in countries at the frontier. And much of the innovation that is required is organizational and institutional. But what is going on in catch-up most certainly is innovation in the sense that there is a break from past familiar practices, considerable uncertainty about how to make the new practice work effectively, a need for sophisticated learning by doing and using, and a high risk of failure, as well as a major potential payoff from success.

In turn, the economic exploitation of innovative activities is mediated by the transformation of the production structure and the reallocation of resources from low productivity to high productivity sectors typically characterized by dynamic increasing returns. Historically, such sectors of activities comprised a good part of manufacturing activities. More generally the dynamics of industrialization rest upon major structural transformation which entail a changing importance of different branches of economic activity as generators of both technological and organizational innovations. The recent literature on innovation highlights the diversity in the sources of learning opportunities and their complementarities between them (Dosi 1988a; Cimoli and Dosi 1995; Mowery and Nelson 1999). In fact in each epoch there appears to be technologies whose domains of application are so wide and their role so crucial that the pattern of technical change of each country depends to a good extent on the national capabilities in mastering production/imitation/innovation in such crucial knowledge areas (e.g. in the past, mechanical engineering, electricity and electrical devices, and nowadays also information technologies). Moreover, the linkages among production activities often embody structured hierarchies whereby the most dynamic technological paradigms play a fundamental role as sources of technological skills, problem-solving opportunities and productivity improvements. Thus, these core technologies shape the overall absolute advantages/disadvantages of each country. The patterns of technical change of each country in these technologies does not average out with the technological capabilities in other activities but are complementary to them. These core technologies often also imply the construction of basic infrastructures and networks common to a wide range of activities (such as, for example, the electricity grid, the road system, telecommunication information networks). Historical evidence strongly supports the view that self-sustained technological dynamism in catching-up countries is hardly possible without a progressive construction of a widening manufacturing sector involving also indigenous skills in a set of "core" technologies[1].

Complementarities, incentives and coordination hurdles

So far, we addressed some basic motivations underlying the policies and the institutions affecting primarily the mechanism of knowledge accumulation. But what about coordination problems, stemming in a first instance from the very inter-relatedness among multiple heterogeneous agents? Of course, the distinction is not as clear as that: "coordination" involves also demand ("Keynesian") feedbacks, and requires reasonable degrees of incentive compatibility among agents as well as coordination in learning processes and linkages. However, the fundamental "coordination" issues

[1] Germane discussions are in Freeman and Louça (2001) and Perez and Soete (1988)

here are that of matching between decentralized behaviours, the radically different outcomes that such processes might entail depending on the institutions in which they are nested, and the importance of policies in all that.

Interestingly, the basics are quite clear to some founding figures of development economics as a discipline (Including Nurske, Gerschenkron, Rosenstein-Rodan, Hirschman and Prebisch). Consider the following remarks by Nurske:

"in our present context it seems to me that the main point is to recognize how a frontal attack of this sort - a wave of capital investments in a number of different industries - can economically succeed while any particular industry may be blocked or discouraged by the limitation of the pre existing market. Where any single enterprise might appear quite inauspicious and impracticable, a wide range of projects in different industries may succeed because they will all support each other, in the sense that the people engaged in each project, now working with more real capital per head and with greater efficiency in terms of output per man-hour, will provide an enlarged market for the products of the new enterprises in other industries. In this way the market difficulty, and the drag it imposes on individual incentives to invest, is removed or at any rate alleviated by means of a dynamic expansion of the market thorough investment carried out in a number of different industries" (Nurske 1953, pp. 13-14).

