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Science, technology and innovation capability gaps, policy environment, and evolving policy tools for sustainable development

Note by the UNCTAD secretariat

Executive summary

Building on the work of the previous Multi-year Expert Meeting on Enterprise Development Polices and Capacity-building in Science, Technology and Innovation (STI), this note addresses the role of STI capabilities, policy environment and the current trends in policy tools to strengthen the technological and innovation capacity of developing countries. The note discusses the importance of an enabling environment for innovation in developing countries, presents the main capability gaps identified in these countries, and describes some features of the policy environment in which developing countries need to address their STI challenges. It also examines a number of developments in the area of STI policy tools. The note concludes by presenting some suggestions about issues that can be addressed by participating experts.

Contents

Introduction

1. Technological progress and innovation are at the heart of economic development. Through effects on productivity and economic growth they have played a crucial role in the convergence of income levels of a number of developing countries with that of industrial economies. Conversely, it can be argued that weak technological catch-up accounts to a considerable extent for the absence of such convergence in the case of many developing countries, particularly for those developing countries where innovation has become a key challenge for advancing their structural transformation.

2. The impact on development of technological progress and innovation extends well beyond their direct effects on productivity and growth. Science, technology and innovation are essential to achieve the goals that the international community has set for itself in terms of sustainable and inclusive development (see for instance, United Nations, 2012 and 2013). This view has been clearly expressed in the Doha Mandate, where the member States of UNCTAD agreed that the development of a strong STI capacity is key to addressing many of the persistent and emerging trade and development challenges that developing countries face (UNCTAD, 2012).

3. However, strong innovation performance remains a feature of only a handful of countries – those in which innovation has become an embedded feature of the economic system. Spreading innovation capabilities and making those capabilities more relevant to the needs of the poor remains a fundamental development policy challenge.

4. Access to technology and innovation remains most limited in the case of the least developed countries (LDCs). However, middle income countries also need to improve their capabilities to insert themselves into higher value added activities of global production networks, improve export sophistication and increase the knowledge content of their products. For these countries, technological innovation could provide a way out of the middle-income trap.

5. Technology and innovation-driven development strategies should be compatible with poverty reduction. This requires a proactive, holistic STI policy agenda that in many cases demands capacity-building on the policymaking side. In this context, there is a clear need to identify and share good practices in STI policies for development.

6. This second session of the multi-year expert meeting builds on the work accomplished in the previous (pre-Doha) cycle of the multi-year expert meetings on entrepreneurship and STI capacity issues. In that context, experts discussed a number of policy priorities in the area of STI, such as the need for evidence-based policies to strengthen national innovation systems, the importance of pro-poor innovation, the role of higher-education institutions and the policy instruments to finance innovation. Taking that work into account, this note gives prominence to a number of other important considerations that have tended to receive less attention, or in which new trends appear to be evolving.

7. This issues note is structured as follows: section II presents a quick overview of the main gaps that affect the capabilities identified as important in the innovation process; section III discusses aspects of the innovation policy environment that may be gaining in importance; section IV briefly introduces some changing features of innovation policy instruments; section V addresses the question of international linkages for national innovation systems; section VI concludes by suggesting some possible issues for discussion by the experts.

II. Enabling environments for innovation

A. Promoting an enabling environment for innovation

8. The national system of innovation (NSI) is the analytical approach used by UNCTAD in its policy analysis and technical cooperation work in the area of STI, including in the context of earlier expert meetings. The analysis of the factors that influence the performance of the system is therefore not addressed here in any detail. However, as a base for a discussion of the changing conditions in which STI policy for development must be designed and implemented, it is useful to provide an indication of the dimensions of NSI that are relevant to policy action. Such action usually targets gaps in terms of the capabilities of the different elements of the NSI, the links between those elements, as well as the provision of conditions and incentives for these elements to grow and interact.

9. A practical way to capture information about the gaps and strengths that characterize an NSI can be to categorize it according to different kinds of capabilities. In the discussion that follows, these are classified broadly in two types: (a) innovative capabilities, which includes factors related to the ability of a country to produce and commercialize a flow of new technology over the long term; (b) absorptive capacities, which includes factors necessary for imitation-based technological development.[1]

10. Innovative capabilities can be linked to three factors: (a) innovative inputs – the efforts and investment made by a country in research and development or innovating activities; (b) scientific outputs – the research and innovation activities undertaken by the public sector, for example, publications; (c) technological outputs – the output of innovative and technological activities by private firms. These three elements are crucial to the ability of a country to innovate beyond the frontier.

