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Innovation systems and policy for development in a changing world

By Carlota Perez

4.1. Looking at the question

Whether innovation systems and policies are just for the rich or not was the question originally posed to me by the editors of this book. Its implication is clear: the general thrust of innovation has until recently been seen as mainly serving the interests of the rich countries. Could innovation systems and policy favour advance in the poor countries? Is there a particular reason to ask that question now? Probably yes. Would the answer be the same today as it was in the 1960s and '70s? Certainly not! Could it be that this issue is not inherent to innovation or innovation systems themselves (or to capitalism), but that it changes with the stages of diffusion of technological revolutions and the nature of their paradigms? This is what I will suggest, arguing that such a dynamic understanding would have consequences for innovation studies, for evolutionary economics and for innovation policy.

Such an interpretation is based on an “appreciative theory” of how the capitalist economy evolves through successive technological revolutions and techno-economic paradigm shifts, as Chris Freeman and I have proposed (Freeman and Perez 1988; Freeman and Louçã 2001; Perez 2002 and 2010a). It represents a style of theorising that has been predominant in innovation studies (Nelson and Winter 1982: 46-48) as well as in the “high development theory” of Prebisch, Hirschman and others. Appreciative theorising attempts to understand important historical processes that cannot be handled by formal analytical tools. The criticisms put forward by Romer (1993) and Krugman (1995) were based on the vain hope that such processes could be formalised by new growth theory and new trade theory. Instead, some of the most important insights of the appreciative theorists vanished due to certain neoclassical restrictions, and the major hope of rescuing them probably lies in the hands of evolutionary economists.

What this alternative form of theorising does is to avoid isolating the economy from the specific forms that technology and institutions assume as they evolve, and to refuse restricting itself solely to the quantifiable aspects. Its main role is to provide a set of heuristics to identify relevant questions, to help formulate research hypotheses, and to serve as a framework for judging alternative explanations. Its main virtue, given its evolutionary form, is to recognize change as intrinsic to the workings of the economy and to be able to handle processes of transformation without having to exclude aspects of the causal network merely because they cannot be measured. Consequently, phenomena such as the recent major bubble and collapse do not need to be seen as “black swans” but can be understood as long-term regularities of the system (Freeman 2001; Perez 2002 and 2009).

The role of history in the interdisciplinary mix

The stubbornness of the post-collapse recessionary trends reveals not only that free markets are not the answer to the crisis, but also that “pure” economics is not able to analyse it. Society cannot afford to continue looking for the missing keys under the street lamp only. In these uncertain times we need an interdisciplinary – or perhaps rather a post-disciplinary – approach, similar perhaps to the appreciative analyses of the German Historical School on which Schumpeter based much of his theoretical work.

As Freeman (1988: 2) argued in the introduction to the book by Dosi et al. (1988) that was central in launching the new wave of innovation economics, the interaction between economics, science and technology, and institutions is essential for understanding growth and development. He further insisted that those interrelationships can best be understood when incorporating history (Freeman 1984 and 1995; Freeman and Perez 1988; Freeman and Louçã 2001). This is in line with Schumpeter’s view on how ultimately to pursue economics. Indeed, by opening the door to interdisciplinarity, evolutionary economics and the innovation systems perspective have offered much richer theories for understanding the uncertainties of the real economy and its diversified functioning. We can be proud of the achievements in this area. Yet there is one aspect where we have not gone far enough. In order to design effective policies, society needs to understand the big picture, or more specifically the big *moving* picture.

We need to fully incorporate history in the interdisciplinary mix. The search for eternal unchanging truths, as in physics, is not appropriate when studying social phenomena as complex – and as human – as innovation, growth and development. This criticism can be levelled against neoclassical economists, but their work is at least consistent with their overall goals and criteria. However, ignoring history is simply unacceptable in evolutionary economics. It would have been unthinkable to Freeman but also to Marx and Schumpeter. Technical change continuously modifies the conditions for innovation and for development, and we must be at the forefront of explaining such changes and identifying the specific transformations taking place in each period. Only then can we hope to be useful as a science that serves to guide effective policy design and to shape viable political goals.

Changing answers to the same question

So, is innovation only for the rich? There are two traditional answers to this question by appreciative theorists:

1. the Dependency School, in its various versions (e.g. Singer 1949; Prebisch 1951; Gunder Frank 1967; Cardoso and Faletto 1968; Sunkel 1970; Amin 1976), basically held that Third World countries could not define their future but were technologically dependent on the interests and decisions of foreign investors from the advanced world;¹
2. the appropriate technology movement (e.g. Sen 1960; Cooper 1972) recommended the selection of technologies better adapted to the endowments of the developing world, in the sense of being less capital-intensive and using more labour.

¹ Indeed, the most innovative technology policies at the time, such as those promoted by UNCTAD and those of the Andean Pact, concentrated on regulating the transfer of technology by MNCs, avoiding restrictive clauses and excessive royalties, and trying to guarantee that effective transfer would indeed take place.

In both cases, it was assumed that technical change was continuous and cumulative, that technology came from the North, and that it was up to the developmental states of the South to try to choose the most appropriate technologies among those that could be acquired. The context shaped the analysis, the theoretical answers and the policy recommendations.

Today, we are looking at dynamic innovation systems, policies for enabling innovation and catching-up, upgrading the role of local companies in global value networks, new pathways for development and so on. Why have the answers and the policy goals changed? Because technical change is constant but not continuous. From the mid 1970s, the world has been experiencing the Information and Communications Technology (ICT) Revolution, and the resulting paradigm shift has radically changed the opportunities available to all participants. It has enabled flexible production patterns and network organisations; it has induced and facilitated globalisation, disaggregation of value-chains and outsourcing; it has made possible catching-up (and even forging ahead) in the developing world; and it has opened up new opportunities for innovation and for diversity across the whole production spectrum (both tangible and intangible). None of these conditions existed in the 1960s and '70s.

