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North-South Collaboration and Systems of Innovation

Introduction

There is general agreement that scientific advances and technological innovations are a core component of the complex, worldwide transformations that are now occurring. Given the centrality of new technologies in all aspects of human activities, only societies that become, to some extent, 'knowledge societies' have prospects for future success.[1] Against this backdrop, one overarching concern is that the development gap between the North and the South is widening, one reason being that 'knowledge' tends to be even more concentrated than capital.[2] Such divide in technology is perceived now as the most serious constraint to international development and is the most talked about point of concern from civil society to governments and international organisations of all kinds.[3]

[1] The importance of technological innovation for development has been acknowledged by analysts and institutions of all kinds, but it is particularly meaningful that the just released Human Development Report 2001 of the United Nations Development Programme has chosen to concentrate on the topic and was named: *Making New Technologies Work for Human Development.*

[2] While the average income per capita of the 24 richest countries is about 60 times greater than the 50 poorest countries, the average S&T expenditures of the former are 250 times greater (UNESCO, World Science Report 1996).

[3] The technological divide among countries in the North is also a considerable concern for policy-makers, analysts and international organisations. This is made explicit in the OECD's STI Scoreboard 2001, which presents significant differences among the member countries on their transition to a knowledge-based economy.

Consequently, it is also generally accepted that developing countries must develop and strengthen their capabilities to generate and exploit technology to solve production problems, feed their population, care for the health and education of their people, and do so in a sustainable way.[4]

A third point of consensus is that in order to build the much needed research and technological development-oriented capabilities in the South, partnerships with the countries in the North are essential. This is so because the current accelerated pace of technological change increased the need for developing countries to engage in a continuous process of innovation if they are to participate in any meaningful way in the new world order.

Obviously, not all North-South collaborations lead to the desired impacts. Actually, the crux of the problem is exactly to be able to identify the conditions and circumstances under which such collaborations do contribute to sustainable development in the South and to design programmes to achieve this.

The main argument of this paper is that in order to be better understood and designed North-South collaboration in research and technological development (henceforth RTD collaboration) must be analysed in a broader conceptual and methodological framework than what has been done so far. And, that this procedure will allow us to move beyond the current 'check-lists' for good collaboration practices which are the conventional outcome of studies on the topic.[5] Thus, the paper proposes that North-South collaboration be analysed in an 'innovation systems' context, an approach which places both collaboration and policy institutions at the centre of the analysis. Such an approach enables us to overcome linear conceptions that see science as a starting point for innovation (still a major problem in many developing-country policy contexts and in many donors' programme modalities), and that relegate policy implications to the end of the analysis.

The paper begins by presenting evidence of the considerable increase in international RTD partnerships in the last decades and of the motivations driving different countries to collaborate among themselves. Then the attention focuses on the special type of North-South collaboration, which is our main interest here, namely the one fostered by Northern donors. Typologies of the different collaboration modalities as proposed by a number of authors are presented.

[4] Sustainable development in this paper is understood as 'a multidimensional undertaking to achieve a higher quality of life for all people. Economic development, social development and environmental protection are interdependent and mutually reinforcing components of sustainable development.' (United Nations, *Agenda for Development*, 1997)

[5] Just as an example, see the list of requirements to make scientific collaborations successful, as suggested by Gaillard, 1998, p. 61.

Finally, on the basis of a typology based on the underlying assumptions of the technological innovation process, the paper proposes a framework to analyse and design North-South collaboration programmes. A number of issues for further discussion are listed in the last section.

International RTD collaboration: intensity and motives

Collaboration is a pervasive phenomenon both in innovation and the performance of RTD. Innovation rests on the creation of knowledge, yet firms are inevitably bounded in their knowledge capabilities. For this reason they constantly look outside the boundaries of the firm, collaborating with other firms and with RTD institutions. Modern innovation research has shown decisively that innovating firms tend to be firms that collaborate. In the RTD system, research collaboration is as old as modern science itself, and collaborative efforts involving researchers of more than one country have been noted as early as the 19th century (Beaver & Rosen, 1978 and 1979). Although international scientific collaboration has been increasing for a very long time, its recent annual growth rate of 7-8 per cent has no precedent.[6] A number of factors have been pointed out as contributing to the increase in international RTD partnerships.[7] Particularly noteworthy for its novelty is the fact that international collaboration has been fostered and stimulated by governmental initiatives.[8] This is largely due to governments' recognition of the importance of science-based technological innovation for economic competitiveness and to the globalisation of the economy.[9]

[6] International collaboration measured as percentage of articles co-authored by researchers of two or more countries in the total scientific output of those countries (LEPI/CNRS, 1993). This is a well-established measure of international research co-ordination (Frame and Carpenter, 1979; Luukkonen *et al.*, 1993; Katz, 1994). Despite the limitations of this approach (Katz and Martin, 1997), it remains a valid, if partial indicator (Georghiou, 1998).

[7] For an extensive list of the factors promoting collaboration in science see Katz, 1994. Such factors – which can be grouped as economic, cognitive and social – have varying relative importance to explain either field-to-field or country-to-country differences in the rates of collaboration (Luukkonen *et al.*, 1992). For a discussion of how and why international collaboration has, in the last decade, acquired a more trans-continental character, see Georghiou, 1998.

[8] The novelty lies in the fact that until the beginning of the 80's international collaborative projects were nearly always born out of informal, spontaneous initiatives between researchers (Miquel, 1991). Also international collaboration was granted only a marginal position in S&T policies of most countries (LEPI/CNRS, 1993). Today, however, different intergovernmental research programmes have been established (e.g. the ESPRIT, the EUREKA and the Framework of the EU, the Human Frontier Science Programme initiated by Japan and the Advanced Technology Program of the US) with the explicit objective to foster regional and global collaboration in research through project support. A recent estimate is that support for international co-operation now accounts for more than 10 percent of government R&D expenditures in some countries (Science and Engineering Indicators, 2000, p. 2-54).

