From innovation as an interactive process to the national system of innovation in an era of globalization - lessons for enterprises, universities and public policy

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Introduction

I am honored to get this opportunity to meet with Cuban scholars, managers and policy makers and I look forward to learn from the Cuban experience during my visit to your beautiful country and attractive society. I also look forward to the Globelics Conference that will take place here in Havana in September this year bringing together scholars doing research on Innovation and Development from all parts of the world (see www.globelics.org). In my talk I will try to summarize what I have learnt from my research on the economics and management of innovation and knowledge and point to implications for how to coordinate innovation policy, how to organise the university and how to manage an enterprise.

I will present three set of ideas and concepts with practical implications:

- Innovation as an interactive process
- The innovation system
- The learning economy

On this basis I will try to give some brief and preliminary answers to three questions:

- What should be the content and who should be in command of innovation policy?
- What is the role for universities in the learning economy?
- How to define and organise innovation and knowledge management at the enterprise level?

Science is a major productive force but innovation is not a linear process

A major factor behind the development of major technical innovations such as the computer and the internetwas of course scientific research. Actually the role of government especially in the US was crucial for the development of the technology. Military support to research and training programs at US-universities was crucial for technical breakthroughs. Public procurement, state finance and subsidies stimulated a growth in research that resulted in new insights that gradually went into new products for the civil sectors. In the longer run the economic impact was enormous.

This gives support to the idea that science is a major productive force. This idea was fundamental in the work by Karl Marx. In the work by Adam Smith on the Wealth of Nations we find a similar argument. In the introduction to the book he presents what he refers to the important role of 'men of speculation' as contributing to innovation and he regards the increased division of labour within science as contributing to progress in science and technology.
1939 in his book on the social role of science the British Marxist natural scientist John Bernal argued in favour of promoting science as a means to increase productivity economic well-being. After the second world war and in the wake of the successful Alamo project the US engineer and inventor Vannevar Bush

wrote the classical report 'Science - the endless frontier' with a strong recommendation to develop an ambitious government financed program for the support of scientific research in medicine and physics.

These important contributions led policy makers everywhere to assumethat there is a rather direct road leading from research in natural science to new technology and next to a more productive economy. This has been referred to as 'the linear model of innovation'. Modern innovation research has developed a very different perspective and demonstrated that feed-back from users is important for performance at all stages including feed-back to the producers of science located at universities.

The basic observation that *innovation is an interactive process* is perhaps the most important new insight that modern innovation research has come up with over the last 50 years. This new perspective has important implications for the role of universities, enterprises and governments and it is reflected in the wide interest in analysing, understanding and managing '*innovation systems'*.

The Chain Linked model, the Sappho project and the MIKE project

How did innovation scholars reach the conclusion that innovation is an interactive process? There were several important steps but three contributions were of special importance.

The Sappho project was organised at Science Policy Research Unit at Sussex University and it was about what characterizes organisations that are successful when engaging in an innovation process (Rothwell et al 1993). Comparing 28 successful industrial innovations with 28 similar but unsuccessful innovations the analysis concluded that there were three crucial factors that contributed to a successful innovation.

- Close interaction across divisional borders within the organisation.
- Close interaction with external organisations such as suppliers, users and knowledge institutions.
- Strong leadership for the specific project in order to overcome conservative resistance.

In a follow up study of technology intensive firms in East Europe (former planned economies)Radosevic and Yoruk (2012) confirm these results. They find that the most important factors for innovation success is interaction with users, understanding of markets and technological collaboration with other firms.

The MIKE project compared the development and use of information technology in four Danish industrial complexes. In all four cases we found that the interaction between those that developed innovations and those who used them was crucial for the speed and direction of technical change.

In a booklet (Lundvall 1985) I generalised the results from the MIKE project and presented a more general theory about product innovation and user producer interaction. One of the major points was that innovation would not thrive in the textbook economy with pure markets. It is actually the impurities that make capitalism a dynamic and innovation prone society.