Changing context; redefining problems

Moreover, it is not only the answers to the question that have changed; the content of the question has also experienced a transformation: Who specifically are the poor when we ask “Not only for the rich?” Do we define them in the same way as in the 1960s and '70s? Probably not. We can indeed still count most of the traditional “Third World countries” among the poor in contrast with the rich advanced ones, but not all. First the Four Tigers and now the BRICS have broken away from the ranks of the laggards and begun to catch up – some of them might even forge ahead. Does this mean that the Dependency School was wrong all along? Did the South Koreans and the Chinese leap forward because of choosing labour-intensive technologies? Or is it that both the Dependency School and the appropriate technology proponents were right when they assessed the situation during the mature phase of the Age of Mass Production, but ceased to be right when the ICT revolution changed the context radically?

Already in the 1980s and '90s Hirschman, Sen, Gunder-Frank and others recognised that the ideas of Development Economics and of the Dependency School were no longer useful. However, they did not see that it was because conditions had changed that the ideas about how to handle technologies had to change. The main lesson of history was unfortunately lost in that case.²

But we can go further in this rethinking. Should we maintain the definition of “the poor” as referring mainly to countries? Isn't it important now to look at the poor and the impoverished in the advanced world as well? Shouldn't we also try to see how innovation could help overcome the inequalities that characterise some of the emerging country success stories? Currently, within advanced, emerging and developing countries there are widening differences between the skilled and the unskilled, between urban and rural populations, between emerging and declining regions (where unemployment is rampant), and, within cities, between the rich areas and the slums.³ Does

² See Hirschman (1982) and Sen (1983). Gunder Frank (1991), writing much later, was one who clearly recognized that times were changing and then went on to attempt a major reinterpretation of history.

³ 70% of the people who live on less than \$1/day live in middle-income countries (Sumner 2010).

technological innovation hold part of the explanation for these trends, and can innovation policy do anything about them? Should the question of “not only for the rich” address these differences? Adequate industrial, employment and welfare policies for the current times may need to involve explicit directions for the specialisation or respecialisation of each country and each region on the basis of its advantages and capacities to address effective demand in the global space. They will also need a strong component of innovation policy to enhance those capabilities.

In the advanced world, from the late 1940s to the 1960s, technology helped the poor to achieve better lives. Charlie Chaplin brilliantly satirised the negative side of the assembly line, but outside the workplace life did get much better after 1945. In those times, the excluded were mainly in the Third World and those countries could be defined basically as “the poor”. Now the picture has changed. Technology and globalisation have been stripping many Western workers of their expected ‘good life’. Can innovation help them? The idea that there is a technological frontier constantly advancing and driving growth may need rethinking if conditions require a reconsideration of what are the most socially relevant directions for innovation. Similarly, the extremely rapid growth processes in China and India have been highly polarised, excluding a high proportion of the population from the benefits of development. Should this issue be confronted by innovation theory and policy? Do we need a more sophisticated picture when addressing the opportunities for the poor? It would definitely seem so.

4.2. The paradigm shift and its effects on the conditions of innovation for and by the poor (and the weak)

Let us begin by looking at the nature of the shift from the viewpoint of the theory of techno-economic paradigms. What has changed since the 1970s, when ICT began replacing mass production as the prevailing techno-economic paradigm (Perez 1985, 1986 and 2010a)? How do innovation conditions differ from those prevailing until the '70s? In what sense do the poor and the weak, be they individuals, firms or countries, find better (or worse) opportunities for employment, wealth creation, innovation and potential improvements in the quality of life? These questions can be seen as constituting a whole new research agenda, and that is the spirit in which the following section is presented.

ICT, innovation and market access by small firms in any country

There are many changes directly attributable to ICT. Access to information is now infinitely easier than before; networking has become simple and cheap at whatever distance; software and other intangibles constitute an increasing element of innovation and of the global product mix; computers and mobile phones facilitate not only software innovation but also product design and testing; and digital equipment can remove the need to acquire skills that previously took many years to master (undoubtedly a loss for many workers from printing to machine-tool operators – paradigm shifts involve processes of creative destruction on many fronts). These new tools mean that the possibilities for innovation and entrepreneurship are now open to individuals and small companies wherever located.

Intangible innovation is easy to transport to the point of use and the “app mania”, however long it may last, has opened possibilities for many brilliant young people, in whichever country they happen to reside. The open source movement has lowered the cost of software for individuals, schools and

companies, but most of all it has provided a collective learning platform for potential innovators. The opportunities for innovating in tangible products have also multiplied due to the replacement of the mass-production world of simple economies of scale for identical products by one in which economies of scope, scale and specialisation co-exist within the flexible production model enabled by ICT. This has resulted in hyper-segmentation of markets and the creation of a very “long tail” of specialised niche products, where small firms can be very profitable (Anderson 2006; Kaplinsky 2005). This has been enhanced by developments in logistics and retail trade that facilitate the handling of small quantities at reasonable cost. Both Damart and Tesco through their purchasing networks and the “fair trade” movement have been built upon those new conditions.

Another possible consequence of this new flexibility is the potential – as yet hardly used – to cater for differences in culture, religion or climate that had previously been almost ironed out by the American (universal) Way of Life. The notion of different lifestyles delivering “equivalent satisfaction” could enhance the quality of life of many without forcing homogeneity. “Frugal innovation” and organic products are an early manifestation of that potential.