And by Gerschenkron:

"industrialization process begins only if the industrialization movement can proceed, as it were, along a broad front, starting simultaneously along many lines of economic activities. This is partly the result of existence of complementarity and indivisibilities in economic process. Railroads cannot be built unless coal mines are opened up at the same time; building half a railroad will not do if an inland center is to be connected with a port city. Fruits of industrial progress in certain lines are received as external economies by other branches of industry whose progress in turn accords benefit to the former. In viewing the economic history of Europe in the nineteenth century, the impression is very strong that only when industrial development could commence on a large scale did the tension between the preindustrialization conditions and the benefits expected from industrialization become sufficiently strong to overcome the existing obstacles and to liberate the forces that made for industrial policies" (Gerschenkron 1952, pp. 10-11)

Similar insights are behind Rosenstein – Rodan's *big push* theory (Rosenstein – Rodan 1943); cf. also the contemporary revisitation in Murphy, Shleifer and Vishny 1989: as one discusses in Hoff and Stiglitz (2001), a crucial feature on which the relevance of big push models rest is diffused externalities, where the interaction effects occur through system wide variables such a aggregate demand, industrial demand for inputs, and search costs.

These are all domains where appropriate mixes of policies may and do help – as historical

experiences have shown – to “delock” from the past and foster novel developmental trajectories. It has been so in the past, and, as we shall argue below, there is little reason to believe that it will be radically different in the future, notwithstanding so-called "globalization".

The development of technological capabilities: policies and institutional engineering

A fundamental element in countries that successfully catch-up with the leaders during the 19th and 20th centuries was active government support of the catch-up process, involving various forms of protection and direct and indirect subsidy. The guiding policy argument has been the need of domestic industry in the industries of the day judged critical in the development process for some protection from advanced firms in the leading nations. Alexander Hamilton’s argument (1791) for infant industry protection in the new United States was virtually identical to that put forth decades later by Friederich List (1841) regarding Germany’s needs. Gershenkron’s (1962) famous essay documents the policies and new institutions used in Continental Europe to enable catch-up with Britain. The same story also fits well with the case of Japan, and of Korea and Taiwan somewhat later. In many countries these policies engendered not successful catch-up but a protected inefficient home industry. However, they also were the hallmark during the 20th century of all the countries that have achieved their goals of catching-up (for a broad historical overview of the role of policies in some now-developed countries, see Reinert 2006; for ambitious synthesis which we largely share, cf. Freeman 2004 and Reinert 2007)

These policies obviously angered companies in the leading countries, and their governments, particularly if the supported industry not only supplied its home market but began to invade the world market. While the case made after World War II for free trade was mostly concerned with eliminating protection and subsidy among the rich countries, and at that time there was sympathy for the argument that some infant industry protection was often useful in developing countries, the more recent international treaties that have been made increasingly have been used against import protection and subsidy in countries seeking to catch-up from far behind. Our belief is that Hamilton and List were and continue to be right that successful catch-up in industries where international trade is considerable requires some kind of infant industry protection or other modes of support.

Moreover, during the 19th and early 20th century, many developing countries operated with intellectual property rights regimes which did not restrict seriously the ability of their companies to in effect copy technologies used in the advanced countries. There are many examples where

licensing agreements were involved, but we believe that for the most part these were vehicles through which technology transfer was effected for a fee or other considerations, rather than instances of aggressive protection of intellectual property by the company in the advanced country.

Given that, what are the different domains of policy intervention and how do they map into different policy measures and related institutions? Table 1 summarizes an exploratory taxonomy.

In the last resort, policies and other activities of "institutional engineering" affect together (i) the technological capabilities of individual and corporate organizations, and the rate at which they actually learn; (ii) the economic signals that they face (including of course profitability signals and perceived opportunity costs); (iii) the ways they interact with each other and with non-market institutions (e.g. public agencies, development banks, training and research entities, etc.)

Table 1. Some classification of the variables and processes which institutions and policies act upon (in general and with particular reference to technological learning)