11. The second dimension, absorptive capacities, refers to the set of factors that are necessary for imitation-based technological development. The critical factors identified in this category include the following: (a) openness of the national system, either in the form of international trade, foreign direct investment (FDI), licensing or exchanges of human capital; (b) human capital; (c) infrastructure, such as roads, networks, laboratories, and the like; (d) the quality of institutions and governance systems. It can be noted that most of these factors are relevant for many other aspects of development, beyond innovation and technological development.

12. Other variables besides capabilities shape the environment in an important way, providing incentives and conditions for firms to innovate. These include macroeconomic stability, intellectual property rights (IPRs) and competition conditions. Intellectual property rights have a role in fostering innovation by ensuring that innovators are sufficiently rewarded for their investments, which includes their creativity, energy and financial capital. Nevertheless, it is important to mention that the level of intellectual property protection that provides the optimal balance of incentives to innovation is likely to be specific to the particular conditions of the development of each economy. This is especially the case since the empirical evidence for the incentive that patents provide to increase innovation and productivity is controversial (Lerner, 2009; Boldrin and Levine, 2013). Competition policy can also be important as a means to foster an enterprise-driven competitive process and keep the market order open to entrants. With regard to competition policy and innovation it is also important to recognize that abnormal returns are more likely

[1] For a detailed discussion and empirical analysis on the co-evolution of the different elements in the national innovation system, see Castellacci and Natera (2013).

the result of transient innovative superiority rather than the exploitation of static market power (Metcalfe and Ramlogan, 2008).[2]

B. The technology-gap challenge

13. Before engaging in a discussion on policy prescriptions, it is useful to have an idea of the differences between developed and developing countries, in terms of the capabilities generally accepted as important for the innovation process.

14. Technological capabilities and knowledge are unevenly distributed across the globe (see, for instance, Castellacci and Archibugi, 2008; UNCTAD, 2007). No matter which indicator is used for measuring technological capabilities, there is a strong sense that there is an important technological gap between developed and developing countries, and particularly in the case of LDCs (UNCTAD, 2007), and that this gap widens with time as a result of rapid technological advances in developed countries and the relatively slow advances in most developing countries.

15. A number of synthetic indicators about the innovative performance of economies are available in the academic literature as well as in more policy-oriented publications. Although there are differences between them there are also significant similarities and most tend to measure, in different ways, the same factors – for example, human capital, infrastructure, public or private research and development expenditure, innovation outputs (patents or publications), and the like.[3] In fact, the country rankings generated by the different indicators present very high correlation coefficients (Archibugi et al., 2009). This points to a certain convergence in terms of (a) the key measurable factors that influence technological capabilities, and (b) the methodologies used to measure and aggregate those variables.

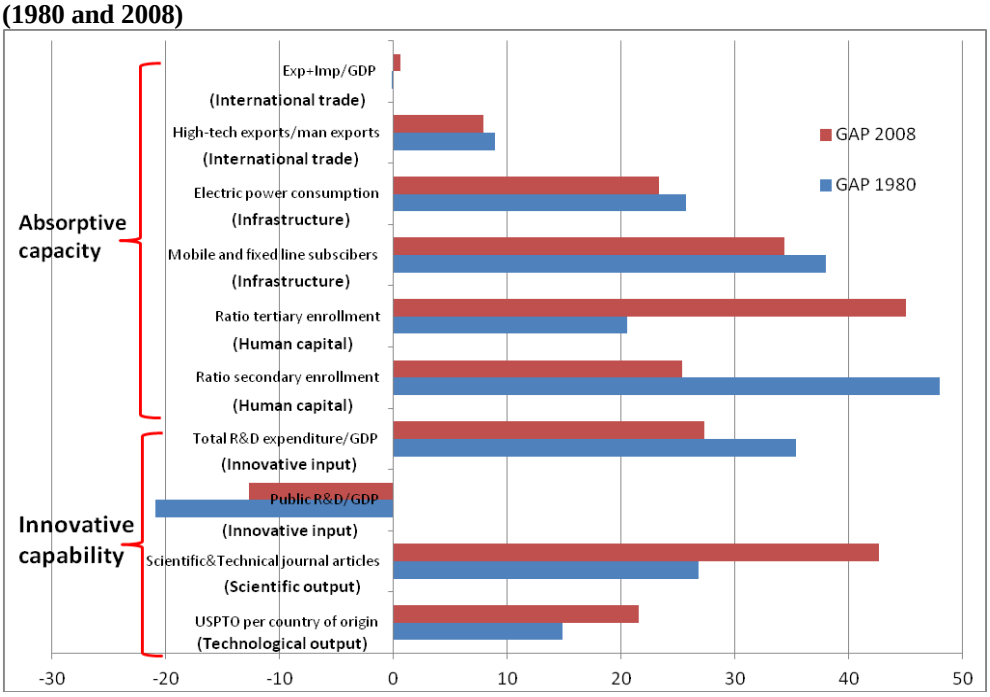
16. Taking this convergence into account, a forthcoming report by UNCTAD (UNCTAD (forthcoming)) attempts to depict the gaps between developed and developing countries in terms of the main factors described in the previous section. Some of the results of this work are summarized in figure 1, which illustrates the size of the technological gaps between developed and developed countries in 1980 and 2008.[4]