Flexible production and global networks

Besides making possible greater segmentation of markets, ICT has provided the infrastructure and tools for the giant global corporations to operate. It is now much easier not only to manage enormous and highly complex organisations with units in many parts of the world but also to do so with a relatively flat structure and with a variety of arrangements such as alliances and contracts with other companies, suppliers and partners. It is this profound change that has given impetus to the Asian leap forward in its various forms. The practice of outsourcing has opened up a wide range of possibilities for incorporating producers in all parts of the world. The much greater volumes that are now possible with changing models and varying product mixes have had a huge employment effect. This is one factor underpinning the success of China and other Asian countries on the basis of low-cost labour for the standardised segments of fabricated product markets.

As the process of learning to globalise proceeds, corporations have been experimenting in many countries with the use of local knowledge workers and local innovative talent. India became central with experience gained from handling the computer problems expected with the year 2000⁴; and soon the software industry was largely globalised (Arora and Gambardella 2004; Friedman 2005). Currently, there is increasing outsourcing of R&D (raising possible intellectual property problems that are not yet clearly defined) as well as a trend to develop knowledge-intensive suppliers, even in traditional sectors such as mining.⁵

From the perspective of emerging countries, there are also important new developments. Several Korean, Indian and Chinese companies have themselves become global corporations, and are investing by buying companies and outsourcing to both advanced and lagging countries. Some Latin American companies are also now investing globally.

⁴ The so-called ‘Y2K problem’, when the need to modify all software to go from two to four characters for the year (from 19XX to 2000) raised fears as to whether all computer-controlled equipment would stop working, providing work opportunities to thousands of programmers in India (Friedman 2005).

⁵ BHP Billiton in Chile has employed a SPRU PhD to develop local high-tech suppliers for its copper-mining activities (see Urzua 2011).

Natural resources: curse or opportunity?

There is an assumption dating from the 1950s, inherited from the mass-production era, that development is only about manufacturing and that natural resources were a dead end (Singer 1949; Prebisch 1951). Then, in the late 1970s, there were concerns about the “Dutch disease” – i.e. de-industrialization brought about by revaluation due to natural resource exports (*The Economist* 1977). More recently, research has associated the alleged “resource curse” with corruption and other ills (Sachs and Warner 1995).

By contrast, natural resources were seen as very important for development during the first globalisation, from the 1870s to 1914. The technological revolution that was then taking place, in the age of steel and heavy engineering, was about chemistry and electricity, about transcontinental railways and world-trading steamships, about metallurgy and major engineering projects. It was also about counter-seasonal world markets for meat, wheat and other agricultural products. In those times, natural resources were considered as a blessing not a curse. Australia, Canada, Sweden, the US and others partly owe their catching up to their resource endowment.⁶ Yet, as Reinert (2004) emphasizes, policy-makers in those countries understood that raw materials alone – without concomitant highly-skilled, technology-intensive activities – would not result in development.⁷

Times are changing once more. The growth of the emerging countries implies such an increase in the demand for natural resources that prices are likely to oscillate at much higher average levels (Dobbs et al. 2011; Farooki and Kaplinsky 2012), and it will be necessary to engage in a lot of innovation to guarantee supply as well as to serve the “long tail” in specialised materials, organic and gourmet foods, and many other niche products (Perez 2010b). This is happening already, together with upstream innovations in equipment, chemicals and other inputs. But most importantly, the competition for resources among the established companies and those of the emerging ones is likely to open up unprecedented opportunities for developing countries to negotiate better terms. If energy prices are very high, this could lead to efforts to avoid the transport of unprocessed materials by locating some downstream processes *in situ*. These changes would also require innovations in order to solve problems of scale and mobility. Such incentives for innovation could underlie a dynamic growth process among natural resource producers (Marin et al. 2010).

The environmental challenges as a guide to innovation

Finally, there is the issue of the environment. Both the planet and the economy need extensive “green” innovation. The potential is there in technological terms. The ICT revolution can enable innovation across a wide range of sectors, from smart-grids to specialised materials, from redesigning products for durability and upgradeability to reducing the need for transport. But “green” products and services are not capable of being immediately profitable, as many ICT products were at the beginning. The way to increase their economic viability is to induce a clear common direction. Convergence and networking can lead to synergies in suppliers and markets, increasing the profitability of the entire network. Markets alone cannot reach that outcome; an active government can.

⁶ Of course, it makes a huge difference if such resources are to be exported raw or to be used as the basis (or as a source of income) for technological development. Morris et al. (2012) examine the new conditions and the increase in upstream innovation opportunities.

⁷ Reinert (2004) proposes to establish Schumpeterian development economics based on these and other criteria.

The need to greatly enhance the productivity of resources could lead, with the right policies, to redesigning products for true durability. This could generate new second-hand markets, enabling the bottom of the pyramid to take a step onto the consumption ladder sustainably and at low cost. This could also revive maintenance as a major source of jobs for the displaced manufacturing workers of the advanced world. Clear policies to favour a “green” direction in innovation through such measures as regulation, taxes, and R&D funding are likely to be necessary in all countries, including the poorest, where the need to do more with less is even more pressing (United Nations Environment Programme 2011).

Finally, there are innumerable opportunities for improving the lives of the poor in an environmentally friendly way, with innovations adapted to harsh climates, renewable energy, the use of waste or local materials, and many other appropriate technologies. The policies and conditions that could bring these innovations forth – from private or public sources – and propagate their use surely merit the attention of innovation scholars.

4.3. The big *moving* picture

Research is needed to provide a deeper understanding of recent changes in the conditions for innovation by and for the poor. Such transformations have been long and complex. It has taken considerable competitive pressure to overcome inertia and to move from a world of mature technologies and international corporations operating in oligopolistic markets, which characterized the late 1960s and 1970s, to the current world of even larger corporations spread across the globe and surrounded by a multitude of nimble, small, knowledge-intensive companies. The countries of the mature world have been slow to realise that emerging countries could threaten their lead in certain areas of innovation, and that their internal unemployment and income distribution problems will probably need to be addressed with more active policies.

