Weak knowledge demand in the South: Learning divides and innovation policies

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Weak knowledge demand in the South: learning divides and innovation policies

Rodrigo Arocena and Judith Sutz

Many developing countries confront serious problems in benefitting from the advancement of knowledge; a main difficulty being to expand the learning processes. Related policies have been jeopardized by weak market demand for knowledge. Both supply-side and demand-side science and technology and innovation policies have thus been below expectations. This paper argues that to reverse this long trend, current policies can profitably be complemented by a set of innovation policies conceived as social policies, which can simultaneously answer a strong social demand for knowledge and expand endogenous innovative capabilities.

TODAY'S RICH COUNTRIES ARE the knowledge-rich countries: access to knowledge and use of knowledge are both widespread, knowledge has been their 'lever of riches' (Mokyr, 1992). That is even more important today: a 'knowledge-based and innovation-driven economy' (de la Motte and Paquet, 1996) has emerged in a set of countries frequently termed 'developed countries' or the 'North'. In comparison, most other countries are more or less poor in terms of access to knowledge and use of that knowledge. This can be termed the problem of knowledge for development. The causes of the problem have been explored from different standpoints (Herrera, 1971; Cooper, 1973; Steward, 1977; Landes, 1998; Rosenberg and Frischtack, 1985). During the second half of the 20th century it was recognized as a policy problem by most developing countries. Policy instruments were put in place, ranging from measures to fortify the scientific infrastructure to those aimed at stimulating technology transfer. Since then, several developing countries have improved some knowledge-related indicators, like higher education enrollment and the number of researchers. However, many of them have not, most of them being within the UN Conference on Trade and Development (UNCTAD) classification of 'least developed countries' (UNCTAD, 2007). In general terms, despite important differences between the countries, the problem of knowledge for development persists.

Two intertwined explanations for this persistence deserve particular attention. The first relates to the prospects for learning, which are of utmost importance if an economy wants to transform knowledge into one of its fundamental resources (Lundvall, 1992: 1). Such prospects are not brilliant in developing countries. Poor countries are stuck in poverty because, amongst other reasons, they specialize in activities that are devoid of learning potential (Reinert, 2007: xxviii). The second explanation relates to the demand for knowledge, a main driver of the process of learning: such demand is weak in developing countries (Cimoli *et al.*, 2009; Rodrik, 2007). Analyzing these two issues in an interrelated way can be an Ariadne's thread leading to a better understanding of the obstacles that deter a better use of knowledge for developmental purposes.

The analysis of this interrelatedness is based on a re-examination of the concept of learning and of the sources of knowledge demand. The social processes of advanced learning increasingly influence the

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actual role of knowledge. Broadly speaking, these processes have two main aspects:

- Learning by studying at high level in a way that makes it possible for a person to continue acquiring knowledge throughout their life.
- Learning by participating in knowledge-demanding activities that include problem solving.

Briefly speaking, these are learning by studying and learning by solving. Knowledge-rich countries are such because many people have opportunities to learn both by studying and by solving. Such opportunities are distinctively less frequent in other countries: thus a major 'learning divide' emerges.

Learning by studying is mainly related to knowledge supply: learning by solving is mainly related to knowledge demand. The weakness of market knowledge demand in most developing countries makes it particularly difficult to foster learning by solving, giving rise to persistently unbalanced learning processes. Policies for science, technology and innovation that do not take this situation into account are bound to increase such an imbalance. In the words of Reinert:

> …successful cases of economic development prove the importance of *simultaneously* providing not only a flow of better educated people, but also jobs where their skills are demanded. … Nations that only address the supply side of educated people end up educating for migration. (Reinert, 2007: 320–231, emphasis in the original)

Policies for science, technology and innovation are limited in their capacities to fortify market knowledge demand, which depends primarily on the productive structure and other factors beyond their reach. But they can systematically combine efforts with other public policies in order to foster the social demand for knowledge. This demand is extremely diverse: in developing countries the demand for 'inclusive innovations' is particularly important. These are characterized as solutions to problems that primarily affect deprived populations and are truly innovative, that is, they exhibit some degree of newness and originality. Mobilizing learning by solving through this demand is one of the ways in which to cope with the problem of knowledge for development.

The rest of this paper is divided into five sections. The first section deals with the characterization of the above-mentioned processes of learning, and with the 'learning divide' among countries that result from differences in the opportunities to perform such processes. The second section deals with the role of knowledge demand in fostering learning processes. The third section shows that learning by solving is particularly difficult to foster in developing countries. The fourth section considers related l essons stemming from the experience of Latin American policies for science, technology and innovation. It follows that policies should foster the social demand of knowledge, particularly paying attention to 'inclusive innovations'. The final section exemplifies this alternative.