[2] It is worth noting that there is no linear relation between competition and innovation (Aghion et al., 2005). The optimal levels of competition for innovation are country and industry specific.

[3] For a deeper analysis on the differences and similarities between some of the most common synthetic indicators see, for instance, Archibugi et al. (2009) and Archibugi and Coco (2005).

[4] The graph is based on the elements identified as critical for the dynamics of an innovation system according to Castellacci (2011) and Castellacci and Natera (2013).

Figure 1
The technology gap: developed versus developing countries (1980 and 2008)



Source: UNCTAD.
Note: For more details on the methodology and calculation, see UNCTAD (forthcoming).
Note: USPTO: United States Patent and Trademark Office. Man exports: manufactures exports.

17. As figure 1 shows, the gap has decreased in some areas, but increased in others. Nevertheless, the gaps remain important in almost all its dimensions. Additionally, these calculations of the gap can also hide important heterogeneity between countries. Moreover, there is also the internal gap, which is not depicted in the chart, that refers to the differences in technological capabilities within countries, which could also reveal uneven distribution of technological capabilities within the country. Internal imbalances tend to be a cause of underperformance of the NSI of developing countries.

18. The figure also hides an important fact frequently observed in practical studies of innovation systems in developing countries, such as UNCTAD's *Science, Technology and Innovation Policy Reviews* – in the case of LDCs, the dynamic interactions between the elements of the system are likely to be weak or non-existent. Below a certain threshold level of development, innovative capabilities and absorptive capacities are low and their interaction is unlikely to be an important driver of economic development.

III. Considerations in innovation policymaking

19. The previous section highlights the different technology gaps that exist between developed and developing countries. Since technological gaps hinder the ability of economies to catch up and grow, and also amplify income and social disparities between and within nations, policy will target as a priority the closing of those gaps. This requires primarily improving absorptive capacities and innovation capabilities. When undertaking action to strengthen these capacities, there are several features of the policy environment that have an impact on the ability of policymakers to design and implement effective policies. This section reviews some of the key challenges they face.

Coordination

20. The inherent complexity of a systems-based approach to STI policies, the need for a highly sophisticated understanding of policy interactions and for strong coordination and collaboration among ministries, agencies and other public and private actors can represent a strain for the human and institutional resources of many developing countries (UNCTAD, 2011a). Innovation policy is not only the result of the work of the ministries of science and technology, but of a coordinated action between all institutions with jurisdictions over the different parts of the innovation system. Moreover, lack of coordination may also result in ineffective utilization of resources, where different ministries or institutions design their own programmes and strategies and compete among themselves for the allocation of public funds.

21. In this context, and as highlighted by the work published in the UNCTAD *Science, Technology and Innovation Policy Reviews*, innovation requires the establishment of an efficient government machinery able to ensure the needed coordination, a recurrent issue in a developing country context.[5] At the same time as horizontal coordination, the implementation of innovation policy also presents the challenge of striking a balance between bottom-up and top-down approaches for stimulating business innovation. Top-down approaches may be used for changes in policy directions that affect economy-wide capabilities, whereas bottom-up approaches should be used for standard types of innovation projects and for gathering information and inducing self-organization in new areas (World Bank, 2010).

Relevance and prioritization

22. The allocation of limited public resources and their effective use are also important challenges, especially in developing countries where financial and human resources for STI are scarcer and the legitimacy of expenditure in this area is more open to political challenges. It is certainly important to establish evaluations and better controls over public spending in order to ensure its efficient and effective use. However, before doing that, countries face the challenge of establishing priorities and identifying the most relevant areas, where the use of public resources can render wider benefits for the economy. This is not an easy task as it requires an ability to identify the main problems in the system, the appropriate solution and then determine how many resources should be allocated to this cause. It is probable that there will not be enough resources to address all the challenges in the relevant areas, and it is here that prioritization plays a critical role. A consistent finding in the UNCTAD *Science, Technology and Innovation Policy Reviews* is that insufficient efforts, or lack of political strength to prioritize results in a long list of "priority actions", which spread resources too thinly, make it difficult to accumulate critical mass and, given serious implementation weaknesses, undermine the overall credibility of STI policy.