But greater degree of internationalisation of research is affecting differently the countries of the North and those of the South. The former have increased their collaboration activities in all dimensions. Firstly, in conventional academic research, recent data show that from 1985 to 1995, European countries have doubled their production of scientific articles but have tripled the number of articles co-authored with partners of advanced countries in other continents (Georghiou, 1998).[10] Secondly, the interactions between sectors – universities, industry, government, non-profit organisations – have also been considerably strengthened as revealed by different indicators.[11] Additionally, collaboration is on the rise in the private sector as well – as indicated by the increase in the number of formal co-operative agreements between firms, the growth of overseas R&D activities performed under contract and through subsidiaries, and the increase in the number of R&D laboratories located abroad (OECD, 1998).[12] The STI Indicators of OECD which have just come out show very clearly that collaboration between business and non-business entities is rising, that the share of R&D performed by the higher education and government sectors and funded by the business sector is increasing and, most significantly, that

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[9] Georghiou (2001) provides an account of the European transition to a rationale based upon government support for industrial competitiveness in the form of co-operative research involving public and private sector institutions, from the pilot phase of the ESPRIT programmes to the current Framework, EUREKA and COST. He also develops the argument of the role of globalisation and international competitiveness in this process. The same does Ohmae (1985).

[10] When international co-authorship is looked at more broadly, its increase in the 90's is much sharper: from 1986-88 to 1995-97, the total number of articles in the ISI databases increased by 12 percent; internationally co-authored articles increased by almost 115 percent (Science and Engineering Indicators, 2000, p. 6-48).

[11] Of the total number of articles produced in the academic sector in the US in 1995-97, 23 percent had a co-author in the industrial sector. The figure for articles emanating from industrial research is much larger: 75 percent had an academic researcher as co-author (Science and Engineering Indicators, 2000, Appendix table 6-52). Also, industry patent citations to academic articles have risen from 48 to 54 percent from 1987 to 1998 (Ibidem, p. 6-54). There was also an increase in programmes to foster partnerships between public and private sector, such as the Intelligent Manufacturing Systems Project, which involved 73 companies and 67 universities from 21 countries (Georghiou, 1998).

[12] The motivations for research alliances involving industry have been analysed many times (Katz, 1986; Chesnais, 1988; Mytelka, 1993; Hagedoorn, 1996) but it is worth reminding that as the main argument goes, the costs and the increasing rate of innovation in the science-based industries make it very difficult for firms to do their own basic research. The solution is their association to organise and fund joint R&D activities to reduce costs and minimise risk and, separately develop internal capability to explore the results of such research.

production of scientific research and technological know-how depends on research conducted in other countries (OECD, 2001, p. 9).

International RTD collaboration among the advanced countries, whether it has been the result of 'bottom-up' initiatives of individual researchers or of more formalised institutional arrangements, is driven by very pragmatic motives and aims at direct benefits for all those involved. Among these are access to complementary expertise, knowledge or skills to enhance scientific or technological excellence and sharing costs and risks of uncertain and expensive R&D activities. In such circumstances, international RTD collaboration is clearly linked to innovation objectives.[13]

Research collaboration involving countries from the South[14] has also increased in the last years but not at the same rate as partnerships among advanced countries (Wagner *et al.*, 2001). Moreover, the collaborating partner of the South is almost invariably a country from the North,[15] resulting in asymmetric relations.[16] Consequently, the rationale and motivations underlying North-South partnerships are totally different from North-North partnerships. Among them, geo-political reasons have, historically, played an important

[13] Technological innovation is the clear goal of most government collaborative programmes. Consequently, collaboration in engineering and technology increased more than in any other field from 1986 to 1990 (Miquel, 1991), and also during the 90's (Science and Engineering Indicators, 2000, chap. 6).

[14] While it is relatively unproblematic to treat countries of the North as a quasi-homogenous block, the same is not true for those in the South. Particularly when talking about R&D, a few countries such as the Republic of Korea, Singapore, Taiwan (the Asian 'Tigers') cannot be included in the South since they behave closer to countries in the North. Thus, the general treatment of the South in this paper, does not include those countries. Moreover, given that the author is more familiar with Latin America, she tends to develop her argument with those countries in mind.

[15] A detailed presentation of who collaborates with whom internationally is given in Appendix table 6-61 of the Science and Engineering Indicators (2000). There one can spot selected developing countries in Latin America, Asia and Africa for clear evidence that they do not collaborate among themselves in any significant way. Also, a detailed study of RTD collaboration among countries of the Mercosur, using both bibliometric techniques and on-site survey and interviews with a large number of stakeholders, revealed that Argentina, Brazil, Uruguay, Paraguay and Chile as a rule, collaborate much more with the advanced countries than among themselves (Velho, 1997; Russel, Berthelemot & Velho, 1999).

[16] The term 'asymmetric' here is used in a very broad form and includes differences among partners in various aspects from scientific qualification and access to the various research resources (funding, equipment, facilities, publication channels, etc.) to the social and political contexts conducive to research and innovation. The nature and number of problems derived from inequalities between Northern and Southern partners have been documented and discussed exhaustively in the specialised literature.

role.[17] The geographical distribution of collaborative programmes is largely determined by historical, geopolitical and linguistic conditions. More recently, other criteria have been added such as the level of poverty and underdevelopment. A number of countries, among them the Netherlands and Sweden, have decided to concentrate their support only in a handful of the poorest countries (Gaillard 1999 p. 297).