Domains of policy intervention	**Policy measures**	**Related institutions**
(i) Opportunities of scientific and technological innovation	Science policies, graduate education, "frontier" technological projects	Research universities, public research centers, medical institutes, space and military agencies, etc.
(ii) Socially distributed learning and technological capabilities	Broader education and training policies	From primary education to polytechnics, to US-type "land-grant colleges", etc.
(iii) Targeted Industrial Support Measures, affecting e.g. types of firms, etc. – *in primis* the structure, ownership, modes of governance of business firms (e.g. domestic *vs*. foreign, family *vs*. publicly owned companies, etc.)	From the formation of state-owned firms to their privatization, from "national champions" policies to policies affecting MNCs investments; all the way to the legislation affecting corporate governance	State-owned holdings, public merchant banks, public "venture capitalist", public utilities
(iv) The capabilities of economic agents (in the first instance business firms) in terms of the technological knowledge they embody, the effectiveness and speed with which they search for new technological and organizational advances, etc.	cf. especially points (ii), (iii) and also R&D policies; policies affecting the adoption of new equipment, etc.	
(v) The economic signals and incentives profit-motivated agents face (including actual and expected prices and profit rates, appropriability conditions for innovations, entry barriers, etc.)	Price regulations; tariffs and quotas in international trade; Intellectual Property Rights regimes, etc.	Related regulatory agencies, agencies governing research and production subsidies, trade controlling entities, agencies granting and controlling IPRs
(vi) Selection mechanisms (overlapping with the above)	Policies and legislation affecting Anti-trust and competition; entry and bankruptcy; allocation of finance; markets for corporate ownership; etc.	Anti-trust authorities, institutions governing bankruptcy procedures, etc.
(vii) Patterns of distribution of information and of interaction amongst different types of agents (e.g. customers, suppliers, banks, shareholders, managers, workers, etc.)	Governance of labor markets, product markets, bank-industry relationships, etc. all the way to collectively shared arrangements for within-firms information-sharing mobility and control, forms of cooperation and competition amongst rival firms, etc. (cf. for example the historical differences between Japanese *vs*. Anglo-Saxon firms)	

It happens that all major developed countries present indeed relatively high degrees of intervention – whether consciously conceived as industrial policies or not – that affect all the above variables. And this applies, even more so, to the period when today's developed countries were catching–up with the international leader. What primarily differentiate the various countries are the instruments, the institutional arrangements and the philosophy of intervention.

In another work, one of us considers the case of Japanese policies, especially in relation to electronic technologies, after WW II, as a paradigmatic example of catching-up policies (Dosi, 1984). Interestingly, Japan appears to have acted comprehensively upon all the variables categorized in our taxonomy above. A heavy discretionary intervention upon the structure of signals (also involving formal and informal protection against imports and foreign investments) recreated the "vacuum environment" 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 terms of collusive monopolistic pricing.

It is tempting to measure this Japanese experience - notwithstanding, recent, mostly macroeconomic difficulties - with others, on average 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 signals and the response capabilities of individual firms. Certainly, there are country-specific features of the Japanese example which are hardly transferable. 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.

The comparison between the experience of Far Eastern countries and Latin American ones is equally revealing (cf. Amsden 1989 and 2001, Wade 1990, Stiglitz 1996, Lall 2000, Kim and Nelson 2000, Dosi, Freeman and Fabiani 1994, Cimoli et al. 2006).

In a nutshell, Korea - as well as other far-eastern economies - have been able to "twist around" absolute and relative prices and channel the resources stemming from "static" comparative advantages toward the development of activities characterized by higher learning opportunities and demand elasticities (Amsden (1989))[2]. And they did that in ways which penalized rent-seeking

[2] On the "perverse" importance of rent-seeking in the development process, cf. Khan (2000a) and (2000b)

behaviours by private firms[3]. In fact, in the Korean example, the major actors in technological learning have been large business groups - the chaebols – which were able at a very early stage of development to internalize skills for the acquisition of technologies from abroad, their efficient use and their adaptation and, not much later, were able to grow impressive engineering capabilities (cf. Kim 1993).

This process has been further supported by a set of institutions which in the case of Far Eastern economies, and unlike most of South America ones, have been successful in improving the diffused augmentation of technical and organizational skills (Amsden 1989).

All this sharply contrasts the Far East with the Latin American experience, where the arrangement between the State and the private sector has often been more indulgent over inefficiencies and rent-accumulation, and less attentive to the accumulation of socially diffused technological capabilities and skills. After more than two decades of largely ungoverned economic liberalization, Latin America ended up with relatively simple production structures, increasingly fragmented and disarticulated in terms of local capabilities and progressively more specialized on static comparative advantages (often based on natural endowments)[4].