Historical analysis indicates that such profound changes in conditions have been typical of the diffusion of technological revolutions (Perez 2002). If radically new industries and technologies were merely added to the existing stock, the transformations would not be so deep or wide-ranging. What warrants the term ‘revolution’ is precisely that each set of major new technologies rejuvenates the mature ones, opening up important new innovation trajectories for pre-existing industries. The combination of a new infrastructure network expanding markets and a new paradigm changing behaviours redefines industry structures and reshapes their regional distribution. The diffusion of a new paradigm can radically change opportunities for laggards (for better or for worse) and this, in turn, requires important changes in development and innovation policies.⁸

In a recent study of the Latin American experience in science and technology policy, Sagasti (2011) identifies five phases. Each encapsulates a different set of fundamental ideas about technology, employs different policy instruments, and creates – or eliminates – different institutions (see Figure 4.1). It is significant that, despite major differences in political conditions between countries (from military dictatorships to democracies), the changes in technology, ideas and policy instruments described by Sagasti occurred at almost the same time throughout Latin America. There are always some countries that lead and others that lag by a few years, some that design and apply more

⁸ For a discussion of opportunities for development as a moving target, see Perez (2001).

sophisticated policies, and others that copy and do a minimum, but the fact is that the whole continent went through a similar sequence.

Figure 4.1. Chronology of the phases in science, technology and innovation policies in Latin America

Phases	Time period					
	1950-59	1960-69	1970-79	1980-89	1990-99	2000-09
Science push	—————					
Regulation of technology transfer		—————				
Science and technology policy instruments			—————			
Washington consensus and market driven transformation of S&T policy				—————		
Systems of Innovation and competitiveness					—————	
Renewal of Science, technology and Innovation policy						—————

Source: Sagasti (2011: Table 1 – translation from the Spanish original).

This continent-wide regularity suggests that the transformation may not have been entirely endogenous. The fact that all countries acted in a similar way in relation to technology may indicate that they were experiencing the same set of external forces driving those changes. It may also suggest that the recommendations received – whether from academics, consultants, UN organizations or whoever – were a response to conditions observed on the ground across the world. This is indeed what would be expected in the framework of successive technological revolutions and paradigm shifts adopted in the current chapter.

According to this interpretation, in the 1970s the advanced world was going through the maturity and decline phase of the main industries of the mass-production paradigm (exacerbated by a dramatic increase in the price of oil) at the same time as it was witnessing the eruption of the ICT revolution and the rise of Japan. The mature industries were setting up final assembly plants in the Third World in order to expand their saturated markets. This was favoured by a set of incentives offered by the import-substitution policies adopted by most underdeveloped countries seeking industrialisation. Since mature technologies, by definition, have exhausted their previous trajectories, there was little that could be done in the receiving countries except learning the routines and, as they all did, trying to develop their own science in the hope of arriving at new technologies in a linear process.

Gradually, however, the ICT revolution began to transform the conditions for competitiveness, and mature corporations were forced to introduce not only computers in their offices but also computer-aided equipment in their plants and microelectronics in their products. By the 1980s it was

understood, from the Japanese success, that major organizational changes were required in order to reap the expected benefits from new technologies. The Japanese model was then imitated in the offices and plants of advanced countries. This created a problem for the many Tayloristic factories already operating in developing countries, with some of the transferred products becoming obsolete. In addition, the regulation of technology transfer was making conditions more difficult for multi-national corporations. Selling the licenses and letting the locals take over was one solution; using low-cost labour for exports from processing zones was another. Tariff barriers stopped being attractive to foreign investors. The opening up of markets encouraged by 'Washington consensus' policies finally dismantled the model. In the new conditions, in Latin America the inward-oriented economies were unable to resist the pressures or to adopt new competitive practices, and the so-called "lost decade" set in. By contrast, the "Four Tigers" in Asia jumped on the new bandwagon with intensive export-oriented learning and rapid implementation of the new paradigm.

In the 1990s and 2000s, there was a revival of official interest in science and technology policies. Seeing the Asian success and relating it to technological learning efforts, the new ideas about science, technology and innovation policies located within the notion of a national system of innovation began to spread (see Lundvall, chapter 2, this volume). Technology parks and other "clustering" attempts became common; innovation funding and entrepreneurial incentives also spread. Global corporations, although not investing much in Latin America, did however modernize their working practices in the remaining local plants and began to outsource to domestic suppliers within their value networks. The experience of Brazil as one of the BRICS established a different view of technological innovation opportunities, which is now being followed across the whole sub-continent.

Hence, we face a "chicken or egg" situation. Do the circumstances change the thinking about technology and innovation, or does the thinking change the policies? The more likely answer is that there is a continuous feedback loop. Nevertheless, the usual response is to say that "our knowledge of the processes is increasing" rather than recognising that the conditions are changing and our previous knowledge no longer captures the new reality. Furthermore, our current knowledge of innovation in the developing world is not a deepening of what we understood in the 1970s. Indeed, it would not have been possible to apply it to design more effective policies in those years. The conditions of the import-substitution model inhibited innovation. When technology was 'acquired' under strict contract clauses that prohibited any changes, and when there were no innovative capabilities in firms and no entrepreneurial models to follow, trying to promote innovation in the way that is effective today would have resulted in frustration.

This brief overview suggests that innovation studies and evolutionary economics share an object of study that is constantly being transformed by the very nature of innovation and by its capacity to go beyond technology to modify organizations, institutions, behaviour and ideas. It is a truly evolutionary process in need of dynamic theories.