The desire of Northern researchers and institutions to have access to unique sites, facilities or population groups available only in the South is another well-known motive for the formers' seeking partnerships.[18] With the advent of new biotechnologies, such motivation has increased in importance and brought new actors to the partnerships arena, namely Northern corporations interested in tapping into the biodiversity contained in the South.[19] Addressing transnational or global problems forms another motivation,[20] as do the movements of people.[21] Finally, North-South partnerships have perhaps their strongest motivation in the concern of Northern countries for the unequal development of the South.[22] This is the underlying motive for the so-called research-for-aid, which is our

[17] North-South partnerships tend to follow the pattern of economic and political influence. This can be seen, for example, in the ways the US and the former Soviet Union, up to the 70's, stimulated indigenous development, and established RTD partnerships, in the developing countries within their spheres of influence (Shinn *et al.*, 1997). Also, Japan has very strong research links with its neighbouring countries (Okubo & Miquel, 1992), while the US is the main research partner of Latin America (Narváez-Berthelemot, 1992); The Netherlands pays special attention to Indonesia and the UK and France to their ex-colonies in Africa (Gaillard, 1999).

[18] This is the case of tropical forests; geological, oceanographic and atmospheric special conditions; astronomic observation (Ailes, 1988). A recent survey of US-based researchers found that they are significantly more motivated to collaborate with developing countries in problems related to seismology, geodynamics, botany and biology, 'in order to obtain assistance in doing field work, access information and materials and benefit from local knowledge' (Wagner *et al.*, 2001, p. 76).

[19] This is the case of the many pharmaceutical firms, both large TNCs (Merck, Novartis) and small highly specialised ones (Diversa), which have signed agreements for bioprospecting in a number of developing countries, such as Costa Rica, Mexico, Indonesia, Madagascar and many others.

[20] Marine resource conservation, climate change, infectious diseases are the most commonly cited examples.

[21] Researchers from developing nations tend to work with those from major science-producing nations in part based on student-mentor ties (Science and Engineering Indicators, 2000, Figure 6-36). In addition, a significant percentage of researchers from the developing countries decide to reside permanently in the advanced countries and become important partners with colleagues in their home countries (Wagner *et al.*, 2001). Considerable knowledge flows result from migration and some countries like the US, make a good use of it and open its door to foreign researchers (OECD, 2001, p. 10).

[22] The EC, for example, lists four main objectives of their development co-ordination policy: help the South to implement sustainable development; enable the South to integrate gradually into the world economy; contribute to the reduction of poverty and consolidating democracy (Pinheiro, 1997, p. 15).

main focus of interest here.

These partnerships, irrespective of their motives, are frequently supported by a formal framework and budget, provided from the North, if only because researchers and institutions in developing economies are unable to respond without such resources. But, differently from North-only partnerships where industry is one central actor in research funding, generation and exploitation,[23] in North-South partnerships industry plays a much less significant role.[24] This is so for a number of reasons, the best-known being the fact that historically neither national private enterprises, nor TNCs subsidiaries in developing countries invest in research locally.[25] This trend has become even more evident in the globalised world with the privatisation of state-owned enterprises, which had active R&D facilities, the denationalisation of the few innovative national companies and the merging of TNCs and the relocalisation of their R&D facilities. Consequently, R&D in the South tends to emphasise *research* and to be located in public universities and government institutes.[26] More recently, research has also being carried out in a few research-minded NGOs. The growing importance of NGOs is, in part, a response of some donors to recurrent criticism of the irrelevance of much North-South RTD collaborations to the needs of the South, for which the 'ivory-towerism' of university researchers has been (unfairly) blamed. Because NGOs are closer to action and to research-users, they are more likely to involve local civil society segments in agenda setting, monitoring and evaluation.[27] Such public participation has also gained relevance with international conventions and the recognition of the strategic value of local knowledge.[28]

[23] The business sector is the main source of R&D financing in OECD countries. In 1999 it provided more than 60% of domestic R&D funding (OECD, 2001, p. 8)

[24] The Science and Engineering Indicators 2000 (p. 2-56) mentions that between 1990 and 1998 more than 5,100 strategic technology alliances were formed, of which 2,700 were intra-regional. The only countries of the South participating in such alliances were: South Korea (119 firms), China (86 firms) and Taiwan (48 firms).

[25] This lack of investment in R&D by firms in developing countries is well documented and was first pointed out by the structural-economists of the CEPAL School of thought. For a comprehensive review, see Sagasti (1980).

[26] Of the 400 collaborative projects between US-based and developing country researchers analysed by a recent survey, 60 percent were based in universities and 35 percent in government research institute in the developing countries (Wagner *et al.*, 2001, p. 47).

[27] A number of examples of North-South collaboration programmes, which created mechanisms to involve local community participation, may be found in Bautista, Velho & Kaplan (2001).

[28] Benefit-sharing agreements between Northern and Southern partners gained prominence with the Convention of Biological Diversity and are becoming common practice in RTD partnerships, despite still existing considerable controversy about the terms to achieve this.

Despite being more limited in terms of its nature and of social actors involved, North-South RTD partnerships are an undertaking of considerable global dimensions. For one thing, nowadays North-South collaboration involves, in varying degrees, practically all existing countries.[29] Funding for North-South research collaboration is channelled either through public R&D spending or through resources set aside to provide research-for-aid. Estimates of these two forms of funding are difficult to make, but is believed to have been over 1.5 billion USD in 1997, from EU countries, USA, Japan and Canada.[30] Also, the number of institutions in the Northern countries that get involved with partnership in the South is quite impressive. In Switzerland, for example, over 60 institutions either participate in research partnerships, promote research, are involved in development co-operation, are government bodies with a development mandate or are foundations that support research partnerships with developing and transition countries (KFPE, 2000, p. 12). Finally, the number of programmes in the North to support research activities in the South is enormous and they have been grouped together in different ways, on the basis of varying criteria as presented in what follows.