Ultimately, success or failure appears to depend on the combinations of different institutional arrangements and policies, in so far as they affect learning processes by individuals and organizations, on the one hand, and selection processes (including of course market competition), on the other. Certainly, the historical experience shows a great variety of country and sector-specific combinations between the types of policies illustrated above. Some subtle regularities nonetheless emerge.

First, a regularity, holding from 19th century Europe and US all the way to contemporary times, is the centrality of public agencies, such as universities, and public policies in the generation and establishment of new technological paradigms.

Second, and relatedly, "incentives are often not enough". A crucial role of policies is to affect the capabilities of the actors, especially in the foregoing case of new technological paradigms, but also in all cases of catching-up whereby no reasonable incentive structure might be sufficient to motivate private actors to surmount big technological lags.

[3] The liberalization induced the reinforcement of Latin America's international specialization according to two different patterns: the one proper of the Mexican Gulf and the other specific to Southern Cone. Mexico and Central American countries integrated their manufacturing and assembly activities into global chains, basically offering to Northern economies cheap labor. On the other hand, Southern Cone countries (like Argentina, Brazil, Chile and Uruguay) reinforced their specialization in natural resources and standardized commodities (Cimoli 2005).

[4] This diagnosis, we believe, holds notwithstanding notable exception of individual firms which represent important success stories, so to speak against national "revealed comparative advantages", and, of course, notwithstanding individual major successes in resource-based manufacturing..

Third, market discipline is helpful in so far as it weeds out the low performers and rewards the high performers within particular populations of firms. However, nothing guarantees that too high selective shocks will not wipe out the entire populations themselves, thus also eliminating any future learning possibility.

Fourth, policies - especially those aimed at catching-up - generally face the need to balance measures aimed at capability building (and also at protecting the "infant learner") with mechanisms curbing inertia and rent-seeking. For example, the latter are indeed one of the major elements missing in the old Latin American experience of import substitution while the former are what is lacking under many more recent "liberalization" policies.

Fifth, historically, a successful catching-up effort in terms of per capita income and wages has always been accompanied by catching-up in the new and most dynamic technological paradigms, irrespective of the initial patterns of comparative advantages, specialization and market-generated signals. 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. This is what Amsden (1989) has provocatively called policies of deliberately "getting the prices wrong". 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 technologically and politically leading countries.

Sixth, policies affecting the access to technological knowledge have been always important, mostly by default, but have turned out to be in the enforcement of property rights by leading oligopolists, especially in the fields of life sciences, software and entertainment products.

On some fundamental tradeoffs facing institutions and policies in learning economies

In a world characterized by technical change (both "continuous" change along defined technological trajectories and "discontinuous" one related to the emergence of new technological paradigms), technological lags and leads shape the patterns of intersectoral and interproduct profitability signals and, thus, also the patterns of microeconomic allocation of resources (Klein 1974; Dosi, Pavitt, and Soete 1990). 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 signals (related to profitability, long-term demand growth and technological opportunities) upon microeconomic processes of adjustments are likely to be *asymmetric*. In another work one of us elaborates on this point distinguishing between the notion of (i) allocative efficiency; (ii) innovative (or "Schumpeterian") efficiency; and (iii) growth efficiency of particular patterns of production (Dosi, Pavitt, and Soete 1990). There we argue especially in countries far from the technological frontier patterns of allocation of resources which are "efficient" on the grounds of the incumbent distribution of technological capabilities and relative prices might well entail negative long-term effects in terms of demand elasticities of the goods one country will be able to produce (the "growth efficiency") and of the innovative potential associated with that (the criterion of "innovative efficiency"). Whenever trade-offs between different 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 can see at work here dynamic processes which Kaldor called of “circular causation”: economic signal 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.

Note that these possible tradeoffs have little to do with the informational efficiency of market processes, *even if*, of course, *various forms of informational asymmetries are likely to make things worse*. Rather it is the general condition of an economic system that technological opportunities vary across products and across sectors. Moreover, 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 resource allocation *today* affect also where technical skills will be accumulated, (possibly) innovation undertaken, economics 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 conditions of allocative efficiency.