4.4. Does (or should) evolutionary economics also evolve?

This brings us to the observation made at the start of this chapter regarding the "obsolescence" of the Dependency School and of the original choice-of-technology discussions, in the light of the paradigm shift in the real economy. Can we analyse the successive changes in the focus of evolutionary economics, of science, technology and society (STS), and of innovation studies in connection with the changing trends in the economy?

In contrast with other schools of thought, evolutionary economics is naturally open to change, not only due to its theoretical premises but also for the simple reason that it is much more rooted in reality and is constantly studying specific technologies, companies, sectors, etc. Indeed, it would be interesting to examine the shifts in emphasis in the topics addressed in publications and see how they relate to real shifts in behaviour in the world economy. Could we do something similar for the shifts in emphasis in innovation studies?⁹ One might expect to see a process of “creative destruction” in policy-oriented knowledge as clusters of radical innovations transform the context conditions.

The balance between permanent and changing truths

This is not to deny that there must be some unchanging basic truths. If the basic tenet is that innovation is the driver of economic growth, then a central task is to identify what one might call the “laws of change” in market economies, at the micro, meso and macro levels. That defines much of the theoretical work that evolutionary economics has undertaken. Notions as fundamental as technological trajectories and routines,¹⁰ or the processes of learning, or the fact that innovations are interrelated, that the agents in the economy are diverse and that the process of innovation is a system of interactions¹¹ are all indispensable for the analysis of any period. Yet even the Pavitt (1984) taxonomy, assuming that the classification can be seen as a stable truth, is likely to change in terms of the industries included in each category.¹² And the same can be said about systems of innovation. The early formulation was very much defined in national terms, but globalisation now requires us to analyse more complex networks and interactions across borders.

Distinguishing between fundamental theoretical principles and changing processes should be the normal approach for a truly evolutionary economics. That would be one of the differentiating features enabling it to deal with an economy in evolutionary (and sometimes revolutionary) change, in contrast to the immanent and unchanging constructs of neoclassical economics. Understanding technological opportunities as a moving target and economics as the uneven realisation of those opportunities, be it for the rich or poor, would not only enrich our academic contribution to the social sciences but also fill a gap in the sort of expertise that policy makers require. The constant awareness of the interconnection between changing technologies, changing economies and changing economics would guarantee that we never lose the connection with real life and real processes.

The challenges of the present moment in history

When we ask about the consequences of technology systems and policy for the poor and the weak, we are not then in some abstract state of limbo where time and place are of no importance. We are at a specific moment in the evolution of the market economies. I have argued elsewhere that the major financial collapse of 2008, which amongst other things morphed into a Euro crisis, is the result of a decoupling of finance from the real economy, which requires the return of an active State, in both

⁹ Fagerberg et al. (2012) and Martin (2012) could serve as an excellent initial basis for the process. See also Morlacci and Martin (2009).

¹⁰ See Dosi, chapter 5 of this volume, for an extended discussion.

¹¹ See Lundvall, chapter 2 of this volume, for a discussion of interactive learning.

¹² A move in that direction can be found in DeJong and Marsili (2006) but the next technological revolution is likely to make more substantial changes to the sectors in each category.

advanced and lagging economies (Perez 2009 and 2012). Overcoming the quasi-religious belief in the free market of the old “First world” and abandoning the Washington consensus in the old “Third world” will require something to replace it that involves not just going back to policies that served their purpose in the mass-production era. Evolutionary economics, in general, and innovation studies in particular, seem to be ideally placed to provide the necessary new thinking to reshape the economy, reversing the process of income polarization and taking advantage of the new potential for innovation.

Bengt-Åke Lundvall, in chapter 2 of this volume, urges innovation studies and evolutionary economics to become more involved in policy and politics in order to more effectively confront capitalism, as it is today, as well as to provide alternatives to the interpretations and recipes of neoclassical economics. His plea would be much more easily fulfilled by a scientific community with a keen awareness of historical change and of the dynamic interrelations between changing technologies, changing institutions and changing economies. This is all the more urgent as we see innovation policy moving from the margins of development strategies to the very core. The BRICS are all incorporating science, technology, innovation and the promotion of entrepreneurship as a central basis of their economic policy, and developing countries are gradually following their lead.

The need for interdisciplinarity and inter-institutional collaboration

This new relevance of innovation for development strategies brings to the fore another of Lundvall’s propositions to increase our relevance: making connections with other social sciences. Indeed, the complexity of the situation warrants not only interaction with other disciplines but also closer collaboration with groups that have approached technology and institutions from different points of view. For instance, innovation studies would benefit greatly from incorporating the whole issue of transitions. There are easy connections to be made with Dutch scholars in this area (e.g. Geels and Schot 2007; Geels 2010), who have made valuable contributions to theory, methodology and case-study work. They have also become directly involved with policy making and experimental processes of change (Grin et al. 2010). Joining forces with the STS community may also enrich the capacity to go beyond technology policy and to cover a broad spectrum from industrial policy to welfare and education policy. And within innovation studies itself there are understudied areas such as finance¹³ and institutional innovation. Their incorporation would enhance the power of the interdisciplinary mix and facilitate wider collaboration.