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Learning divides in the 21st century

Without the type of knowledge acquisition that comes from formal processes of studying, neither further knowledge production nor the application of knowledge is possible. Without the opportunity to utilize the acquired knowledge, such knowledge looks like a library that continues purchasing new books, but is seldom used. Making mistakes and being able to overcome them is a key component of any learning process: without the opportunity to solve problems this key component is absent from the learning process at nation level. As Lall put it almost 20 years ago:

> If physical capital is accumulated without the skills or technology needed to operate it efficiently, NTC [nation technological capabilities] will not develop adequately; or if formal skills are created but not combined with technological effort, efficiency will not increase dynamically. (Lall, 1992: 170)

Lundvall and Soete (2002) also suggested a differentiation between two types of learning:

> In national education systems people learn specific ways to learn. In labour markets they experience nation specific incentive systems and norms that will have an impact on how and what they learn. (quoted in Robertson *et al.*, 2007: 160)

We refer to the process of acquiring knowledge and skills through the formal process of studying at tertiary level as 'learning by studying'. The process of acquiring knowledge by systematically using advanced knowledge for solving problems is termed 'learning by solving'.

One good indicator of the opportunity for learning by studying is given by the enrollment in higher education. Such information is available for most countries. A different indicator of the supply of knowledgeable people is the number of researchers (full-time equivalents) in relation to the population. As would be expected, these indicators are linked. Countries usually score high or low on both indicators (see Table 1 for some selected countries).

The opportunities for learning by solving are difficult to approach by means of a single indicator. A relatively good indicator would be the percentage of all human resources in science and technology (S&T) working in businesses; this indicator can be built from innovation surveys, but is not available for the vast majority of developing countries. Another, more restricted, indicator is the percentage of all researchers working in firms; again, it has serious problems with coverage. The ratio of gross expenditure on R&D to gross domestic product (GDP) and the part financed by firms are very popular indicators of the importance given to science, technology and innovation in a given country. The first of these is widely available. It can be taken as a proxy for opportunities for learning by solving, even if a rather indirect one, because it makes sense to infer that the more a country invests in R&D in proportion to its wealth, the more opportunities knowledgeable people will have to work in knowledge-demanding activities. In fact, as is elaborated later in this paper, one of the reasons why most developing countries continue to have dismal figures for R&D/GDP is because such knowledge-demanding activities are scarce.

Table 1 shows these indicators for several countries, some of which are known for having economies that are to a large extent innovation-driven. Others are included for purposes of comparison.

The figures in Table 1 are consistently high for developed countries. In some cases, like Brazil and South Africa, the figure for R&D/GDP is not as low as in most developing countries, reaching a threshold of 1%, but the rest of the indicators are much weaker. Argentina is relatively well placed in terms of the enrollment in higher education and number of researchers, but scores low in the proxies for learning by solving. China exhibits figures which are fully comparable with those of developed countries in some indicators, but it still lags behind in others. However, its rhythm of change is impressive: between 1996 and 2006 its gross expenditure on R&D multiplied by six (Ministry of S&T of the

Table 1. Some indicators of capacities to produce and to use knowledge for diverse countries

Countries	HE gross enrolment ratio	Researchers (FTE) per million inhabitants	GERD/GDP	GERD % funded by business enterprises	Researchers working in business firms (% of total researchers)
USA	82	4.671	2.67	66.4	79.2
Sweden	75	6.139	3.68	63.9	72.8
South Korea	96	2.044	3.47	73.7	68.5
China	22	1.071	1.49	70.4	68.3
Japan	58	8.840	3.45	77.7	66.1
Denmark	80	5.431	2.57	59.5	65.1
Finland	94	7.382	3.47	68.2	56.8
France	55	3.440	2.10	52.4	55.5
UK	59	3.695	1.84	47.2	48.8
Spain	68	2.784	1.28	47.1	43.5
Brazil	30	629	1.02	47.9	37.4
Mexico	26	460	0.50	46.5	31.1 (2003)
India	13	137	0.80	19.8	16.8
Argentina	62	980	0.51	29.3	15.5
South Africa	15	382	0.96	43.9	…
Colombia	33	151	0.18	27.0	0.3

Source: UIS, available at <http://stats.uis.unesco.org/unesco/TableViewer/document.aspx?ReportId=198&IF_Language=eng>, 2007 reference year or latest year available; for South Africa, Southern Africa Regional Universities Association. Available at <http://www.sarua.org>, last accessed DDD/MMMM/YYYY

People's Republic of China, 2007); the enrollment in higher education increased from 7% to 22% between 1999 and 2007 (UNESCO, 2010).

We can put each country in a 'map' (see Figure 1) by using enrollment in higher education and R&D/GDP, respectively, as proxies for learning by studying and learning by solving.

Figure 1 schematizes a learning divide between developed countries and several other countries (Arocena and Sutz, 2000). This notion recalls how difficult it is for many countries to cope with the enrollment revolution and to use knowledge for development, that is, to cross the learning divide. Nevertheless, it can be crossed, as is shown by the differing positions of South Korea over time.

Why is knowledge still a weak lever for development in many countries?

Mokyr (1992: 4–6) asserts that economic growth stems from four distinct processes:

- investment, that is, increases in capital stock;
- trade and division of labor;
- economies of scale or, more generally, size effects; and
- increases in the stock of human knowledge, including technological and institutional changes, which are the source of the so-called Schumpeterian growth.