It is rather easy to see how such trade-offs between "allocative efficiency" and "innovative efficiency" can emerge. The 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) (more in Dosi, Pavitt, and Soete 1990). Whenever the gap is highest in the most dynamic technologies (i.e. those characterized by the highest technological opportunities), allocative efficiency will conflict directly with innovative efficiency. We would suggest that the likelihood of such trade-offs between the two notions of efficiency is proportional to the distance of each country from the technological frontier in the newest, most dynamic and most pervasive technologies.[5]

A similar argument applies to the trade-offs between allocative and growth efficiency: ultimately countries may well end up by "efficiently" specializing in the production of commodities which a relatively small or even decreasing number of world consumers wants to buy thus tightening their ability to grow consistently with some foreign balance constraint.[6] Under conditions of non-decreasing (often increasing) returns, there is no straightforward way in which markets can relate the varying growth and innovative efficiencies of the various commodities to relative profitability signals for the microeconomic agents.[7]

This defines also a fundamental domain for policies. A detailed understanding of, and intervention upon, patterns of signals, rules of allocative responses and forms of institutional organization of the "economic machine" are particularly 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 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.

[5] Somewhat similar conclusions on the crucial importance of the distance from the international technological frontier in term of required mix of policy measures can be drawn also on the grounds of "neo-Schumpeterian" models of growth: cf. Aghion and Howitt (2005)

[6] In Dosi, Pavitt, and Soete (1990) and Cimoli (1988) one argues this proposition on the ground of a model nesting a Kaldo-Thirlwall growth dynamic onto diverse technology gaps at commodity level.

[7] Putting the same argument in a language more familiar to the economist, the widespread possibility of trade-offs between allocative, Schumpeterian and growth efficiencies arises from the fact that the general case is one of non-convexity of production and consumption possibility sets and dynamic increasing returns and path-dependencies of technological advances. On the point, within a growing literature, see the complementary arguments of Atkinson and Stigliltz (1969), David (1988), Arthur (1994), Dosi, Pavitt and Soete (1990), Krugman (1996), Antonelli (1995), Cimoli (1988), Castaldi and Dosi (2006)

Policies in a "Globalized" World: the new challenges

What argued so far, we believe, applies in general, to the generality of processing of catching-up and industrialization, notwithstanding their obvious historical variety. But what are the specific lessons which can be drawn from the most recent phase of international development?

In fact, the last couple of decades of "globalization" have gone hand-in-hand with powerful efforts to impose a policy regime grounded in rather extreme forms of economic orthodoxy, which in the case of developing countries has gone under the name of "Washington Consensus". Of that Latin America has been an exemplar victim.

Trade liberalization, leading eventually to free trade, was a key part of such a "consensus" - sometimes imposed indeed at gunpoint. The emphasis on trade liberalization was natural: the Latin American countries it was claimed had stagnated behind protectionist barriers. Import substitution according to the same view had proved a highly ineffective strategy for development. In many countries industries were producing products with negative value added, and innovation was stifled. The usual argument - that protectionism itself stifled innovation - was indeed somewhat confused. Governments could have created competition among domestic firms, which would have provided incentives to import new technology. It was the failure to create competition internally, more than protection from abroad, that was the cause of the stagnation. Of course, competition from abroad would have provided an important challenge for domestic firms. But it is possible that in the one-sided race, domestic firms would have dropped out of the competition rather than enter the fray. Consumers might have benefited, but the effects on growth may have been more ambiguous. Trade liberalization may create competition, but it does not do so automatically. If trade liberalization occurs in an economy with a monopoly importer, the rents may simply be transferred from the government to the monopolist, with little decrease in prices. Trade liberalization is thus neither necessary nor sufficient for creating a competitive and innovative economy.

At least as important as creating competition in the previously sheltered import-competing sector of the economy is promoting competition on the export side. The success of the East Asian economies is a powerful example of this point. By allowing each country to take advantage of its competitive strength, trade increases wages and expands consumption opportunities. For the last decades in the case of far Eastern countries trade has been doing just that.