Institutional and policy innovation as central objects of study

Up to now, there has been a tradition in virtually all PhDs and most journal articles in this field to end with “policy recommendations”. From my experience as a policy maker, I can say that these are rarely directly usable.¹⁴ However, at this particular time the need for truly creative policy innovation is considerable. Yet the process of policy innovation has rarely been studied as such by the innovation studies community. Much attention has been given to university industry-links from the 1980s

¹³ A recent exception is FINNOV, an EU funded project led by Mariana Mazzucato. – see Mazzucato (2011), Lazonick (2007), and others in <http://www.finnov-fp7.eu/publications>

¹⁴ See Radosevic (2012) for a critique of this practice as well as a thorough analysis of the state of the art in innovation policy. See also Bartzokas and Teubal (2002) proposing a more explicit policy orientation.

onwards but virtually none to university-policy links or to learning in policy making. Do we understand how the social sciences contribute to the effectiveness of innovation policy or to that of the related industrial, science, education or welfare policies? Back in 2001, Edquist (2001: 17) noted that the system of innovation perspective “lacks a component (theory) about the role of the State ... about how innovation policy has actually been designed and implemented and which societal forces have governed these activities”. Since then, this has been partially addressed¹⁵ but many questions still remain. Now is the time to enrich our policy recommendations with a deeper understanding of institutional and policy innovation as an object of study in itself.

Analysing and also anticipating context changes: a truly evolutionary science

Focusing on institutional innovation would be one way of consciously moving to a relevant area; going further by deepening our understanding of the historical processes of organisational and policy change would guard against obsolescence in recommendations. Furthermore, if we acknowledge the role of major innovations and their diffusion in changing our object of study, then it should be our task to improve our understanding of historical change by looking at the evolution in the focus of research and of ideas within our own field. This implies the construction of a very dynamic science that is constantly aware of its own evolution in relation to the changing nature of technology, of the economy and of the other phenomena it studies.

Nevertheless, merely following the changing historical context as it unfolds is not enough. We also need to be able to anticipate change, to identify weak trends that are likely to become stronger and to study them as they appear. That is what the pioneers of evolutionary economics and innovation studies did. It is not by chance that the seminal work by Freeman (1974) and by Nelson and Winter (1977 and 1982) appeared in the 1970s and early '80s, followed shortly by the concept of national systems of innovation (Lundvall 1985 and 1988; Freeman 1987; Nelson 1993). Truly creative social science identifies trends when they are only just becoming visible. We could, of course, leave the job to historians of science and thus avoid the risk of being accused of speculation. However, the greater risk of offering irrelevant or obsolete recommendations may be too high a price to pay.

4.5. In conclusion

This article has engaged in two levels of discussion. First, at a very general level, it has challenged evolutionary economics and innovation studies to be more consciously and explicitly historical, given the radical changes observable in the context for innovation in the developing world. Second, with specific regard to development-related research, it has given a brief overview of how those conditions have changed in order to outline an agenda and highlight the need for a more interdisciplinary and collaborative approach to meet the new needs of policy makers in developing countries

The problems facing innovation policy-makers have changed significantly in recent decades. Not only are there new forms of access to knowledge and technology and new possibilities for the poor and the weak, but both the definition and the location of the poor in the world have changed. These phenomena are themselves natural objects of study for innovation scholars, given their close

¹⁵ See, for instance, Nelson (2008) and the earlier work of the Aalborg group such as Gregersen (1992), Johnson (1992) and Gregersen and Johnson (1997).

relationship to technical change and their relevance for innovation policy. Rather than merely extracting policy recommendations from every study, the process of policy innovation itself needs to be seriously studied as well as the university-policy links. Research on the latter would seek to understand how social sciences, and in particular evolutionary economics and innovation studies, support institutional innovation, offering a parallel with what the study of university-industry links has achieved.

Innovation policy used to be a somewhat marginal addition to development policies, more connected to research and education than to growth, employment and social well-being. It has now become a core element in the efforts aimed at catching up and forging ahead in developing and emerging countries. At the same time, the scope of innovation has widened to involve products and processes adapted to the conditions of the poor, such as frugal innovation, direct energy production and solutions to cater for very harsh climatic conditions, extreme poverty and other specificities. Given this changed context, it will probably be necessary to differentiate innovation policy for growth and competitiveness from innovation policy for alleviating poverty. In both cases there is a need for research on innovative processes in policy and institutions as well as on technical and organisational innovation for production and wealth creation for and by the poor and the weak.¹⁶ Furthermore, since income polarisation has characterised the recent decades in both advanced and emerging countries, it has become crucial to identify innovation policies capable of helping to reverse these trends, taking into account the very different origins, conditions and levels of such poverty.

Because of this much more complex picture, innovation studies will require the inclusion of both history and political science in the interdisciplinary mix, and much closer collaboration with complementary schools of thought that focus on historical transitions, development, poverty alleviation, politics and the role of the State. The challenge will be to maintain coherence while confronting the full complexity of the object of study. The outcome could be truly effective and relevant policy advice.

References

- Amin S. (1976), *Unequal Development: An Essay on the Social Formations of Peripheral Capitalism*, New York: Monthly Review Press.
- Anderson, C. (2006), *The Long Tail: Why the Future of Business is Selling More of Less*, New York: Hyperion.
- Bartzokas, A. and Teubal, M. (2002), A Framework for Policy Oriented Innovation Studies in Industrialising Countries, *Economics of Innovation and New Technology*, 12, 477-496.
- Arora, A and Gambardella, A. (2004), "The globalization of the software industry: perspectives and opportunities for developed and developing countries", NBER Working Paper 10538, June, <http://www.nber.org/papers/w10538>
- Cardoso, F. H. and Faletto, E. (1968), *Dependencia y Desarrollo en America Latina*, Mexico: Siglo XXI.
- Coase, R. (2012), "Saving Economics from the Economists", *Harvard Business Review*, December <http://hbr.org/2012/12/saving-economics-from-the-economists/ar/1>
- Cooper, C. (1972), "Science, technology and production in the underdeveloped countries: An introduction", *Journal of Development Studies*, 9, 1-18.