North-South RTD collaboration: modalities

The most common path is to consider co-operation as pertaining to two distinct approaches. The first, which is both older and more widely used, refers to formal and informal co-operation, usually on scientific projects, between researchers working in different countries. The second uses the term 'scientific co-operation' as synonymous with aid – it refers to resources granted and programmes implemented to contribute to the development or strengthening of scientific and technological capabilities in different countries (Oldham, 1995; Wagner *et al.*, 2001). These two approaches involve different objectives and are managed differently. Moreover, some argue that: 'the two lines have had little intersection, and indeed, the activities of these two communities have little in common. Merit-based science is by definition aimed at creating excellent science no matter where in the world it is being conducted; research aid for development focuses primarily on building capacity and only secondarily is

[29] In 1995-97, for example, United States researchers collaborated with colleagues in more than 170 nations (Science Indicators 2000, p. 6-50).

[30] Expressed in terms of GNP, Official Development Assistance (ODA) fell everywhere from 1989 to 1996, but still represents from 1.03% (Denmark) to 0.12% (US) – something from USD 7-8 billion (Japan, USA, Germany and France) to 2-3 billion (UK, Denmark, the Netherlands), according to Gaillard (1999, p. 298-301). However, only a fraction of ODA (from 5 to 10%) is spent on research co-ordination (see also Wagner *et al.*, 2001, p. 21-2).

consideration given to whether excellent science is being funded' (Wagner *et al.*, 2001, p. 2).

Actually, such clear-cut differences not always manifest themselves in practice. There are a number of examples of projects undertaken under the merit-based category which create exactly the same problems of asymmetry of all kinds as the research-for-aid ones and which contribute only to the excellence of the Northern partner (Velho, 1996; Vessuri, 1996).

Another typology, suggested by Gaillard (1998), is devised on the basis of the different rationale underlying the co-ordination. They are:

i. Counteracting brain drain in the South: support to individuals, institutions and projects. Examples are IFS, CIRAD, ORSTROM and AUPELF-UREF, TWAS.
ii. Benefits are to accrue to both countries: partnerships. Generally, resources are spread between the two sides. Examples: CEC/STD (INCODEV); DANIDA/ENRECA(Denmark); IDRC, National Academy of Sciences, US (BOSTID/NAS); USAID, SAREC. With the exception of BOSTID/NAS, all of them have spent at least 50% (but more often 60%) of programme's budget in institutions and activities in the North (Gaillard, 1998, p. 56-7). Also the Scientific Co-operation Netherlands-Indonesia Programme is an example of partnerships.
iii. Putting in contact a number of institutions and researchers, which could not otherwise know of each other's work (collaborate where they are and as they are): networks (for information and material exchange, for co-ordination and consultation, for producing knowledge or carrying out collaborative research). E.g. AFREPREN (African Energy Policy Research Network).
iv. Compensating for weak national research systems, for the fact that very few developing countries can organise, finance, manage and maintain a critical mass of researcher: centres of excellence, often at the regional level. E.g. CGIAR system of research institutes.

Waardenburg (1997) created a typology based on the degree of Southern ownership of the research process, as follows:

i. The finance comes fully from the North, but agenda setting and implementation is fully left to the South – northern researchers have no part unless specifically invited by the South.
ii. A majority vote for the South in agenda setting, in expenditures of the budget provided by the North, with management and programme committees, to counteract the asymmetry.

iii. Symmetric collaboration with equal vote in agenda setting, in financing within the budget provided largely from the North, and in management.
iv. Collaboration without operational guarantees for real symmetry or against domination of the Northern partner – expenditures managed mainly by the North.
v. Participation of researchers or institutes from the South in research initiated, designed, managed and in majority implemented by the Northern partners.

There is evidence here that strengthening and building research capacity has become a central and largely accepted concept in the research aid community, and a number of models to implement it have been tried over the past three decades. When it comes to the evaluation of the impact of this collaboration effort on the countries of the South, it is often pointed out that far too many research projects are still managed from outside the developing countries and are highly dependent on donors' good will. This notwithstanding, there seems to be consensus among analysts in relation to two points. Firstly, despite the much talked about problems of asymmetry in project ownership and benefit-sharing, North-South collaborations are firmly believed to have contributed significantly to research capacity building and strengthening in the South. Such capacity manifests itself in various dimensions such as: better integration of the southern partners to the international scientific community; improvement of scientific and managerial skills; increased scientific output, etc. All these forms of capacity, however, are more related to individual capacity building and it is also clear that there is considerable room for improvement as far as institutional capacity building is concerned.[31] Having said this, there is no denying that, in terms of research capacity, countries in the South are better off today, as measured by a number of indicators, than 30 years ago when the collaboration programmes began.[32]

[31] The position expressed by RAWOO, for example, is that that North-South research co-ordination funded through research co-ordination budgets should aim at strengthening the (institutional) role of the Southern partner. The dialogue on research co-ordination and capacity enhancement has to move from the individual researcher's level and their organisation, towards including the broader cultural and institutional context of which the researcher and their organisation are part. Donor policies aimed at strengthening the research capacity in the South require both a country specific approach and a comprehensive vision (Maan, 2001).

[32] A number of studies performed from quite critical approaches have pointed out that despite a number of problems, research capacity has been built. See, among others, Gaillard 1998 and 1999; Bautista, Velho & Kaplan, 2001.