Moreover, as the comparison between different experiences in Latin American and in the Far East shows, a free-trade shock does not automatically trigger any increase in the accumulation of knowledge and innovative capabilities. On the contrary, in a world characterized by multiple forms of localized increasing returns (both "localized" in terms of technologies and in spatial terms), greater integration may well lead to phenomena of increasing differentiation with self-reinforcement and lock-in of particular production activities, specialization patterns, technological capabilities (or lack of them): cf. the discussion above. Putting it another way, it is easy to show that a world which becomes, at some level, increasingly integrated - but not (roughly) identical in initial conditions, institutions, technological capabilities, mechanisms of economic interaction, etc. - might be subject to various forms of "local" virtuous or vicious circles, even more so than in the past.

Finally, the impact of greater integration is likely to depend on the modes through which it is implemented. The experience of many Latin American countries is a good case to the point. When macro ("globalizing") shocks suddenly induced higher selection upon domestic firms, massive mortality of firms did often entail an apparent reduction of the productivity gap *vis-à-vis* the international frontier. But this seems to come together - at least in Latin America - with striking increases in both unemployment rates (i.e. transitions of parts of the labor force from low productivity to zero productivity states) and with tightening foreign-balance constraints to growth, in turn the joint outcome of relatively low elasticities of exports to world growth and high elasticities of imports to domestic growth (cf. Cimoli and Correa 2002, Castaldi, Cimoli, Correa and Dosi 2004).

Certainly both the recent changes in international – political and economic – relations and the ongoing "ICT revolution" are reshaping the opportunities and constraints facing policy making and "institutional engineering" but by no means have decreased their importance. On the contrary: they demand new forms of governance which one is only beginning to explore.

So, for example, on the technological side, the characteristics of productive knowledge have nowadays changed as compared to, say, the electromechanical paradigms within which countries like Germany and the USA caught-up and overtook England nearly one century ago, and they might be also partly different from the type of knowledge – a good deal centered on "first generation" ICT – through which, more recently, Korea and Taiwan approached the technological frontier. In turn, with changes in the type of knowledge countries need to accumulate and improve upon, often come also changes in the most appropriate policy packages concerning e.g. the type of offered education; the support to national incumbent firms vs. MNCs vs. new entrants; the role of public training and research centers. Indeed, many of the contributions to this *task force* tackle these issues.

Major changes have come also in the regime of international trade and property right protection, associated with WTO, TRIPS and several bilateral agreements. The new regime, first, has implied a reduction in the degrees of freedom developing countries can enjoy in their trade policies, while notably all catching-up countries in the preceding waves of industrialization could exploit a large menu of quotas, tariffs and other forms of non tariff barriers. Second, it involves a much more aggressive international policing of intellectual property rights and, thus, other things being equal, more difficulties in imitating and "inventing around" existing products and production processes - again, activities which have been at the core of the first phases of industrialization, from the US to Switzerland, to Japan, to Korea…

Hence, a fundamental policy question concerns the degrees of freedom left for discretionary public interventions supporting in different ways specific technologies, sectors and firms. How stringent are the new international constraints? Note that the answer here is likely to vary from sector to sector and from technology to technology. And it is likely to depend also on the distance of any country from the international technological frontier. For example, many African and some Latin American countries might not be directly affected by a tightening in the IPR regimes having little capabilities to imitate to begin with (although they might still be badly affected by being forced to buy e.g. drugs or software at ridiculous prices from first-world MNCs rather than from more advanced but still "imitating" countries). Conversely, tighter IPR regimes may well represent a major hindrance to more advanced catching-up countries. Given that how easy is it to "play around" with existing rules? That is, putting it the other way round, how urgent is it to promote a balanced IP system and realize its development potential?

On all these issues, it is time to build a “new consensus” prominently featuring the exploration of forms of institutional governance which also in developing countries foster knowledge accumulation and render its efficient economic exploitation consistent with the multiple interests of profit-motivated agents. Such a "consensus", we suggest, is going to be based on a pragmatic view of markets whereby the latter sometimes work in a "developmental" sense, sometimes do not, and even when do work, their effectiveness cannot be separated from the contribution of supporting institutions and policies. And, last but not least, it must be a consensus sensitive to issues of equity and of access to the sharing of the benefits from growth stemming from technological and organizational learning.

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