¹⁶ See Perez (2010b) for an argument in favour of a dual strategy for development, with separate institutions.

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- DeJong, J.P.J. and Marsili, O (2006), "The fruit flies of innovations: A taxonomy of innovative small firms", *Research Policy* 35, 213–229.
- Dobbs, R., J. Oppenheim, F. Thompson, M. Brinkman and M. Zornes (2011), *Resource Revolution: Meeting the world's energy, materials, food and water needs*, London: McKinsey Global Institute, McKinsey and Co.
- Dosi, G. et al (eds) (1988), *Technical Change and Economic Theory*, London: Pinter.
- Drechsler, W. (2011) "Understanding the problems of mathematical economics: A 'continental' perspective", *real-world economics review*, issue no. 56, March 11, pp. 45-57
<http://www.paecon.net/PAEReview/issue56/Drechsler56.pdf>
- Edquist, C. (2001) *The Systems of Innovation Approach and Innovation Policy: An account of the state of the art*, DRUID Conference paper.
- Farooki, M. Z. and R. Kaplinsky (2012), *The Impact of China on Global Commodity Prices: The Global Reshaping of the Resource Sector*, London: Routledge.
- Flanagan, K, Uyarra, E. and Laranja, M (2011), "Reconceptualising the 'policymix' for innovation", *Research Policy*, 40, 702-713.
- Freeman, C. (1974). *The Economics of Industrial Innovation*, Harmondsworth, Middlesex, Penguin Books.
- Freeman, C. (1984) "Prometheus Unbound", *Futures*, Vol. 16, No. 5, October 1984.
- Freeman, C. (1987). *Technology Policy and Economic Performance: Lessons from Japan*, London, Pinter.
- Freeman, C. (1988) "Introduction" in G.Dosi et al (eds), *Technical Change and Economic Theory*, London: Pinter, pp.1-9.
- Freeman, C (1995). "The 'National System of Innovation' in historical perspective". *Cambridge Journal of Economics*. 19: 5-24.
- Freeman, C. (2001) "A hard landing for the 'New Economy'? Information technology and the United States national system of innovation". *Structural Change and Economic Dynamics*, Vol. 12, No. 2, July, pp. 115–139
- Freeman, C. and Louçã, F. (2001) *As Time Goes By*, Oxford University Press.
- Freeman, C and Perez, C. (1988), 'Structural Crises of Adjustment: Business Cycles and Investment Behavior', in Dosi et al. (eds), pp. 38–66.
- Friedman, T. (2005) *The World is Flat*, New York: Farrar Straus and Giroux.
- Geels, F.W. and Schot, J.W., (2007), 'Typology of sociotechnical transition pathways', *Research Policy*, Vol 36, No. 3, pp. 399-417.
- Geels, F.W. (2010), 'Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective', *Research Policy*, Vol. 39, No. 4, pp. 495-510.
- Gereffi, G.-J., Humphrey, J. and Sturgeon, T. (2005) 'The Governance of Global Value Chains', *Review of International Political Economy* Vol. 12 No.1, pp 78–104
- Gereffi, G., and Kaplinsky, R., (eds) (2001) *The Value of Value Chains: Spreading the Gains from Globalisation*. *IDS Bulletin* Vol. 32 No. 3: July, Brighton Institute of Development Studies.
- Gregersen, B. (1992). "The Public Sector as a Pacer in National Systems of Innovation". In Lundvall B-Å ed. pp. S.129–S.145.
- Gregersen, B. and Johnson B (1997) "Learning economies, innovation systems and European Integration". *Regional Studies* 31(5): 479-490.
- Grin, J., Rotmans, J., Schot, J., Geels, F.W. and Loorbach, D., (2010), *Transitions to Sustainable Development: New Directions in the Study of Long Term Transformative Change*, London: Routledge.
- Gunder Frank, A. (1991) *Underdevelopment of Development. an Autobiographic Essay*, Stockholm: Bethany Books.
- Hirschman, A (1982) "The Rise and Decline of Development Economics". In Gersovitz, M. et al., eds., *The Theory and Experience of Economic Development*, London: Allen and Unwin, pp. 372-90.
- Johnson, B. (1992). "Institutional Learning". In Lundvall, B-Å ed. (1992).