The chain-linked model developed by Kline and Rosenberg (1986) summarizes empirical and historical research on the link between science, technology and innovation. It illustrates that most scientific knowledge drawn upon in the innovation process is established knowledge rather than brand new knowledge coming out of frontline research. It also demonstrates that innovations may be triggered by demand and that during the innovation process it is important to link up with the demand side all the way through. The model points to the feed-back mechanisms at work at all stages from knowledge supply to

the final outcome. Users of knowledge are as important as producers and successful knowledge producers need to learn from knowledge users.

Common for the Chain linked model and the two research projects Sappho and MIKE is that they point to the importance of users of innovation and knowledge and insist upon the importance of the quality of relationships. The practical implication is of course that investing in knowledge is an important but far from sufficient step when it comes to promote innovation. Linking up with users and with markets is crucial for the transformation of scientific knowledge into productivity, new products and material well-being. Innovation is not a linear process – it is an interactive process. This insight offers important lessons for policy makers and managers.

The national system of innovation

The concept national system of innovation was developed in a dialogue between Christopher Freeman and myself in the first half of the 1980s. Freeman is the founder of modern innovation studies and he was the initiator of the Sappho-project. The concept built upon the insight that innovation is an interactive process and this is reflected in the way we define the national innovation system:

The national innovation system is an open, evolving and complex system that encompasses institutions and economic structures. The quality of its elements and of the relationships between elements determine the rate and direction of innovation.

We had several reasons to link the innovation system to the national level. The relationships between users and producers are built in a process of interactive organisational learning where the parties build channels for information and develop a common language. It is no surprise that such relationships are easier to build within national borders. A shared culture, shaped by common education and work experience makes it easier to interact among national citizens. Second the nation state has played a key role as frame for industrial innovation and progress

This was confirmed by empirical network analysis finding that the network partners most frequently mobilized for innovation are national rather than local or global. But the analysis also demonstrates that more radical innovations would often require interactions that take place across national borders. Today the process of globalization puts national innovation systems under pressure and how to manage their openness to the rest of the world becomes a crucial issue for enterprises and policy makers.

The distinction between explicit and tacit knowledge

In order to get a deeper understanding of why innovation systems are more or less localised it is necessary to go beyond the concept of national culture and into the relationships between innovation and knowledge and also to make the distinction between explicit and tacit knowledge.

Within economics there are two ways to see knowledge and at first sight they seem to contradict each other. In modern Economics it is often assumed that knowledge equals information. This leads economists to see knowledge as a public good that can used by anybody without the wider use undermines its use value. Not all knowledge can be turned into information, however. Tacit knowledge is important in all fields of human activity. The classical examples given such as mastering the art of going on a bicycle and swimming are illustrative. But they are also misleading. The know-how of the

scientist is tacit, the know-how of the top manager and the policy maker are also tacit. There are always elements of tacit knowledge in this kind of know-how and learning by doing and interacting is necessary to establish know-how. It cannot be transferred through books or computers.

This implies that critical elements of knowledge are embodied in people and embedded in organisations. To move such elements of knowledge from one location to another requires different tools than computer networks or written documents. Moving people from one country to another has historically been a crucial step in getting access to foreign technology and it remains important. It may be argued that one of the most important origins of the industrial revolution in England was Henry the VIII's project to build cannons of iron. This required a immigration of skilled welders from Belgium and France.

The distinction between tacit and explicit knowledge is useful to understand the geography of innovation as well as the pattern of location of enterprises. In some sectors and technologies much of the crucial knowledge is codified and here multinational firms are keen to impose very strong intellectual property rights to avoid that competitors copy their new products – this is true for pharmaceuticals and to some degree for informatics.In other areas the elements of tacit knowledge are crucial and here learning by doing is necessary for establishing efficient production. This is the case for mechanical engineering and not least of automobile production.

The fact that much of the knowledge behind economic performance is tacit may be used to explain why local, regional and national innovation systems matter and why they differ in terms of specialisation in both production and trade and in technological capacity (as reflected in patent statistics). Much of the more recent literature on regional and national innovation systems has referred to the fact that tacit knowledge is important for economic performance when explaining why it is easier for developing countries to catch up with the rich countries in some sectors and more difficult in others.