Many developing countries have experienced periods of economic growth stemming from different combinations of the first three of these processes. But backwardness has been substantially and permanently diminished only in the comparatively few cases when the fourth process became relevant. Remarkable examples have been provided during the 20th century by the Scandinavian countries and by East Asia where learning processes expanded quickly.

Importing knowledge has been of paramount importance in every successful story of development. But the problem of knowledge for development could not be solved solely by importing knowledge. This is connected with the following assertions due to Lall (1990: 22):

- Without investment capabilities 'there is little understanding of the technology transferred, leading to subsequent high costs of operation and a lack of upgrading'.
- Process innovation capabilities are necessary, particularly because 'buying new technology may be quicker and less risky than innovation, but, to be successful and economical, also requires a high degree of technical skills'.
- 'Capabilities to follow trends in product development, (almost as difficult as independent innovation)', are necessary because new technologies are often not transferable to independent firms.

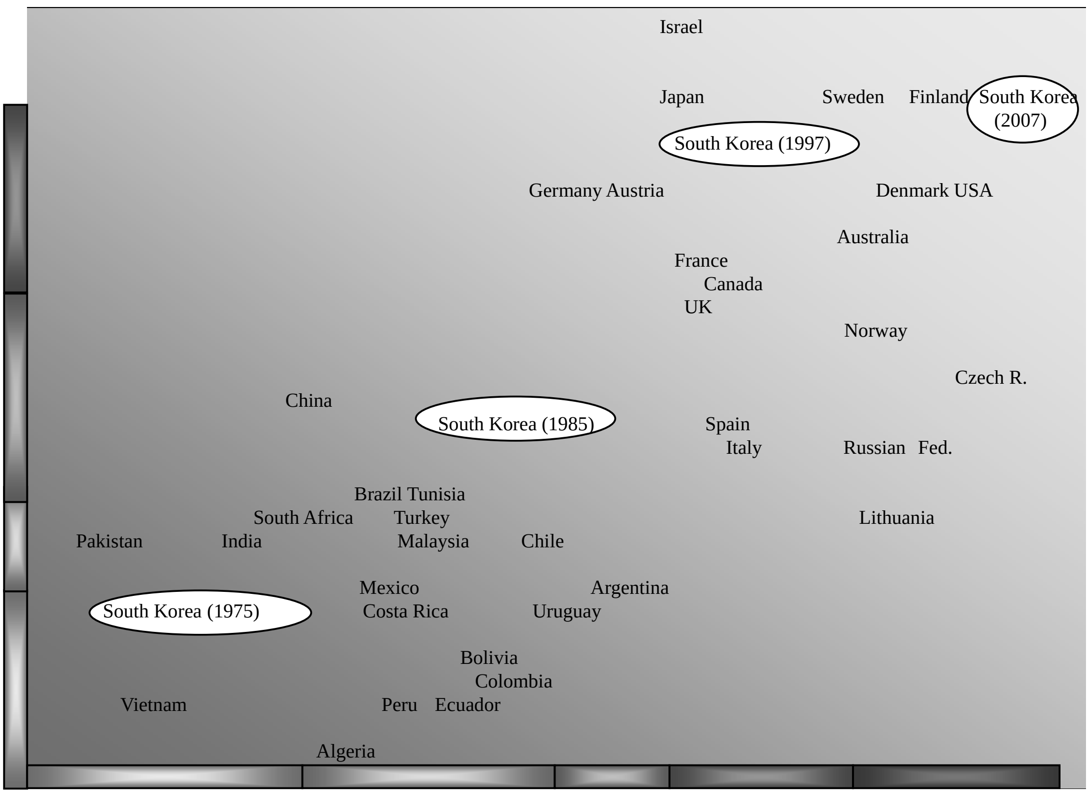

Figure 1. Illustration of the 'learning divide'

Notes: Vertically, from bottom to top, R&D/GDP: <0.5, 0.5–1, 1–2, 2–3.5
Horizontally, from left to right, gross enrolment in tertiary education (%): <30, 30–50, 50–60, 60–75, >75

Source: As for Table 1, Arocena and Sutz (2000)

Lall exemplifies the conscious building of these capabilities in South Korea, and shows that Sub-Saharan Africa is an example of the lack of such efforts. In Latin America importing industrially embodied knowledge was a failure if it was not combined with endogenously generated knowledge (Fajnzylber, 1984). Nowadays technical cooperation with least developed countries also faces the difficulties of building long-term capacities and the likelihood of limiting or inhibiting local alternatives (Bell, 2007: 10).

Endogenous generation of knowledge is a necessary complement to the success of knowledge imports, particularly when knowledge in the making is imported. A general feature of the changes in the production and use of knowledge is that both are increasingly intertwined. Advanced learning, scientific research, technological innovation and economically efficient diffusion of innovations become more entangled. Thus, the last process becomes increasingly difficult if it is not closely connected with the other three.