Policy continuity versus policy experimentation

23. As in many areas of public policy, there is always the need for balancing policy continuity with policy innovation and experimentation. This is a difficult challenge because in some developing countries, policy continuity by itself is already a challenge. In some cases there is a lack of long-term planning and continuous implementation of STI policies,

[5] For examples on the coordination challenges in developing countries see the various *Science, Technology and Innovation Policy Reviews* available at http://unctad.org/en/pages/publications/Science,-Technology-and-Innovation-Policy-Reviews-(STIP-Reviews).aspx (accessed 3 January 2014).

and in other cases these policies suffer frequent institutional changes (Padilla-Pérez and Gaudin, 2014).

24. The above mentioned complications point to the need to reach a fundamental social consensus about the role of STI together with a few core policies. This could help to foster continuity despite political changes. However, it is also important that countries retain some flexibility to experiment with specific policies. In this context, a sound monitoring and evaluation process is crucial to provide appropriate feedback to policymakers, to adjust policies and experiment with new ones.

Institutions and incentives to innovate

25. Innovators tend to challenge the economic status quo. Supporting innovation includes providing incentives to firms and individuals to take that risk and discourage rent-seeking behaviour. If bribing public officials is the source of competitiveness, if regulatory capture is the easiest way to maintain market share, if lobby and not merit are the basis to assign public procurement contracts, innovation is unlikely to have a prominent role in society. In this context, better institutions and better governance are needed to increase the incentives for innovation and technological upgrading (Fagerberg and Srholec, 2008; Lee and Kim, 2009; Castellacci and Natera, 2013).

Inclusiveness and balance between productivity and the goals of societal needs

26. From the perspective of the NSI, STI capacity-building should also aim to facilitate the ability of a wide range of stakeholders to generate, access, adapt and apply knowledge to a particular context. In particular, access to a broad set of technologies for agriculture, energy, industry, infrastructure, health services and others is needed. Some of these emerging technologies originate in developing countries themselves and are thus particularly relevant and affordable for other developing countries.[6]

27. Including a pro-poor dimension in STI policy involves significant changes in policy formulation and implementation.[7] Supporting and building pro-poor STI policies and institutions requires developing institutions that effectively support pro-poor STI, aligning STI policies with national poverty reduction strategies and fostering an inclusive and participatory approach in the design and management of STI policies and interventions. These are some reasons why, while the need for pro-poor STI policies is broadly accepted, its enactment and implementation remain a policy challenge in most countries.

Balancing competitiveness and productivity goals with societal needs

28. It is important to include in the policy agenda the needs of poor populations, as well as the means to make the products of that innovation more readily available to those who need it. It is thus also important to implement policies that help to lessen the effects of skill-biased technological progress. A skill-biased technological change may increase economic growth, but could increase unemployment in some sectors of the economy, resulting in growing income inequality. Finding the right policies to cushion these effects is also important for our quest of prosperity for all.

[6] For some examples of innovation in the agricultural sector see UNCTAD (2010).

[7] Pro-poor STI can be defined as a system of innovation that enhances the ability of poor women and men to participate in, contribute to and benefit from STI (UNCTAD, 2008).

The increasing need for strategic intelligence in innovation policy

29. Strategic intelligence refers to the collection, processing, analysis, and dissemination of intelligence that is required for forming an innovation policy plan with a long-term perspective. This activity involves, among other things, the understanding of global trends in the demand of goods and services, technological development, the assessment of the country's capabilities to engage in emerging industries, the assessment of the financial resources needed, and the like. To undertake strategic intelligence in a developed-country context is a difficult endeavour, which becomes even more challenging in a developing-country context, since this activity requires important financial and human resources and specific capabilities to do it. Under these circumstances, developing countries face the challenge of designing an innovation policy when important information may not be available to them.

30. The preceding description of the challenges posed by the policy environment is far from comprehensive, but it attempts to provide an axis for discussion by experts. It also provides the background for some changes that can be observed in the innovation policy toolbox and that are covered in the next section.

IV. Evolving national innovation policies

31. The increasing recognition of the systemic nature of innovation accounts for the development of more holistic policies, with a scope that extends beyond traditional efforts to increase the supply of scientific and technological knowledge. This section presents some changes that can be observed in STI policies in developing countries. While few of the policies are entirely new instruments for innovation promotion, many are only recently attracting significant attention from policymakers and being fully incorporated into their policy toolboxes.