In order to understand the future role of national systems of innovation in a context of globalization it is thus crucial to understand how globalization affects the production, use and diffusion of different types of knowledge both the explicit knowledge that takes the form of information and the tacit knowledge that is embodied in people and embedded in organisations.

The distinction between STI and DUI mode of innovation

As a follow up to the distinction between explicit and tacit knowledge we made an attempt to relate the innovation performance to two different forms of learning as it takes place at the level of the single firm. We referred to respectively science based and experience based learning (Jensen et al 2007). The study was based upon a survey of 700 Danish firms and it indicated that in most sectors enterprises need to combine experience-based learning with research and science-based learning in order to have success in innovation.

In Jensen et al (2007) we demonstrated that firms that combine interaction with universities and hiring of scientists (STI-mode of innovation) with establishing learning organisations and with interaction with customers (DUI-mode of innovation) were more than double as innovative (measured in terms of probability to develop a new product over a 3-year period) as those who only engaged in one of these forms of learning.

This result confirms the importance of regarding innovation as an interactive process. It indicates again that innovation policy and innovation management needs to go further than supporting research and stimulate the development of new technologies. It is equally important to stimulate the wider use of learning organizations and to develop the capacity to relate innovation to the users and to the market.

Defining the national innovation system

On the basis of what I have discussed so far I propose to make a distinction between a narrow and a broad definition of the innovation system. The narrow definition is an extended version of the national science system. It would focus on high tech industries and on radical and science based innovation. The core elements of the system would be research intensive enterprises, universities and government technological institutes. The most relevant policy would be science policy and technology policy.

The broad definition may be seen as combining the national science system with the national production system. Here low tech sectors are seen as important as high tech sectors and incremental innovation and the absorption and efficient use of new technologies from abroad are given equal attention as radical innovations. Experienced based learning is seen as important prerequisite for successful innovation on line with research efforts and use of scientific knowledge. Almost all policy areas would be seen as influencing the innovation process. I would argue that for national development strategies this broader definition is the most useful.

National systems that at a superficial look seem to be quite similar when it comes to the narrow perspective may turn out to be quite disparate when we use the broad definition. In the next section I will illustrate this with a comparative analysis of how people work and how they learn at the workplace in different parts of Europe.

Work organisation and innovation – the European case

The normal view of innovation is that it is an activity that takes place in an interaction between enterprise leaders, engineers, scientists and the policy makers in charge of innovation policy. The role of workers and farmers is normally neglected. The so-called triple-helix approach to innovation policy is based upon such a perspective (Etzkowitz and Leydesdorff 2000).

Our recent research linking working organization to innovation shows that this perspective is too narrow (Arundel et al 2007). How work is organised in the enterprise sector and how it impacts upon learning processes among workers is important for innovation and for the dynamic performance of the national economy. In a series of studies based upon survey data comparing the European countries we have demonstrated:

1. That work is organised very differently in different parts of Europe. In the South and East of Europe Taylorist jobs are frequent while in the North of Europe Creative jobs are frequent.
2. There is a close correlation between the proportion of workers with creative jobs (jobs offering discretion and learning for the worker) on the one hand and innovation performance on the other hand.

The quality of working life and organisational learning is a neglected dimension of national systems of innovation. This is especially problematic in the current context that we refer to as 'the learning economy'. I will discuss this third concept in the next part of my lecture.

From the knowledge-based economy to the learning economy

With investments in science and in education, the knowledge base of the economy has become increasingly important. There is little doubt that the most important resource in the economy is knowledge. Knowledge is a key to capture and manage all the other resources and also to cope with problems such as global warming and poverty. Therefore it is not surprising that international organizations and national governments have referred to the current state of the economy as a 'knowledge-based' economy.

My research and my experience from public policy have led me to propose that we refer to the current state as a *learning economy*. The major point is that what is required from individuals, enterprises and regions is not just a set of given competences but rather the requirement is the capacity to learn. The rate of change in terms of markets, technologies and organizations is high and accelerating. Therefore it is not enough to safe-guard the knowledge once acquired. Permanent learning is important for all individuals and organisations.

There are several drivers behind the acceleration of change. New technologies and not least information and transport technologies, deregulation of financial markets and globalisation of production and competition all contribute to the speed up. Among the indicators that indicate speed-up are shorter product life cycles and more frequent changes in the content of work and in the required competences.