The need to cope with such issues ‘systemically’ has also been reinforced by their context-dependent aspects. Health and life sciences in Latin America owe, in no small measure, their comparatively distinguished history to that phenomenon. Some of the main health problems in the continent were quite specific. They could not be solved by knowledge transfer alone: systemic building of research and innovation capabilities was needed. Today, generally speaking, problems and disciplines with strong context-dependent aspects are expanding their influence in knowledge-related activities. Health, environment, nutrition, and sanitation are all examples of that. Related problems often have solutions that are affordable in the North in terms of research, development and production costs as well as in terms of the purchasing power of the expected customers, but that are not affordable in poorer contexts. When only unaffordable solutions exist, the problem is still open and requires specific research (Srinivas and Sutz, 2008).

Summing up, the new centrality of learning and innovation processes gives new weight to an old idea: to make knowledge a lever of development, ‘massive’ endogenous capabilities and opportunities for creatively using advanced knowledge are needed. But that is quite difficult when demand for knowledge is weak, in quantity and/or in quality.

The role of such demand has been frequently stressed. Porter (1990: 86) stated that home demand conditions:

> …shapes the rate and character of improvement and innovation by a nation’s firms

Arguing further that, the quality of home demand is more important than its quantity, Lundvall and Borrás (1997: 123) stressed that the effects of supply-side policy instruments:

> …are uncertain in that their success depends on the ability and readiness of the actors operating in the system to absorb and maximise the potential of these incentives. Developing *demand-side policy instruments* is of equal relevance for European and national systems, and relate to policy actions designed to enhance the technological competencies of the system by emphasising the role of the user.

A case study in an economically depressed part of France shows:

> …that it is not sufficient to legislate a policy for making scientific and technological knowledge available in order to create a relationship of synergy between the development of universities and economic development. In the case in point, the problem is the lack of demand on the part of the main economic actors (industrial firms). (Laperche, 2002: 168)

A report on the state of S&T in Latin America indicates that the most important factor explaining the shortage of linkages between knowledgeable people and institutions and production is still the weakness of the knowledge demand from enterprises (RICYT, 2008: 22).

Of late, demand has been a rather forgotten issue:

> Imagine trying to cut a piece of paper with just one blade of a pair of scissors. It’s near impossible. Yet that is what we try to do with innovation policy. (...) Innovations are the product of the creative interaction of supply and demand. However, in focusing on how to increase the supply of innovative businesses, policymakers have lost sight of the importance of demand. (Georghiou, 2007: 1–2)

That is particularly worrying for developing countries. We conjecture that one of the main causes of the learning divide is the weak knowledge demand addressed to endogenous sources of knowledge by the productive structure of developing countries. In Latin America this has been and still is a dominant trait.

> The Latin American and Caribbean production pattern on the one hand, induces private sector and enterprises to express a meager demand for knowledge, and on the other hand, leads domestic agents to mostly seek outward oriented linkages, privileging foreign companies and research laboratories that already have sound reputation and worldwide recognized experience in effective and efficient S&T efforts. Thus a mismatch ensues between demand-side needs and supply-side offerings, hampering policies’ impact. (Cimoli *et al.*, 2009: 12)

The mismatch between demand and supply and, particularly, the problem of the knowledge outward oriented linkages, was already well understood by the Latin American scholars of S&T 40 years ago (Sabato and Botana, 1968). It leads to a sort of globalization of the sociology of science concept, the Matthew effect famously proposed by Merton (1968): those knowledge and innovation producers that receive the knowledge demand from developing countries get stronger in terms of their ability to satisfy such demand; conversely, those that even having the knowledge skills to solve problems are not called to solve them in their own countries, will change profession, migrate or exploit their skills well below their possibilities.

Consequently, as Rodrik (2007: 101) has commented:

> …innovation in the developing world is constrained not on the supply side but in the demand side. That is, it is not the lack of trained scientists and engineers, absence of R&D labs, or inadequate protection of intellectual propriety that restricts the innovations that are needed to restructure low-income economies. Innovation is undercut instead by lack of demand from its potential users in the real economy – the entrepreneurs. And the demand for innovation is low in turn because entrepreneurs perceive new activities to be of low profitability.

Knowledge supply *per se* does not create knowledge demand. This has been recently recognized in India, where around one-third of all graduates are in scientific fields but 66% of those holding advanced degrees and unemployed are also in those fields (Bagla, 2005).

Fostering knowledge demand needs specific and context-dependent policies. It cannot be assumed that the same policies will be efficient where such demand is rather strong and also where it is weak.

Concerning the developing world, what is asserted is the weakness of market demand for knowledge. According to Rodrik, the explanation is that entrepreneurs think that, on average, innovative activities offer low profits. Usual policies for fostering knowledge demand focus on firms. So the problem requires a more diversified set of policies. Further support for this assertion will be given in the section of this paper devoted to a brief review of the achievements and limitations of Latin American knowledge policies. Now we turn to another reason for focusing on knowledge demand: the most difficult aspects of learning processes are directly dependent on the level of such demand.