Addressing both the supply and the demand sides of innovation

32. In general, the predominant approach of countries as they first start to develop their STI policies focuses on the promotion of socially optimal levels of innovation through the use of supply-side mechanisms. These tend to target market failures that result from the externalities that are present in the production and diffusion of knowledge. This approach considers innovation as the outcome of the operation of market competition. A systemic approach complements this view of innovation with the recognition of the equal importance of non-market linkages and interactions for innovation outcomes. Consequently policy action needs to consider markets, but also systemic failures, when designing innovation policy (UNCTAD, 2011a). Policies solely focused on fostering the production side at best are incomplete (Lundvall and Borrás, 2006). Attention also needs to be paid to users and linkages. Demand-side innovation policies are a suitable mechanism to contribute to these goals.

Supply-side innovation policy

33. Supply-side innovation policies have traditionally played an important role in guiding innovation efforts and continue to do so. Such policies are generally aimed at addressing market failures that characterize the innovation process and lead to underinvestment in research and innovation (Edler et al., 2013, p.12). They include public funding to support public and business research and development, funding to support venture-capital funding, creation and strengthening of infrastructure, strengthening of links between research and development in science and industry, and investment in human resources (UNCTAD, 2007; UNCTAD, 2013a).

34. From this perspective, an analysis of the latest policy trends shows that increasing attention is being paid to prioritizing research and innovation funding and to support mission-driven research and innovation (Izsak and Griniece, 2012). This report also found that, in terms of emphasis of the policies, there is a concentration on research and development cooperation, support to start-ups and policies to promote excellence in research. As a part of the efforts in research and development cooperation, it is important to recognize that the strengthening of collaboration between science and industry has been central to innovation policy, and that this has been an important focus on the design of supply-side instruments. Some examples of instruments to foster science–industry links and help research to develop into innovation include indirect and direct tools such as technology-transfer offices, IPR regulations, encouraging licensing and spin-offs and support to innovation networks and clusters (UNCTAD, 2007).

Demand-side innovation policy

35. In recent years several countries, both developed (for example, Finland and Australia) and developing (such as Brazil and China) have increased the use of targeted demand-side innovation to overcome market and system failures in areas in which social needs are pressing (Organization for Economic Cooperation and Development (OECD), 2011, p.9). Demand-side innovation policies are generally defined as a set of public measures aimed to increase demand for innovation, improve conditions to undertake innovation activities or to improve the articulation of demand in order to foster innovation and allow their diffusion (Edler, 2007). They are often designed to address deficiencies in the ability and willingness of potential users to demand and apply innovation as well as improving the interaction and linkages between demand and supply (Edler et al., 2013, p.12).

36. This type of policy includes initiatives such as public procurement, regulation, standards, consumer policies, and user-led and lead-market innovation initiatives. In practice, however, the most popular demand-side instruments are public procurement of innovation, while recent trends in developed countries show that there are just a few cases of using regulations and standardization to influence demand conditions, and even fewer measures that provide support to user-driven innovation (Izsak and Griniece, 2012).

Public procurement

37. Among demand-side innovation policies, procurement is probably the one with the longest record of successful application. Public procurement has been particularly relevant for the development of radical innovations that have resulted from public investment in, for example, defence research.[8,9] According to Edquist, "public procurement for innovation occurs when a public organization places an order for the fulfilment of certain function within a reasonable period of time (through a new product)" (Edquist and Zabala-Iturriagagoitia, 2012, p.1758).

38. Public procurement for innovation can take several forms: it can be general or strategic in relation to the types of innovations that it aims to foster; it can occur in cooperation with private users; and it can also concern commercial or pre-commercial procurements, when the latter involves the acquisition of products that are not ready for

[8] This includes, for example, the Internet: see http://www.internetsociety.org/internet/what-internet/history-internet/brief-history-internet (accessed 3 January 2014).

[9] In this note, public procurement is referred to as the use of public procurement as an innovation-policy instrument.

commercialization and that require further research and development (Edler and Georghiou, 2007).

39. Public procurement presents opportunities for proactive innovation policies in countries at all levels of technological development. For example, in the case of Sri Lanka the development and deployment of e-government and information technology (IT) public procurement has contributed to strengthening the capacities of local business in information and communication technologies (see box 1).