The policy implications of the learning economy are radical and few national governments and few international organizations respond fully to the new challenges. It would require a new way of understanding the economy and new designs for economic and social policy. The learning economy has an inherent tendency to polarize between those with a professional education and the rest. Those with the weakest skills will find it difficult to find jobs while the well educated will become better off since they are better prepared for the learning economy.

With social polarization the learning economy will be undermined. Growing inequality weakens the participation of workers in processes of change and learning. Therefore there is a need for special efforts to upgrade the skills of the low-skilled workers through adult vocational training. I have referred to this as a need for a new new deal where the critical issue is redistribution of access to education and learning (Lundvall 1996).

The Globalising learning economy

The national innovation system is an open system and in many cases you may say that it is wide open. Some scientific networks are truly global and innovation processes increasingly involve interaction across national borders. Financial markets have as a result from deregulation become global. Other dimensions of the national innovation system such as education systems and labor markets remain with national characteristics. The globalization process is one of the drivers of the learning economy but it is also one of the factors that tend to undermine national institutions that support the learning economy.

One of the most important contradictions in the world today is the one between national governance and an increasingly global economy. I cannot go into this discussion in any detail. But let me signal that it is my opinion is that the increasing openness of the world economy may undermine both social welfare and productive forces when nation state institutions are weakened and no transnational institutions are taking over the responsibility. The predominant neoliberal assumption that trade is always promoting wealth creation neglects the potential negative dynamic effects on productive forces.

While the opening of the national economies to trade in foreign direct investments in many Asian countries went hand in hand with a strengthening of the national innovation systems in these countries many Latin American countries saw many examples of opening up where the impact on their knowledge base was negative.

These different experiences may be related to the critical perspective presented by Friedrich List who criticized the free trade doctrine of Adam Smith. He argued that Adam Smith when he proposed free trade neglected the potential negative impact upon – what List saw as the most important source of wealth 'mental capital'. When assessing the impact of internationalization of the economy it might be wise to follow List in this respect and ask the question about how trade will affect the strength of the national innovation system.

In the very first paper referring to the role of the national innovation system Christopher Freeman the founder of modern innovation studies pointed out that List's main argument for protecting infant industries was to make sure that the participation in international trade should strengthen rather than weaken the knowledge base of the economy (Freeman 1982).

Globalisation is an uneven but strong process that needs to be taken into account of policy makers, enterprises and universities.
The Globalisinglearning economy perspective points to a new approach to managing enterprises and universities. In the last part of this conference I will draw upon my discussion of innovation and of the learning economy to sketch what I see as the most implications for public policy, enterprise organisation, universities.I will thus come back to my three questions:

- What should be the content of innovation policy and who should be in command?
- What is the role for universities in the learning economy?
- How to define and organise knowledge management at the enterprise level?

What should be the content of innovation policy and who should be in command?

We need to redefine science, technology and innovation policy when we take into account that innovation is an interactive process and that the wider setting influences innovation performance. Innovation policy should aim at creating missing links within the innovation systems and sometimes even help breaking up links that lock in firms in obsolete network formations. Education and training as well as labour market policies need to be assessed from an innovation perspective. Energy, transport, health and environmental policy may be designed so that they contribute to innovation and make use of new technology and new forms of organization.

There is a great potential in engaging in 'policy learning' when it comes to innovation policy. One form of policy learning relates to comparing foreign experiences from designing and implementing innovation

policy. Interesting cases outside Latin America are China, Russia, South Korea and Finland. Russia may be studies as a negative case while the other three give examples of some degree of success. It is not a question of importing best practice since contexts are important for what works and what does not work.

It should be clear from what I have said that innovation policy must be seen as covering many dimensions and sectors. If we look at how different countries have organized the responsibility for innovation policy we find different models. In some countries innovation policy is linked to a ministry of science. In others it is linked to the ministry of industry or to the ministry of finance. For many years I have advocated that the Finnish model with a coordinating role for a national council for science technology and innovation with the prime minister as chair person is a good solution.