Two aspects of fostering learning processes: a difficult and a more difficult task

Learning by studying is less difficult to achieve than learning by solving, the latter being directly related to the level of knowledge demand. The former process is not at all easy. Although enrollment in higher education is steadily growing globally, in most developing countries this growth is far from enough to redress the gap. Nevertheless, even if results are slow to achieve, and moreover some processes, like emigration, can jeopardize them, the move towards increasing the opportunities to study at tertiary level is distinguishable (see Figure 2). Understanding why this is so helps us to better grasp the difficulties of fostering learning by solving.

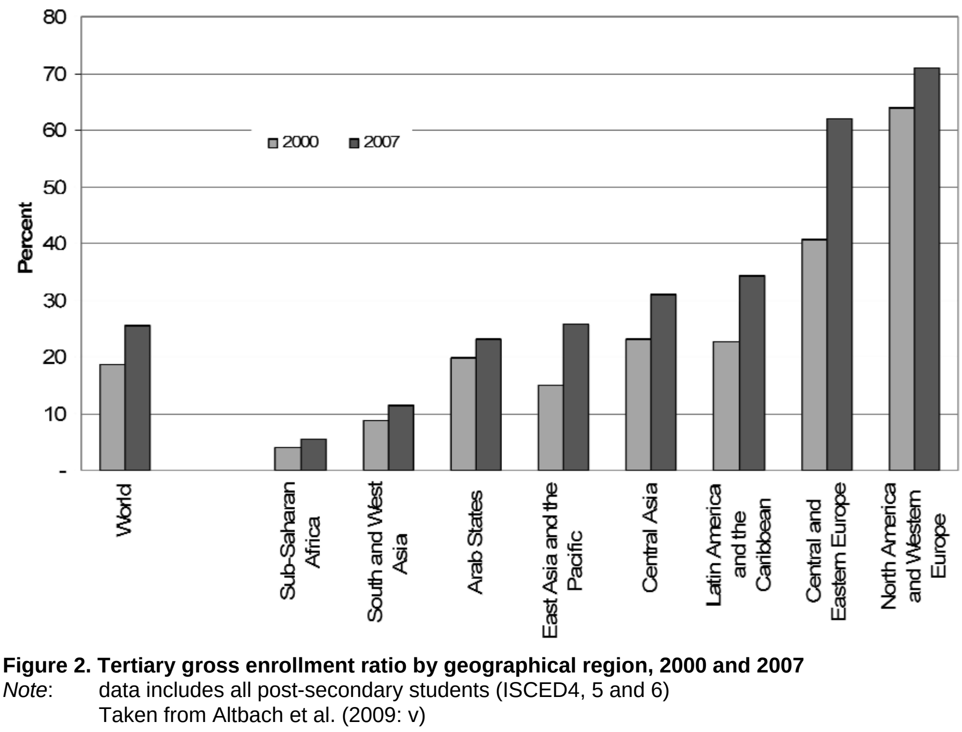

Figure 2. Tertiary gross enrollment ratio by geographical region, 2000 and 2007
Note: data includes all post-secondary students (ISCED4, 5 and 6)
Taken from Altbach et al. (2009: v)

People's motivations to seek access to higher education can be relatively independent of market situations. Even if increasing pressures are exerted upon universities to transform them into more market-dependent organizations, they still have a relative autonomy from purely market considerations. Universities are seen as enabling organizations par excellence in the knowledge economy: expanding them is usually considered a legitimate aim of public policy. The advancement towards a higher rate of enrollment in higher education in developing countries has an increasingly positive citizenry valuation. Thus the move towards learning through studying, including at higher levels, has a growing level of political support. So, it can be expected that this leg of the learning opportunities, notwithstanding all the difficulties involved, will on average, become steadily stronger (see Altbach *et al.*, 2009).

We now turn to the other leg of the learning opportunities. Learning by solving usually involves some sort of human group, where learning is fostered by the cross-fertilization of what different people in the group know. Even if each person learns in this way, the most productive result is that the group as such learns.

> It is important to distinguish between the concepts of 'learning community' and 'collective of learning individuals.' Learning communities demonstrate as such learning behavior, i.e. as a whole they have the ability to constructively interact with change at a level that transcends the simple sum of the various individuals who constitute the community'. (Visser, 1999: 7)

The strength of 'learning communities', stemming from systematic processes of applying knowledge to problem solving, is strongly dependent on the level of knowledge demand.

Any group where learning by solving occurs requires searching how to solve problems. Searching is always costly and time consuming, be it by:

> …looking up the answer in a source known to contain the answer, or an extended search for a problem solution that may not exist. (Nelson and Winter, 1982: 64)

The propensity to search depends on the perceived rewards of finding solutions to unsolved or not satisfactorily solved problems. Such rewards need to be sufficiently attractive to overcome inertia and the reluctance to incur the different costs that searching involves. Again, the opportunities for searching, a key component of learning by solving, are strongly dependent on the level of knowledge demand. Even if fostering learning by studying is not an easy task in developing countries, learning by solving is even more difficult.