The second point of agreement among analysts is that all previous and existing North-South collaboration effort has had only a very *limited impact on sustainable development,* which is the ultimate expected result of development co-ordination. This is a growing concern among policy makers as well as donors because the assumption still prevails that RTD partnerships are needed if developing countries are to have a place in the new world order. As a result, a number of conferences, meetings, evaluation exercises and studies have been organised and produced recently in order to help to understand the reasons why the enhanced research capacity has not yielded the expected results in boosting development.[33] Various important results have been produced by these evaluation activities of which perhaps the most relevant is the recognition of very weak links of the collaboration initiatives with local businesses and stakeholders beyond the research communities. Actually, the argument about the need to involve stakeholders from the beginning and throughout the whole process of research has considerable support from a number of case studies.[34]

Despite the above and other important results highlighted by such studies, they all share a common flaw. This is the fact that they are very localised, descriptive and lack a well-defined analytical and methodological framework, which would allow some kind of generalisation. The tendency is to evaluate the partnerships in the light of the programmes' own internal objectives and point out reasons for success or failure on a case-by-case basis. Thus, they consist of narrative accounts and *ad hoc* observations and are mainly based on secondary analysis, personal reflection and/or anecdotal evidence. Consequently, what the studies offer in terms of future policy options is very limited.[35]

[33] The list of such conferences and studies is very long indeed. Examples of only the very recent ones are: Bautista, Velho & Kaplan, 2001; KFPE, 2001; KNAW's organised International Conference on North-South Research in 1999; RAWOO's sponsored Expert meeting on North-South Partnership in Trivandrum, 1999.

[34] A study conducted at DGIS revealed that only about half of the research results intended for utilisation by DGIS were actually being used. And that 'the decisive factor favouring application turned out to be whether the research had been conceived within DGIS itself (Waardenburg, 2001, p. 9). Thus, the utilisation of research 'involves fostering direct ties between researchers and policy planners, who will meet in small problem-centred discussions, workshops, conferences and symposiums, always on the basis of a thorough preparation of the subject-matter and literature within the ministry beforehand' (p. 11). Another study emphasised the need for a pro-active role of the user, and the necessary competencies to go with it (Rip, 2001, p. 17). Others have argued that the best knowledge transfer is achieved when one is also willing to involve people from industry or potential interest groups in society in brainstorming about potential utilisation. To speed up innovation paths potential users must be involved as early as possible (Den Beemt, 2001, p. 23).

[35] This opinion is shared by a number of analysts: Bautista, Velho & Kaplan, 2001; Spaapen, 1999 and Gaillard, 1999.

So how can we both study and evaluate North-South RTD collaboration, especially in terms of its linkages and impacts? And how can we propose a design and policy framework for North-South collaboration, which could have a favourable impact on development in the South?

This paper intends to contribute to fill this gap by proposing an approach to North-South partnership analysis from an innovation systems standpoint. This is the idea developed in the next section.

Systems of Innovation: is it a useful approach for North-South collaboration analysis and policy-making?

A system of innovation consists of a network of economic agents together with the institutions and policies that influence their innovative behaviour and performance (Freeman, 1987; Lundvall, 1992; Nelson, 1993).[36] The literature dealing with the development and refinement of this conceptual framework is very large indeed, but a number of broad principles are particularly useful in the context of partnership arrangements. One of such principles is that innovation increasingly takes place at the interface of formal research and economic activity and in national institutional contexts, thus denying the linear, step-by-step model of innovation, which prevails in most North-South partnership arrangements.

What is the difference between a linear model of innovation and the system of innovation that we suggest here? Why do we believe that the latter is more appropriate than the former not only to analyse but also to conceive of North-South co-operation framework that will be more consequential for sustainable development?

In order to understand that, it may be useful to briefly reconstruct the historical evolution of our mainstream idea about knowledge production and of how such knowledge relates to innovation (technical and, ultimately, social). The main argument here is that the model adopted by specific research co-operation programmes rests upon particular concepts of science, and consequently, upon particular ways to understand knowledge production and the means whereby such knowledge feeds into technological innovation and consequently, contributes to development. This relation is summarised in the tables that follow.

[36] Institutions are understood here as the combined environment of physical organisations and the practised routines, norms, shared expectations, morals, etc (Edquist & Johnson, 1997).

Period/paradigm	*Conception of Science*	*Who produces scientific knowledge*	*Model of technological change*	*Policy Framework and Policy Tools*	*Tools for policy analysis and research evaluation*	*Model of North-South co-operation*[1]
Post war period until beginning of 60's 'Science as an Engine for Progress'	Historically and socially neutral, follows its own internal logic.	The Scientists ('Republic of Science')	Linear relationship: basic research, applied research, technological development, innovation, diffusion, economic progress and social welfare ('science push').	Focus on Science Policy: large scale science funding; allocation of resources through institutional normative mechanisms, scientific merit.	Peer review (sooner or later the 'good' science finds out its practical application. Input indicators.	Problem-solving phase: find quick solutions to development problems through the use of human and financial resources of the Northern countries.
60's and 70's 'Science as Solution for Problems' (and also as 'cause of problems')	Disputes about the neutrality of science.	The scientists (but they must be directed and put in contact with the 'demand').	Linear relationship (The same as above, but 'demand pull') Science Policy and Technology Policy	Emphasis in resource allocation in terms of priorities (often by sector of activity). Science had to find a way to be used by technological development.	Peer review plus output indicators (basically bibliometric) studies: role of S&T in economic growth; history of technology innovation at firm level (learning in TT). Developing	indigenous capacities of individuals (problem-solving and research capacities) in the recipient countries.
80's and 90's 'Science as a Source of Strategic Opportunity'	Science wars (dispute between realism and relativism/ constructivism)	Scientists directly influenced by a complex network of actors and its interests.	Complex – includes several actors, a diversity of institutions and processes. (Technological trajectory subjected to 'lock-in' – somewhat deterministic).	Emphasis on resources administration and – allocation to strategic programs, interdisciplinary and collaborative research (national, institutional and disciplinary level) 'alliances'.	Technology policy. Intensification of the peer review process, program assessment (concern with the 'impacts'), prospective and foresight.	Generate new collaborative partnerships that benefit both sides. From supply-driven to demand-oriented (involvement of stakeholders by using participatory methods).