Box 1. Public procurement to foster the IT sector in Sri Lanka

In Sri Lanka, ICTA (the agency responsible for large e-government programmes) has contributed to the promotion of technological capacity development among local firms through the use of public procurement. This organization has established the use of transparent and competitive tender procedures that has stimulated local IT small and medium-sized enterprise (SME) development. One of the mechanisms used by ICTA is the deployment of targeted preferential marks to local firms which has stimulated joint ventures between local and international firms, and has fostered capacity development among local firms. These initiatives have allowed local firms to succeed in bids of IT services; in a sample of 13 key services procured by ICTA, all but one included a local firm in the winning bid. In addition, technology-related strategies adopted by ICTA have also contributed to the participation of local SMEs in public-sector tenders. This has been possible because of the governance mechanisms of ICTA. In this sense, this organization has a reasonable amount of authority to set policy on technical matters, has established clear interoperability standards and has implemented modular e-government architecture. A consequence of the latter is that it increases tender attractiveness for SMEs and local firms with specific expertise.

Source: (UNCTAD, 2013b).

40. In relation to the effectiveness of public procurement in comparison to other demand-side measures, empirical work has shown that public procurement is especially effective for smaller firms in regions under economic stress and in distributive or technological services. Public procurement for innovation can thus be a particularly appropriate instrument for strategies to promote the technological development of SMEs (Aschhoff and Sofka, 2009). However, it is also necessary to consider the limitations of public procurement. For instance, the focus on value for money, the problem of fragmentation of public demand, and the fact that because many agencies or local governments operate separately from line ministries or government agencies, the potential benefits of this policy instrument can be limited (OECD, 2011).

41. Empirical evidence evaluating the performance of public procurement as a mechanism to drive innovation that can stand the test of markets has also shown that some of the deficiencies at the firm level that public procurement policies were intended to address seem to persist. Some explanations that have been suggested for such persistence are: (a) lack of consistency of the policies; (b) policies may not be rooted in governance terms (different agencies design and implement the policies); (c) austerity plans have halted some measures; (d) the policy instrument addresses the act of procurement itself and is lacking the engagement in the whole process of identification and diffusion of the innovations (Georghiou et al. (forthcoming)). Georghiou et al. claim that a systemic approach is required to harness the potential of public procurement as innovation policy. The authors identify three key dimensions: extensions of the time frame of the interventions so that the whole cycle of need can be addressed; extension of the breadth of reach of policy to include all the stakeholders, and to ensure the understanding of innovation among

both the agencies and ministries involved, as well as the understanding of procurement and its relation to innovation in those dealing with supply-side innovation policies on the other hand; deepening of the measures to address the underlying cultural practices of the public sector, especially those related to risk management.

User-driven innovation policies

42. User-driven innovation is a manifestation of the increasing use by enterprises of open innovation models. In terms of innovation policy, the increasing importance of user-driven innovation strategies means that there is a need to support efforts by firms to understand user needs and involve them in innovation activities, as well as to enable users to engage directly in innovation. The objective of policies in this regard is to enable and facilitate innovation outside the boundaries of the firm, increasing the overall level of innovation in the economy and in the society on a wider basis. This type of innovation policy emphasizes the promotion of innovations that meet needs identified by users, and, therefore, puts special emphasis in product development collaboration and information provided by users. Enabling user-driven innovation requires policy actions in areas such as competence-building, infrastructure development, redesigning financial incentives for innovation, and reconsidering regulations in a broad scope of matters (Finland, Ministry of Employment and the Economy, 2010).

43. The focus on developing solutions identified by users can potentially contribute to the development of pro-poor innovations. This is because the poor are easily ignored by innovation policies as they hover between the formal and informal economy, and also because of differences in culture, technological awareness and education (UNCTAD, 2011b).

Effectiveness of demand-side instruments

44. There are several strategic factors that will influence the success of demand-side mechanisms, from the points of view of both market effeciency and the improvement of social welfare. The existence of coordination and coherence between supply- and demand-side policies is one of them. Policy objectives also need to be clearly formulated and their impact should be measurable. Coordination is critical within government, industry and other stakeholders. Solid governance and coordination capabilities within the public sector are thus decisive to take advantage of these mechanisms. Since demand-side policies rely heavily on public administrators, to complement this type of instrument with investments in skills and capabilities in public administration and organizational and cultural change is essential (OECD, 2011).

45. In addition, it is also important to consider the practical coordination between industrial and innovation policies. There is convergence between both policy areas in terms of an increasingly significant role of demand-driven instruments. Both are also considered to be instrumental for competitiveness and to serve or link other policy fields (European Parliament, 2011). This is not surprising, since the evolution of the technological capacity of countries is connected with the history of their industrial development. Notions of technology skills development, entrepreneurship and innovation are increasingly entwined in the policy debates about international competitiveness, which results in a growing overlap between the players of innovation and industrial policies.