On Latin American science, technology and innovation policies

Supply-side policies in Latin America started as classical science policies: in some cases they became more elaborate S&T policies. Resources and position in the government agenda rose and fell in different periods. On average they have hardly ever been high, but the balance differs greatly from country to country. Nevertheless, they have contributed to the building of a fairly significant research structure. During the period 1996–2006 the number of full-time equivalent researchers in Latin America and the Caribbean grew 85%, reaching 234,661. The weight of the region in terms of researchers at global level also grew significantly during that period, from 2.9% to 3.8% (RICYT, 2008: 16, 17).

The outcomes of supply-side policies in terms of research capacities have been highly influenced by three factors. One is the already stressed weak market demand for endogenous knowledge generation. Lack of continuity and weakness of public policies have also been relevant, Brazil being a partial exception. We see different combinations of periods of almost complete neglect with periods of mild attention to these issues and with some short periods of fairly strong official push. Those two 'external' factors help to explain the relevance of a third factor: the internal dynamics of organized research. The Latin American research structure has been shaped to a large extent by claims stemming from some large public universities and by the different and changing levels of self-organizing capabilities, of international connections and of the national lobbying power of networks of researchers, mainly working in those universities.

OECD innovation policies have provided the rationale for the Latin American wave of innovation policies. Some of its mechanisms were frequently adopted, like tax reductions for innovation-related investments and competitive funds to promote associative innovation efforts. Others were scarcely adopted, for instance those directed towards the internal transformation of the absorptive capacities of firms, like support of small- and medium-sized enterprises (SMEs) for hiring their first employee with

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tertiary education. Instruments related to demand-side innovation policies were hardly ever adopted. Like the most pro-active mechanisms of technological public procurement, innovation policies have not achieved great success. Innovative firms continue to be a small proportion of all firms. Their main innovation efforts are still importing machinery and equipments. The capacities built through the supply-side S&T policies are still under-utilized by firms, which continue to constitute a marginal labor market for researchers and, in the case of SMEs, even for university graduates.

The above assertions can be illustrated by the case of Uruguay. In 1985 the country recovered the democratic rule, after 12 years of dictatorship. S&T supply-side policies have been implemented since then, backed by international organizations. A previously dismal situation has been moderately improved in terms of the number and training of researchers, research infrastructure and salaries, grants, mobility and research quality. Those policies, mainly supported by public money, have not been accompanied by a really intensive demand for local research and knowledge capabilities from industry or services. Policy instruments aimed at fostering innovation at firm level were implemented, but it was tacitly assumed that a main reason why firms do not rely on knowledge and are not too innovative is that they lack sufficient money to do so. Consequently different types of financial instruments were developed, from tax alleviation to co-financing for innovation projects. These instruments were not extensively used. Even between Uruguayan innovative firms the reliance on the available public support was quite low when compared with such reliance in Europe.

To establish a meaningful comparison we take two groups of firms, in Uruguay and in Europe, characterized by being the most innovative within the universe of all industrial firms. The definition of such firms is, for Uruguay: ‘Innovative based on the endogenous competences of the firm’, representing 7.1% of all industrial firms (Bianchi and Gras, 2006). For Europe the definition was: ‘companies (that) shine in all aspects of the innovative process and support this activity through the requesting of advice from experts as well as hiring new graduates from universities at home and abroad’ (European Commission, 2004), representing 20% of the sample. Table 2 shows that the two groups of firms are quite similar regarding innovation, while it also shows how they differ in relation to their utilization of public support for innovation.

On the other hand, indicators of achievement for an innovation policy can include an increase in the proportion of firms that employ knowledgeable people as well as a widening of their relations with knowledge producers. Given that no business would make investments in this direction unless it considers it profitable, such outputs can be reasonably considered to be a shift towards recognition of the

Table 2. Comparison between groups of innovative firms in Uruguay and in Europe

	Percentage of innovative firms based on endogenous competences that have characteristic indicated in row (Uruguay, 2006)	Percentage of innovative firms that excel in all aspects of innovative process that have characteristic indicated in row (statistics for Europe in 2004)
Innovative technologically in product and processes	89.8	88.4
Performing internal R&D	64.1	70.9
Receiving public support for innovation	0.5	28.5

Source: based on Bianchi et al. (2008)

usefulness of the available knowledge supply. Innovation policies of the type implemented so far in Uruguay have not advanced much towards this kind of outputs. For example, 80% of small firms do not have any employee with a background in S&T tertiary education, a trend first measured in 1986 (Argenti *et al.*, 1989) and confirmed in the last industrial innovation survey of 2006 (Bianchi *et al.*, 2008).