Period / paradigm	*Conception of Science*	*Who produces scientific knowledge*	*Model of technological change*	*Policy Framework and Policy Tools*	*Tools for policy analysis and research evaluation*	*Model of North-South co-operation*[1]
XXI Century 'Science for the Benefit of Society' (back to the Baconian ideal)	Socially and culturally constructed, national styles.	Actor network composed by scientists and non-scientists-configuration varies according to each 'event'[2]	Complex multifaceted (technological trajectories reversible according to social choice).	Emphasis in co-ordination and management. Accountability, maintenance of an independent scientific basis. Innovation policy.[3]	Peer review + direct public participation (emphasis given to the process), scenario building with ample social participation - Foresight.	Learning in a SI framework. Co-ordination of donors; Competitive funds for RTD.

[1] This periodisation is based on Gaillard (1998).

[2] 'Perhaps the strongest sign of contextualisation occurring [in the new mode of knowledge production] is the place accorded to people in the production of knowledge: through conceptualising how people enter as users, as target groups in markets or addressees of policies, even as 'causes' for further problems to be tackled or as 'real' people in innumerable interactions and communicative processes, which range from new modes of investment and financing of research to legal regulations and constraints that shape the research process, to markets and media, households and Internet users, other scientists and millions of sophisticated and highly educated lay people as well as those who – positioned on the margins of the global economy – also "speak back" and demand entry'. (Nowotny, 2000, p. 191).

[3] 'Technology policy is taken to mean support for creation of strategic or generic technologies, while innovation policy goes beyond a purely technological remit to include facilitation of the diffusion of technology, encouragement of knowledge transfer and promotion of small firms. Provision of an infrastructure for innovation is the central feature of the new policies, usually in the context of providing incentives or institutions which support better networking with the economy. Linkages with science performed in universities and public sector research institutes provide a second focus for such policies. However the policies also seek to build linkages beyond the R&D sector to encompass potential sources of finance, regulators and other stakeholders who are likely to influence the broader environment for innovation. Foresight programmes are one manifestation of attempts to build a common vision of the future as a means to co-ordinate innovative activities across organisations while avoiding any centralised direction'. (Georghiou, 2000, p. 899).

The idea conveyed by the tables is that since the creation of the government institutional apparatus for science and technology policy after the Second World War, different 'paradigms' have dominated the practice and were adopted both in advanced and developing countries.[40] From this time up to the beginning of the 60's, science operated under what might be described as the 'Vannevar Bush social contract'. Under this, governments provided funds for scientific research in the general expectation that, sooner or later, it would revert in technological development. This view, based on the linear model of innovation, which was dominant in the period, reflected on the ways research was evaluated (by reference to internal quality criteria as defined by researchers only), on the policy tools designed (mostly to foster the 'best' scientific research) and also on the model of North-South co-ordination most widely adopted. Thus, this is the problem-solving phase of the North-South collaboration when it was believed that developing countries did not nor need to develop their own research capacities. As the logic goes, if science is historically and socially neutral, research results produced in the advanced countries can be just transferred to the developing ones and directly applied to the solution of local technical problems.

Soon, however, the neutrality of science began to be questioned, government resources could not cope with the demand from 'good' quality science, implying that choices had to be made. The solution was to identify priority areas for research, which seemed to be linked to demands from society. This notwithstanding, the prevailing view of technological innovation was still a linear one, but innovation was seen now as pulled by the market, instead of pushed by science. Since demand was important to give direction to science, it was natural to expect that the 'product-mix' of science in each country would be different, responding to local demands. Actually, bibliometric studies, which mushroomed in the 60's and 70's, gave considerable support to this idea and showed for example, that the former Soviet Union, the US and the European countries gave different emphasis to the various research fields. The focus of North-South co-ordination in this phase is coherent with the general paradigm and its concepts: invest on the development of research capacities in the South in the fields that are most needed to solve local problems.

In the beginning of the 80's, evidence began to accumulate that the linearity of innovation was illusory. Studies in technology history, for example, provided clear evidence of the complex interaction between various social actors in the

[40] Ruivo (1994) analyses the work of several authors on the evolution and periodisation of science policy in different countries and points out the high degree of congruence on the core of vies and instruments used. She is the one to suggest the existence of 'paradigms' of science policy.

configuration of a new technology. Thus, it was clear that it would be advisable, from a policy perspective, to foster the links between the various knowledge-producers and users (academy/industry/government) – stimulating the most varied types of alliances. Studies went so far as to suggest that society impinges not only on technological development and on the direction of scientific research but also on the contents of science itself. Despite considerable debate about the latter, the contours of a new paradigm of science and technology policy, which paid attention to the preferences, and participation of other social actors beyond the research community began to be delineated. This also reflected in the models of North-South co-ordination: participative methods were introduced in the hope to identify the needs of local research 'users'.

The development of a new paradigm of knowledge production and innovation for the twenty-first century is still underway. There is indication that societies in the advanced countries are claiming a more active role in science and technology decision-making and, consequently, are more aware of who benefits from innovation. The whole process of innovation, in its turn, has begun to be more clearly understood. It seems to be the case that the countries, which have been able to develop a coherent national system of innovation, have fared better in economic and social terms.