Perez chapter

- Kaplinsky, Raphael (2005), *Globalisation, Poverty And Inequality: Between A Rock And A Hard Place*, Cambridge, Polity.
- Karo, E., Drechsler, W., Kattel, R. and Stillings, C. eds. (2012) *Public Administration, Technology & Innovation, Halduskultuur – Administrative Culture*, vol. 13, no. 1.
- Krugman, P. (1995), *Development, Geography, and Economic Theory*, Cambridge, Mass.: MIT Press.
- Lazonick, W (2007) "The US stock market and the governance of innovative enterprise", *Industrial and Corporate Change*, Vol. 16, No. 6, pp. 983-1035.
- Lorenz, E. and Lundvall, B.Å. (2011), "Accounting for Creativity in the European Union: A multi-level analysis of individual competence, labour market structure, and systems of life-long learning", *Cambridge Journal of Economics* Vol 35 No. 2 pp. 269-294.
- Lundvall, B-Å. (1985), "Product Innovation and User-Producer Interaction", *Industrial Development Research Series*, No. 31, Aalborg: Aalborg University Press.
- Lundvall, B-Å (1988) "Innovation as an Interactive Process : From User Producer Interaction to National systems of Innovation" in Dosi et al. *Technical change and Economic Theory*, pp. 349-369.
- Lundvall, B-Å ed. (1992) *National systems of innovation: towards a theory of innovation and interactive learning*. London: Pinter.
- Lundvall, B-Å. (1996) "The social dimension of the learning economy", *DRUID Working Paper* No. 96-1.
- Marin, A., L. Navas-Aleman and C. Perez (2010) "The possible dynamic role of natural resource-based networks in Latin American development strategies", *Globelics Working Paper*.
- Mazzucato, M. (2011), *The Entrepreneurial State*, London: Demos.
- Morlacchi, P. and Martin, B.(2009) 'Emerging challenges for science, technology and innovation policy research: A reflexive overview', *Research Policy*, 38(4), 571-582.
- Morris, M., Kaplinsky, R. and Kaplan, D. (forthcoming 2012) "'One Thing Leads to Another' – Commodities, Linkages and Industrial Development", *Resources Policy*.
- Nelson, R. (1993) *National innovation systems: a comparative analysis*, New York: Oxford University.
- Nelson, R. (2008). "What enables rapid economic progress: What are the needed institutions?", *Research Policy*, vol. 37, pp. 1-11.
- Nelson, R. and Winter, S. (1977). 'In Search of a useful theory of innovation', *Research Policy*, vol. 6, no. 1, pp. 2–112.
- Nelson, R., and Winter, S. (1982), *An Evolutionary Theory of Economic Change*, Cambridge, Mass: Harvard University Press.
- Pavitt, K (1984) "Sectoral patterns of technical change: Towards a taxonomy and a theory", *Research Policy*, Vol 13, No. 6, pp. 343-373.
- Perez, C. (1985) "Microelectronics, Long Waves and World Structural Change: New Perspectives for Developing Countries" *World Development* 13 (3), 441-463.
- Perez, C. (2001) "El cambio tecnológico y las oportunidades de desarrollo como blanco móvil", *Revista de la CEPAL*, No. 75, pp. 115-136, December. [In English "Technological change and opportunities for development as a moving target", *Cepal Review*, No. 75, December, pp. 109-130.]
- Perez, C. (2002) *Technological Revolutions and Financial Capital: the Dynamics of Bubbles and golden Ages*, Cheltenham: Elgar
- Perez, C. (2009) "The Double Bubble at the Turn of the Century: Technological Roots and Structural Implications", *Cambridge Journal of Economics*, Vol. 33, No. 4, pp. 779-805.
- Perez, C. (2010a) "Technological revolutions and techno-economic paradigms", *Cambridge Journal of Economics*, Vol. 34, No.1, pp. 185-202.
- Perez, C. (2010b) "Technological dynamism and social inclusion in Latin America: *CEPAL Review* no. 100, April, pp. 121-141. Original Spanish "Dinamismo tecnológico e inclusión social en América Latina: una estrategia de desarrollo productivo basada en los recursos naturales" *Revista CEPAL* No. 100, April pp. 123-145.

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- Perez, C (2012) "Financial bubbles, crises and the role of government in unleashing Golden Ages", FINNOV Working Paper 2-12. Forthcoming in Pyka, A. and Burghof, H.P. (eds.) *Innovation and Finance*. London: Routledge.
- Prebisch, R. (1951), *Estudio Económico de América Latina 1949*, New York, CEPAL.
- Radosevic, S. (2012) 'Innovation Policy Studies Between Theory and Practice: A Literature Review Based Analysis', *STI Policy Review*, Vol. 3, No 1, 2012, pp. 1-45 Working paper available at: <http://discovery.ucl.ac.uk/1344149/>
- Reinert, Erik S. (1994) "Catching-up from way behind - A Third World perspective on First World history" in Fagerberg, Jan, Bart Verspagen and Nick von Tunzelmann (eds.) *The Dynamics of Technology, Trade, and Growth*, Aldershot: Elgar, 1994, pp. 168-197.
- Reinert, E. S. (1999) "The Role of the State in Economic Growth", in *Journal of Economic Studies*, vol. 26, No. 4/5, pp. 268-326.
- Reinert, Erik S. (ed) (2004) "Globalization, Economic Development and Inequality: An Alternative Perspective". Cheltenham: Elgar.
- Romer, P. M. (1993), Idea gaps and Object gaps in economic development, *Journal of Monetary Economics*, vol. 32, pp. 543-573.
- Sachs, J. and Warner, A.M. (1995) "Natural resource Abundance and Economic Growth", *NBER Working Paper* 5398.
- Sagasti, F. (2011), *Ciencia, Tecnología, Innovación: Políticas para América Latina*. Lima/México.: Fondo de Cultura Económica.
- Schmitz, H ed. (2004) *Local Enterprises in the Global Economy: Issues of Governance and Upgrading*, Cheltenham: Elgar.
- Sen, A. (1960) *Choice of techniques; an aspect of the theory of planned economic development*, Oxford: Blackwell.
- Sen, A. (1983), 'Development: Which Way Now?', *Economic Journal*, **93** (372), 745-762.
- Singer, H. W. (1949) "Economic Progress in Underdeveloped Countries", *Social Research: An International Quarterly of Political and Social Science*, Vol 16, No. 1 pp. 9-11.
- The Economist* (1977) "The Dutch Disease", November 26, pp. 82-83.
- Sumner, A. (2010), "Global Poverty and the New Bottom Billion: What if Three-Quarters of the World's Poor Live in Middle Income Countries?", mimeo, Brighton: Institute of Development Studies.
- United Nations Environment Programme (2011). *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*. Nairobi: UN Environment Programme.
- Urzua, O. (2011) *The emergence and development of knowledge intensive mining service suppliers in the late 20th century*, PhD thesis , SPRU, University of Sussex.
- Urzua, O. (2012) "Emergence and Development of Knowledge-Intensive Mining Services (KIMS)", No. 41, The Other Canon Foundation and Tallinn University of Technology Working Papers in Technology Governance and Economic Dynamics.