To date, innovation policies that could foster the productive use of endogenous knowledge capabilities in Uruguay and other Latin American countries have had limited success. Such policies are frequently defined as a sort of ‘cut and paste’ from the policies of developed countries, so local specificities are not sufficiently taken into account. Information about the innovativeness of firms and related issues is frequently gathered through surveys aimed more at establishing international comparisons than answering relevant questions in a given context. Competitive funds for innovation would be demanded by many firms only if the prevailing high innovative passivity is redressed to some extent by some ‘localized’ instruments that are more pro-active and even customized. If this does not happen, only those few firms that already know that local knowledge is important will apply for funds. Demonstration effects are needed to build stronger bridges between the relatively weak knowledge demand from firms and national knowledge supply. Policies could identify some important and paradigmatic problems affecting groups of firms and support specific programs to search solutions. These ‘tailored demand-side’ innovation policies are scarcely seen in manufacturing. The situation is different in agriculture, where the information about production problems in need of knowledge is permanently updated through different types of institutional arrangements.

There is surely ample room for improvement for different kinds of demand-side policies directed to firms' innovative behavior. It is worth to bear in mind, though, that such improved policies will probably face a high wall of a structural nature, namely the type of productive activities in which national firms are engaged and the main sources of profits obtained by the entrepreneurs that own and govern such firms.

The question has two parts: first, if the knowledge demand of businesses is difficult to foster due to structural reasons; and second, without the strong fostering of knowledge demand the learning divides will not be overcome, then what sectors of social life would be adequate to stem knowledge demand through new types of innovation policies well adapted to promote processes of human and sustainable development?

Policies to foster social demand of knowledge

Improving the innovative capabilities of firms is essential for development. In many developing countries structural obstacles position the perceived risk threshold for starting innovative efforts at too high a level. This is particularly true for those innovative efforts related to a more intensive use of advanced knowledge. Consequently, knowledge demand stemming from business continues to be weak, especially the part of such demand directed to local supply. Thus supply-side S&T policies lack legitimacy, as is seen in the endless re-negotiation of the amounts of the public investment on R&D. Such investment is difficult to legitimize if society at large does not make an extensive use of endogenous knowledge-based capabilities. If those capabilities are not expanded then development is jeopardized, which perpetuates a vicious circle.

We posit that one way to break such a vicious circle is to widen the approach and the scope of innovation policies, while also conceiving them as social policies. Innovation policies as social policies are those that point at detecting and fostering knowledge demand that is both socially very justified, and is addressed to endogenous providers of knowledge. Inclusive innovations are the expected outputs of such policies. They are required to improve the well-being of the most deprived part of the population. The needs that social policies should fulfill and that research and innovation could try to solve are huge. In Latin America at least, after the disastrous social effect of the economic policies guided by the 'Washington consensus' recommendations, social policies have been widely recognized as a legitimate and important sphere of public intervention. If innovation policies are able to show that they are strategic for the implementation of social policies, they will receive stronger support. If innovation policies as social policies are successful, that will have ample cultural consequences. In particular, it will foster a better match between national problem-solving capabilities and demands for knowledge and innovation in society at large.

If these assertions are likely to be correct, one can envisage breaking the vicious circle and starting a virtuous one. Increasing demand can be a self-sustained process if, when demand increases, it is met by a satisfactory supply, that fosters further demand and also enhances supply. That outline of a strategy for mobilizing knowledge demand towards national capabilities is based on inclusive innovations. Thus the potential role of such innovations needs to be assessed.

That potential stems, first of all, from the fact that some problems faced by deprived people have not gained insights from knowledge because they have not been addressed by modern S&T. In some cases this is due to commercial reasons, but in other cases such problems are 'below the radar' (Clark, *et al.*, 2009) of present mainstream research and innovation. Helping R&D agendas as well as businesses' innovation agendas to pick up some of these problems and to give them full attention may have a positive impact on the achievements of social policies. Some of these problems are of tantalizing complexity, like many in the realm of health, where the non-existence of solutions may be related to insufficient knowledge. In other cases the lack of solutions can be traced back to an unposed question or a problem which was not highlighted. A Uruguayan example of a solution found once the problem it solved received attention is the potable water autonomous unit, a transportable engine able to clean mud and other physical contaminants from water. It is small and light enough to be transported in an ordinary truck. It proved particularly useful for serving communities after different types of climatic disturbance, or to provide drinkable water to small, isolated communities, where the distance to urban centers makes the expansion of water services too expensive. The problem was highlighted when Uruguayan soldiers serving under the UN in Africa were frequently moving from place to place, none of which had drinkable water available. The innovation was developed by engineers from the army and the public enterprise devoted to water supply and sanitation. The device is now used in several countries.

This is simply an anecdote, it illustrates that in some cases posing a problem can lead to research, development and innovation efforts that achieve a successful solution. A systematic effort to highlight social problems and to make them the focus of a specific branch of innovation policies could turn anecdotes like this and many others into trends. If this is achieved, more solutions could be found for the type of problems we are discussing. Of course, having solutions does not mean that they will be used effectively: the issue is that solutions must exist before they can be used effectively.

Another reason to consider that inclusive innovations are vital for the well-being of the most deprived part of the population is the high cost in the international market of existing solutions to some types of problem. In many cases, the problem of affordability is the result of political issues – i.e. intellectual property rights (IPR) protection and World Trade Organization regulations: several vaccines are examples of that. However, in some cases, lack of affordability may be related to genuinely high costs of production. Turning things upside down and developing a radically different way of looking into the problem, which can lead to a radically different method of production, can be a good alternative to a heavy subsidy of the existing solutions.