Such a system is seen as made up of actors – firms, government laboratories, universities, professional associations, grassroots organisations, etc. However, the most important element in the system is not so much the individual actors as the links between them. A national system of innovation made up of actors which are not particularly strong, but where the links between them are well developed, may operate more effectively (in terms of learning and in generating innovations) than another system in which the actors are stronger but the links between them are weak.

To summarise, when the research systems of the ex-colonies and other developing countries began to be built after the Second World War the prevailing concept of science was one of an isolated and neutral and universal knowledge. Then, it seems logical that the only way to proceed was to reproduce in the developing countries the type of science and scientific institutions that existed in the North.[41] If science proceeded linearly to innovation why bother with innovation? Just produce good science and it will find its way...

[41] At least the part that was visible: let's remember that scientists in organisations and in mission-oriented institutes were dominant in the US, but those were considered by the conventional scientists and science analysts as 'peripheral to science', as removed from the centre of the profession (in Mertonian terms).

Today, however, we have a much clearer idea of the complexities involved in knowledge production – and in technological innovation. We know that innovation increasingly takes place at the interface of formal research and economic activity, thus denying the primacy of either knowledge creation and validation institutions (R&D bodies, universities, etc) or knowledge application institutes (usually enterprises). Rather, it is partnerships between these types of actors that are important.

Having said this, the point I want to make is that the great majority of the existing North-South collaboration programmes still adopt a linear model of innovation framework.[42] It is the adoption of such a linear model that explains, in part, the privileged support to research capacity building in those programmes. As this conception goes, the market will draw on the technological resources it needs as and when necessary, the same way as technology will draw on research results. The linear model suggests that the dynamics go from a source (new knowledge, new options) through its elaboration to eventual adoption, diffusion and effects.

However, if as we argued above, innovation is not a product of a linear chain of events, it seems legitimate to expect that North-South co-ordination which aims simply to develop research capacity in the Southern country will probably have a very limited impact on development. Not surprisingly, this is exactly what the studies on North-South collaboration have found.

The systems of innovation framework provides a number of advantages to analyse North-South collaboration programmes. First of all, because the SI framework places institutions at the centre of the analysis, it forces us to look closely at the institutional dynamics in the local context. This may have an impact even in our way to understand the role of participatory methods in development strategies. A recent, detailed review of the cases in which participatory methods have been influential in shaping technology development suggests that this influence depended on quite specific historical and institutional conditions. One feature of these histories has been the mobilisation of support and resources around key development issues, methodological and technological options. Thus, the reasons for participatory method's success here and not there, of achieving one goal and not another, have to be sought in the social and political contexts of the methods' application (Biggs & Smith, 1998).

[42] The comparative study of donors-initiated North-South collaboration co-ordinated by Bautista, Velho and Kaplan (2001) shows that the majority of programmes in the same countries analysed could be classified under Mode 1 of Gibbons *et al.*, (2000), which assumes a linear model of innovation framework.

Secondly, in the SI framework the concept of knowledge is defined broadly. It includes not only knowledge produced by science, high-technology and formal academic training, but also skills and competencies obtained through practical experience in traditional sectors such as textiles, agriculture, fisheries and the natural environment, as well as those found in the informal sector of the economy. This is particularly important in the case of North-South partnerships because it makes us pay attention to indigenous technical knowledge of Southern participants and to value it accordingly.

Moreover, the concept of innovation in the SI approach is also very broad. 'Innovations are new creations of economic significance. They may be brand new but are more often new combinations of existing elements, and can be of various kinds, e.g., technological as well as organisational' (UNCTAD, 1996, p. 386). This is very important because among the more common beliefs still encountered in discussions of innovation systems is the notion that innovation is something that only takes place in developed countries or in large corporations and is closely associate with an 'invention' in the traditional sense. This narrow definition, however, is less useful for policy-analysis and policy making in developing countries, which have weak scientific and technological capabilities and a small economy. In the SI approach, however, innovation is defined more broadly as '... the process by which firms master and implement the design and production of goods and services that are *new to them*, irrespective of whether or not they are new to their competitors – domestic or foreign.' (Ernst, Ganiatsos & Mytelka, 1998, pp. 12-13, emphasis added). To emphasise innovation in this sense, is not to deny the role that research and development (R&D) can play in generating new knowledge. Its purpose is rather to permit the extension of the concept of innovation to cover continuous improvement in product design and quality, changes in organisation and management routines, creativity in marketing and modifications to production processes that bring costs down, increase efficiency and ensure environmental sustainability.

Finally, the concept of SI is not only an analytical concept under which to study North-South collaboration, but also an important tool for the policy-making process. It can be used by different countries, which have a knowledge-based development strategy as an institutionalised concept and an explicit policy tool. It may be used to mobilise a multitude of national actors behind a forward looking and coherent strategy. Such a common perspective is useful when it comes to make other development policies more conducive to innovation.

My main argument here is that designing successful North-South partnerships (successful here is defined as a collaboration which contributes to

development) needs a much more holistic understanding of the process of technology development and of the institutional arrangements necessary to achieve it than has been the case up to now. And, that an appropriate means to such holistic understanding seems to be the SI approach.

The application of the SI framework in the analysis of North-South collaboration will require the mapping and evaluation of the channels for knowledge flows, identifying bottlenecks and suggesting appropriate remedial action. In this sense SI presents a set of analytical principles for understanding the innovation process in a national context, namely:

'(a) assessing the extent of institutional interactions, (b) assessing impediments to flows of knowledge between nodes, (c) assessing the opportunities for and constraints to interactive learning and institutional innovation; (d) assessing policy and practices that can give rise to failures of the components parts working as a system' (Hall *et al.*, 2001).