Just a month ago the new Swedish Social Democrat government decided to establish such a council with the Prime Minister as chairperson. The problem with all the other solutions is that they tend to lead to a biased view of the innovation process where either the focus is too narrowly uponscience orupon the interests of industry. The council would typically have ministers for science, industry, finance, labor and education as key members. The fact that the prime minister is leading the activity gives the council great authority. In the case of Cuba the council might cover a combination of fields reflecting its current situation such as indicated by the heading The National Council for Innovation, Development and Trade?

What is the role for universities in the globalizing learning economy?

It is generally accepted that universities should try to build bridges to society and to industry and enterprises in order to make their research results more useful for society. While this view is legitimate it may result in public policy strategies that are too narrow.

With an interactive perspective it is easier to understand the difficulties involved in passing on scientific knowledge to enterprises – and especially to low tech enterprises and to farmers. In many cases the main problem is a lack of demand for knowledge and therefore science, technology and innovation policy should give much more attention to build ‘absorptive capacity’ in the enterprise sector. It is easier to build a bridge over a river if the project starts simultaneously from both river banks.

In the learning economy universities should teach students to learn and ideally also to be good at solving problems and grasping opportunities. My own experience is that traditional pedagogical methods with attending lectures and seminars should be combined with project organised problem based learning where students interact with organisations outside the university.

This form for training make students better prepared for future jobs and for the learning economy. At the same time it contributeto building bridges between university and organisations in different economic sectors such as agriculture and industry. When low tech organisations get more used to interact with students they become more willing to hire them and hereby they increase their capacity to absorb scientific knowledge and engage in innovation.

The other way around it is important to note that increased innovation activities in enterprises and in agriculture stimulates the demand for candidates with a tertiary education – it could be both engineers or business management candidates. (Lundvall 2008).

Universities are under cross-pressure in the learning economy. On the one hand they are expected to respond quickly to the demands from society and economic agent on the other hand they also need to be given some degree of autonomy that makes it possible for scholars to engage in long term efforts in basic science. One major task for university managers is to develop organisational forms that make it possible to cope with this trade-off between speed and long-term efforts. (Lundvall 2002).

Universities are increasingly becoming engaged in global competition when it comes to attract good students and researchers. Promoting the exchange of students and scholars with universities abroad is a way to build network relations and research collaboration that is crucial for keeping a high quality of both education and research.

How to define and organise knowledge management at the enterprise level?

The innovative enterprise needs skilled people. Science based firms will have specific R&D-departments. But it also needs to build learning organisations. Learning organisations are flat and there are low barriers between divisions. With decisions delegated to lower levels this opens up for horizontal cross-divisional interaction at all levels of the hierarchy. This is required both to respond to change and to become innovative. In such organisations employees will have access to learning at the workplace and this is a key to keep the organization up to date in the learning economy.

But it is not sufficient for dynamic enterprises to draw upon in house knowledge. Interaction with suppliers and knowledge institutions give input to the innovation process. Most important is to engage with users, customer and clients. To have privileged access to 'lead users' – customers that are advanced in terms of their needs and competent to present them in a clear way - is a key advantage for the innovative enterprise. The second major dimension of knowledge management is about positioning the enterprise in networks.

Organisations in the enterprise sector should be aware of the fact that entering global value chains may be one way to establish a relationship to a 'lead user' abroad and that such a relationship under certain circumstances may lead to 'upgrading' in terms of products, processes and functions. Understanding what are the necessary conditions from benefiting from participation in global value chains is important for managers.

The challenge ahead

Perhaps the most important challenge for Cuba in the coming decade will be to give a practical response to the question: how to build a stronger national innovation system with Cuban characteristics while at the same time entering more and more into processes of global exchange of knowledge, technologies, capital and commodities.

The key questions are therefore:

How can government, universities and enterprises develop strategies that combine the entering into deeper and wider international exchange and collaboration with a strengthening the knowledge base and the Cuban national innovation system?

This will require an unprejudiced and pragmatic analysis of the strength and weaknesses of Cuba's national innovation system as well as an analysis of strategic threats and opportunities. I hope that we can have a first discussion around these questions today. Thank you so much for your attention!

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