In the case of the Haemophilus influenzae type b (Hib), responsible for meningitis and different kind of sepsis in small children, full-immunization schemes were in place in most industrialized countries by 1991, following the innovation that delivered a workable vaccine. The Global Alliance for Vaccines and Immunization started support for acquiring Hib vaccines in 17 low-income countries in 2005.

> Middle-income and developing countries have been hesitant to introduce the vaccine because of its relatively high price. (Akumu *et al.*, 2007:1)

> So far (...) immunization against this disease has reached only a fraction of the children living in low-income countries (WHO, 2006: 451)

One road towards inclusive innovation strategy is to try to develop alternative solutions to the existing ones, combining the needed technical characteristics with affordable costs. In the case of the vaccine against Hib this strategy was followed in Cuba, in cooperation with a Canadian university. The alternative consisted of developing a synthetic vaccine, that is, a purely chemical vaccine, whose production costs would be considerably lower than those of the current, biological vaccine. It took more than a decade to achieve success as the R&D part of the process was tantalizing complex (Vérez-Bencomo *et al*., 2004). But, at the end of 2004 one million doses of this new vaccine, whose effectiveness is fully recognized by the WHO, were inoculated into those Cuban infants who were aged less than two months.

In the last paragraphs we referred, first, to innovations oriented towards 'not-yet-existing-solutions', and then to innovations geared towards what can be termed 'inclusive and competitive import substitution'. The latter refers to problem-solving innovative efforts that follow to some extent a different heuristic path than that used to achieve the existing solutions. The term innovation is valid because we are talking about different solutions. The term inclusive is valid because it is attempted to provide solutions to problems which affect deprived people. The term import substitution is valid because these innovations solve problems that could eventually be solved through imports. The term competitive is valid because these innovations provide better solutions than the imported ones, due to their cost, adaptability to local conditions or both factors.

Several examples of this kind of inclusive and competitive import substitution from Uruguay can be given. We shall briefly mention one in the realm of health, which is actually used in several public hospitals in Uruguary. The problem posed in technical terms was that the halogen lamps to treat severe jaundice through photo-therapy used in the intensive care divisions of the maternity wards of public hospitals had a high rate of failure due to the short life of the light bulbs. Replacement bulbs were very expensive, thus several lamps were not operating. This photo-therapy involves directing a very precise beam of blue light onto the baby in order to allow the expulsion of the bilirubin molecule, whose concentration causes the jaundice. The problem posed in social terms is that premature babies have a higher probability of being affected by severe jaundice. Such babies are frequently from the most deprived sector of the population and are treated in public hospitals. At the international level, the existing solution was lamps made from light emitting diodes (LEDs), semiconductor devices that have a very long life. These lamps were expensive, mainly because LEDs are low intensity devices, so many of them are required to reach the necessary level of intensity. The new solution was based on the design of an optical device to be incorporated into the lamp that concentrates the light, obtaining the same intensity with a much smaller number of LEDs. The innovation was due to a young electrical engineer and atomic physicist at the Universidad de la República. The new lamp (commercially named BiliLed) was produced by a national electronic firm. It was invented because a physician was enraged by the problems with the existing lamps, and he commented on the problem to a researcher who was able to relate the problem to experimental work in his academic laboratory (Geido *et al.*, 2007). Again, this is an anecdote, told in an extremely stylized way, without entering into the many difficulties that paved the way to the final device. The point is that anecdotes are useful to foresee possible trends: we posit that the trend that this anecdote suggests is not only necessary but also possible.

Conclusion

General comparisons (enrollment in higher education, percentage of researchers in the working population etc.) show that the knowledge supply is quantitatively weaker in developing countries than in the North. Nevertheless, indicators like the amount of investment in knowledge production and the number of knowledgeable people hired by firms, suggest that weak knowledge market demand is a more structural problem. Such demand is frequently exogenously oriented, widening the mismatch between capabilities already acquired and opportunities to use them. Historical experience and empirical evidence suggest that fostering knowledge demand is both more difficult and more specific than fostering knowledge supply, so it is located at the heart of the development problem.

Innovation policies conceived partly as social policies can help to face that problem. Such policies can design a set of incentives, for academia, for businesses and for social policies, to make the involvement in inclusive innovation attractive to each of the actors. Social policies, conceived partly as innovation policies, can systematically build a set of relevant problems in need of knowledge-based solutions. Thus they can act as an effective demander of science, technology and innovation capabilities from among others, the endogenous providers of knowledge and innovation. The combination of these two types of policies can strengthen knowledge supply and knowledge demand and, even more importantly, can help to connect the former and the latter. In this sense, these types of innovation policies and of social policies can be useful for overcoming the mismatch between local knowledge-based problem-solving capabilities and societal problems which need such capabilities in order to be solved.

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