It is believed that these analytical principles of si have a lot to offer in the study of North-South partnerships. Not only can they provide a useful approach to analyse each partnership case, but also to generalise for the context of specific countries and modalities of support. The reason is that the approach requires the analysis of the social actors in relation to their national institutional context. Finally, and more importantly, SI approach is useful to inform policy-making. North-South partnerships programmes devised under a SI approach will be much more likely to encompass a broad definition of technology policy in which interactions with other policy areas are taken into account (Bartzokas, 2001; Georghiou, 2001).

Main issues for further discussion

After reviewing the literature on North-South partnerships, it seems that a number of issues should be getting more attention and deserves further discussion. The list below does not aim to be exhaustive, but just to highlight those, which have particularly caught my attention and concern.

1. Lack of a general framework for analysis and policy-making in North-South collaboration. This is my main concern, the one to which I have dedicated most of my effort in this paper and to which I have proposed the adoption of the Systems of Innovation approach.
2. Multiplicity of donors: co-ordination and creation of research and innovation funds.

The lack of co-ordination among donors, and the piecemeal approach whereby different donors targeted different aspects of science and technology in the

developing world have often been blamed for a disconnected system, in which available skills are also fragmented and out of balance (this is in marked contrast to the integrated and balanced innovation systems which have evolved in the North.).

Besides fragmentation, different donors have different exigencies and all have to be accountable, in different ways, to audits and accountability requirements. This poses considerable difficulties on the Southern partners and limits considerably the actions of donors to a few forms of support, which are in accordance with internal rules.

Despite attempts to co-ordinate donor's activities on a number of occasions, this has not worked properly and institutionalised efforts have been less common.

> Suggestion: establish competitive research and innovation funds, with independent Steering Committees or Boards, at the regional or even country level.[43]

3. Problem: perception and expectation of stakeholders in the North as to how taxpayers' money is spent to support research and innovation in the South. When commenting on the MMRP types of programmes, Gaillard (1999, p. 278) asks: 'How many researchers from the North would be willing to merely play a supportive role? What is the acceptance by taxpayers and by government bodies?'

Different Dutch donors have different perceptions as to the most effective means by which North-South research can take shape.

> Suggestion: organise stakeholders workshops in the North, that is, so-called consensus conferences, to make Northern communities aware of the problems of developing countries, of the needs to develop research capacity in the South, of how the North can contribute to these in a mutually beneficial way, of what has been done and of the results achieved and the constraints to overcome.
>
> Scenario building workshops: there are many possible futures for North-South partnerships; precisely which one we will arrive depends on the choices we make now. This involves a more 'active' attitude towards the future: it is possible to 'shape' or to 'create' a future of our choice from the infinite range of possibilities available, obviously, taking into account certain limits.

[43] The urgency for donors co-ordination and the concept of an endowment fund has already been put forward in different occasions: it is the main conclusion of Bautista, Velho & Kaplan, 2001, and has also been proposed by Bezanson and Oldham, 2000; KFPE 2001 and Castillo (1994, p. 124).

Other forms of participation by the communities of the North to decide how local government spends aid budget may help to clarify the situation. It is well known that in many countries development aid has been severely criticised and proposals have repeatedly being made to close, reform or replace existing institutions from the 70's onwards. As Gaillard points out: 'With the possible exception of Sweden, the public is generally poorly informed on the challenges, objectives and size of budgets allocated for research and development aid'. He cites a survey in the US which revealed that a large majority of Americans believe their country spends 20% of the federal budget on international development aid, whereas in fact it represents only 0.5% of the budget in question (Gaillard, 1999, p. 275). A great effort has to be made to convince politicians and the general public in the donors countries that not only 'promoting lasting economic and social progress and reducing poverty in the developing countries ... is entirely compatible with [their] political, industrial and commercial interests' (British government, quoted by Gaillard, 1999, p. 275), but also that a genuine concern for the life conditions of their fellow human beings in the South is a good justification in itself for budget spending.

4. What to do in countries that lack research capability? Can we start an innovation policy in such countries?

In many developing countries (particularly those targeted by development co-operation agencies), S&T sectors are too small to satisfy the needs of an increasingly knowledge-based economy and the little that exists, given the direction and quality of its activities, are unable to meet society's new and increasing demands. In most developing countries the weak capability to utilise the output of the S&T sector poses a significant challenge. How to make science and technology an integrated part of development strategy thus becomes the key issue. This calls for a new perspective, whereby the focus shifts to the new role of knowledge and innovation in the development process.

In such cases should it be assumed that such developing countries must first develop research capability and then start to think about linking it to development objectives (or productive activities?).

> Suggestion: even in countries that lack critical mass in research, such critical mass should be created already in accordance with our new understanding of what knowledge production is and how such production leads to technological change. That is, an innovation policy seems to be even more important in such countries, aiming not only to generate new knowledge, but also to create the capacities to exploit, utilise and diffuse knowledge generated elsewhere.

5. Financial (budgetary) support can help research institutions in the South to maintain their activities and to formulate their own research agendas. The latter mode of co-operation, however, is relatively rare, 'as donor organisations see little added value for their own countries' (KFPE, 2001, p. 20). Some countries have succeeded in establishing local and sectoral systems of innovation, which lack sufficient financial resources. Why the reluctance of donors to support existing institutions in the South? (The case of Nitlapan in Nicaragua).
6. Government programmes from the North try to avoid negotiation and involving governments in the South (why the asymmetry?); the clout of the institutional apparatus of the North versus no institution or a few NGOs in the South.

International co-operation must help strengthening institutions in the South – stimulate that local people have an interest in their institutions (and not assume that local institutions are corrupt and just do not work and try to start from scratch and experiment with new institution-building).

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