V. Fostering the internationalization of linkages in the national system of innovation

46. The increasing use of open innovation models, which entail collaboration with external partners to expand and strengthen firms' competitive advantages through innovation, is not limited to collaboration at the local level. In particular, multinational companies increasingly locate their research and development activities at different points along their global value chains (GVCs) and rely on innovation created outside their enterprise boundaries (UNCTAD, 2005; OECD, 2008). The increasingly international nature of innovation-related collaboration implies that STI policies need to be designed not only according to the national context but also to the need to participate on favourable terms in international technology and innovation networks. In this context it is important to recognize the existence of firms with different capacity levels when designing STI policy. STI policy should contribute to the strengthening both of firms that already have the capacities to participate in international networks and of firms that only participate in local markets because of their technological capacity or other reasons such as market orientation.

47. Linkages between local and international innovation agents are not limited to firms but are also present between other innovation agents. For instance, international networks in research involve academics and also institutional collaboration agreements between universities and research centres. Another important source of collaboration is produced by the investment in human capital performed by developing countries through supporting students to study abroad. These initiatives are intended to strengthening human capacity and also to foster the creation of networks that may increase research collaboration efforts in developing countries.

48. While the internationalization of the innovation systems requires the adaptation of the national innovation policy to this emergent scenario, this does not necessarily involve radical change. For instance, the inclusion of open innovation models in the overall STI policy framework does not reduce the need to continue to provide public support to universities and public research centres, since these organizations play an important role in open innovation strategies. At the same time, acknowledging the scarcity of resources and the important competition to attract research and development-related FDI, countries must balance their research efforts in specific fields against the need to develop sufficient absorptive capacity in a range of fields (OECD, 2008).

49. In addition, specific policies to foster or enable the development of world-class clusters and networks need to be developed. This is because this type of collaboration network remains important, but integration across fields and borders may require particular competencies and designs. The potential for innovation depends on the potential for knowledge flows within the networks (OECD, 2008). An interesting and novel strategy related to increasing the entrepreneurial and innovation network is Start-up Chile. This programme was created in 2010 by the Government of Chile and executed through its National Development Agency (CORFO). The programme is oriented to attract high-potential entrepreneurs in their early stages to come to Chile and to use the country as a platform to reach international markets. The programme is oriented to transform the position of Chile within Latin America's innovation and entrepreneurial hub. By July 2013 the programme had supported 584 projects which received $40,000 each, space office and local support – without taking equity in exchange for moving to Chile – for six months to build their company.[10] Although it is early to evaluate the impact of this new type of

[10] See http://www.huffingtonpost.com/vanessa-van-edwards/start-up-chile_b_3225480.html (accessed 3 January 2014).

approach to promote innovation, the novelty of this initiative has been internationally recognized and has inspired spinoffs around the world such as Start-up America, Start-up Britain, Start-up Greece and Start-up Italy.

50. It is possible to observe another emergent but alternative approach to connect knowledge when analysing the Danish experience in terms of bridging local researchers and businesses with the international market. The Innovation Centres Denmark programme, which locates research and development centres in strategic locations, is currently managed as a collaborative initiative by the Danish Ministries of Foreign Affairs and of Science, Technology and Innovation. Through the creation of the Innovation Centres Denmark programme the country aims to link Danish companies with international research, innovation and business.[11]

The role of global value chains

51. About 60 per cent of global trade consists of trade in intermediate goods and services, these being incorporated at various stages in the production process of goods and services for final consumption. The fragmentation of production processes and the international dispersion of tasks and activities within them have led to the emergence of borderless production systems. These can be sequential chains or complex networks, their scope can be global or regional, and they are commonly referred to as GVCs (UNCTAD, 2013c). Science, technology and innovation policies can contribute to enhance and strengthening the participation of local firms in international value chains. The introduction of innovations oriented to increasing productivity as well the creation of local capacities produced through the implementation of STI policies can increase the competitiveness of local firms in GVCs, and in this way also expand the benefits for the local economy of participating in the international markets. Simultaneously, with the right strategies and policies in place, participation in GVCs can play a useful role in technological learning and transfer of technology.

52. Global value chains are increasingly present in developing countries. Through the participation of firms and suppliers from developing countries in these networks these organizations secure access to larger (international) markets and innovative technologies. For developing countries, however, these benefits depend on the linkages they develop with other agents of the chain and on the technological effort they make to learn through those linkages. Participation in GVCs may be associated with the upgrading of firms that can take place in the following areas: (a) process upgrading, through more efficient production; (b) product upgrading, by introducing products with higher value added; (c) functional upgrading, through acquiring new or superior roles in the value chain; (d) intersectoral upgrading, which allows local companies to apply their acquired competences in other sectors of the economy (UNCTAD, 2007).

53. An example of participation of small-holder farmers in a GVC that has produced process upgrading of firms is the case of banana exports from East Africa. This case shows that the association of local producers has allowed both creating and taking advantage of economies of scale, and has facilitated the producers' successful participation in international markets (see box 2). Leveraging value chains in the agricultural sector as an innovation policy instrument is particularly important given the significance to this sector for food security, employment, and as a basis for diversification and growth in most developing countries (UNCTAD, 2009). The participation of transnational corporations in this field is increasing and this can bring potential benefits to developing countries. At the

[11] Please refer to http://icdk.um.dk/en for additional information on this initiative (accessed 3 January 2014).

same time there are a number of concerns about the role of foreign investors in this sector that need to be addressed.[12]

Box 2. Banana exports from East Africa

The value chain of export Cavendish bananas is typically considered high cost and price sensitive. On the cost side, the banana industry exhibits economies of scale and is highly capital intensive in both production and transport. Since small-holder farmers cannot reap any scale benefits, usually they have to bear a high-cost price due to low yield and efficiency. On the price side, small-holder farmers cannot afford the risk of price fluctuations of the spot price of bananas in the global markets. In order to integrate small-holder farmers into global markets, AgroFair has pooled the limited volumes of small producers into a stable, marketable offer. The model places small banana farmers at the centre of the value chain and allows them to co-own the AgroFair company. This ownership arrangement allows producers to influence the company's commercial policy, and to receive dividends, and technical and organizational support. This type of value chain ensures that small banana farmers receive a fair price and enjoy a long-term stable relationship with other players of the value chain. This model has shown that small producers can be good partners in global markets.

Source: UNCTAD (2010).

54. Since the internationalization of value chains produces interaction between GVCs and the innovation systems of countries, it also influences whether and how firms in developing countries learn and innovate through their interaction with these value chains (Pietrobelli and Rabellotti, 2011). Empirical evidence of the knowledge spillovers produced by FDI in local firms through contacts between foreign affiliates and their local suppliers in upstream sectors is ambiguous. In any case, it is important to consider that there is no unique mechanism through which global networks contribute to generating productive linkages in the host economies. The development of such linkages (both between domestic and foreign firms and inter-institutional ones) can provide local SMEs with the necessary externalities to cope with the dual challenges of knowledge creation and internationalization that are needed for successful participation in GVCs. In this regard, domestic capacity-building calls for science and technology support (UNCTAD, 2013c).

55. Understanding the differences in the organizations of global networks, their purpose, funding mechanisms and performance metrics may help to explain regional differences in the success in the globalization efforts of different regions. In order to promote global innovation networks it is crucial for policies to support this development. Labour, competition, public infrastructure, financing for innovation, and policies promoting high skilled human capital need to enable the development of new transnational dynamics (Walshok et al., 2012).

56. Finally, it is necessary to consider that, to facilitate the participation of national firms and organizations in global international networks, efforts also need to be made to strengthen the NSI and especially to develop absorptive capacities, which allow local organizations to participate and maximize the benefits of international collaboration, and to develop the institutional and governance structures that encourage the creation of linkages between the host and home organizations that favour the diffusion and creation of innovations.

[12] Please refer to the *World Investment Report 2009* (UNCTAD, 2009) for an analysis of effects of FDI and transnational corporations in agriculture in developing countries.

V. Issues for discussion

57. This note has presented an overview of some STI policy challenges with which developing countries are confronted, focusing on some aspects that may have received insufficient attention in the first session of this multi-year expert meeting. The following questions are suggested as some possible areas for expert discussion:

(a) How are technology capability gaps and innovation policy environments relevant to a pragmatic approach to technology transfer and diffusion of knowledge in developing countries?

(b) What institutional frameworks for policy coordination and collaboration in the area of STI can be suggested as particularly suited to the needs of developing countries?

(c) What can be learned from the experience of developed and developing countries in implementing coordinated supply and demand-side innovation policies? In this area, what are the main trends on demand-side innovation tools?

(d) What are the best strategies for developing countries to take maximum benefit from their integration into GVCs? Which considerations do these countries need to acknowledge when fostering participation in international production networks?

(e) What are the learning opportunities for developing countries through participation in STI policy networks? How can developing countries take advantage of these opportunities? Is there a role for UNCTAD?

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