

# National Systems Of Innovation: Implications On Science And Technology Policies In Sub-Saharan Africa

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## **Abstract**

*There is a widespread recognition that the circulation of resources between knowledge providers and user agents is very important in the process of innovation. In this article we theoretically explore the policy implications of the concept of national systems of innovation on science and technology in Sub-Saharan Africa. After identifying the systemic weaknesses of Sub-Saharan African national systems of innovation we conclude by formulating some propositions for a new agenda science and technology policymakers in Sub-Saharan Africa.*

## **Introduction**

Scholars have wondered if the concept of the national system of innovation (NSI) could be applied to low GDP per capita developed economies (Niosi et al. 1993). Some years

ago I gave two lectures: one on the NSI of Congo-Kinshasa and the other on the use of technological services in the NSIs of less developed francophone countries held in Paris by the Institut des Hautes Études Francophones (Masinda, 1995 and 1995). Based on that experience and despite the problems of the measures and difficulties that occur with multiple approaches to the concept of NSI (OCED, 1997), it can be argued that it is applicable to less developed economies. One can assume first that all countries around the world, including Sub-Saharan Africa (SSA), have developed institutions devoted to the production of knowledge, public policies and programs for building technological capacities in enterprises (Davis, 1983; Eisemon et al., 1985; Odhiambo, 1996). Secondly, the concept of NSI assumes that governments can consciously take actions to avoid systemic weaknesses of the NSI (Freeman, 1988; Vinck, 1991). Indeed some innovation process is endogenous and to that perspective, governments of SSA must develop and use institutional innovations that will consolidate their NSIs.

*The objective of this article is not to provide a complete theoretical analysis and a definitive framework of the applicability of the concept of NSI in less developed countries, but to explore and initiate a discussion on the future of science and technology policy in SSA countries using the concept of NSI. There are systemic weaknesses that inhibit the development of technological capabilities in enterprises and the mechanisms that can improve the distribution power of resources in the NSIs of SSA countries. It is also an opportunity to have a critical glance at indicators of science, technology and innovation as presented in the Oslo Manual.*

### **Theoretical foundation of the NSI**

The concept of NSI involves two hypotheses, which are: 1) innovation is a process of learning and that learning interactions play an important role in the process of innovation (Lundvall, 1992), 2) innovation is shaped by social, cultural and institutional particularities that create, mobilize and distribute resources (Nelson, 1993). For example, despite some convergence of NSIs of industrialized countries, there are differences in governance systems and technological specializations. This suggests that neither globalization nor economic integration is rendering the state obsolete.

Taking into account the fact that learning is an interdependent process scholars stress on the "distribution power" of resources in consolidating the NSI. The production of knowledge is not sufficient to induce innovation; the critical situation is the circulation of the resources between enterprises. The distribution power of a NSI is its capacity to develop efficient mechanisms to promote the circulation of resources and its ability to access and diffuse available resources. The key argument is that a NSI can not be efficient if its capacity to transfer the resources produced from providers to customers is weak (David and Foray, 1996).

Others scholars have explored the innovation process from the local/regional context inside countries that emphasizes cultural, geographical and institutional proximity which create and facilitate transactions among socio-economic actors (Becattini, 1992; Acs, de la Mothe and Paquet, 1996). Studies conducted on the concepts of innovative milieu, industrial district or local systems of innovation have succeeded in demonstrating that conventions and specific socio-institutional factors in regions affect technological change in NSIs (Storper and Scott, 1995).

Some questions of the operationalization of the concept of NSI still exist. For example,

what about the coherence of a NSI? Many NSIs integrate in their process of innovation more inputs from institutions outside of its boundaries than inputs produced locally. On that question, Lundvall is clear. According to him, the interactions between producers and users of technologies inside of a country have to be more important than interactions between national with foreign enterprises. The position of Freeman and Nelson are not evident. They prefer to talk about the importance of national dynamics without talking about its coherence. How do these views match the realities of SSA?

The technological innovation process is defined as the adoption of new products or processes and organizational methods or adaptations of existing products or processes (OECD, 1996). Even the innovation is not only about radical change, developed economies have resources to develop high-tech industries (biotechnology, new materials, air-spatial, microelectronics). They can do that because they have accumulated high level of knowledge and incomes. By contrast, innovation in less developed countries must be thought as a process of adoption, absorption and diffusion of traditional available technology (Lall, 1991; Dahlman et. al., 1985).

This differentiation in the concept of innovation adds the problem of comparability of NSI between developed and low developed countries. But by doing that exercise, we understand the preoccupations of many scholars who propose to create new indicators of innovation because those presented in the Oslo Manual do not capture the variety of innovation processes across countries (Roelandt and Hertog, 1996). It is clear that if we use the indicators of Oslo Manual in third world countries they will not tell us much about, for example, the informal economy, the contribution of foreign workers in technical co-operation, the brain drain of Africans etc.

Despite the problems of operationalization and the lack of appropriate indicators to evaluate the innovation process all authors stress the systemic interactions of enterprises and the key role of institutional factors. They emphasize the synergies generated by the circulation of knowledge as a condition for effective individual and collective learning. Finally, they underline the fact that technical innovation is not sufficient. The innovation requires social innovation that allows adaptation of institutions to rapid changes in economies.

## **National systems of science and technology S&T in Sub-Saharan Africa**

In this section we present an overview on the systemic obstacles of developing indigenous technological capabilities in SSA. In addition, we describe the characteristics of R&D systems such as may exist and their links with the needs of enterprises.

There is an apparent consensus on the three factors inhibiting industrialization in SSA. Scholars point out first the inadequate macroeconomic politics, which allocate too many resources to large public enterprises mostly concentrated in urban areas and discriminate against SME (Biggs and Srivastava, 1996, Lall, 1991). Secondly they observe that the low investment in education and R&D both in the public and private sectors inhibits the production of science and technology. Thirdly they note the low integration of these economies into global economy (Dessing, 1990; Mytelka, 1994). In fact, it is now known that the most important obstacle to the development of technological enterprises in SSA is not the lack of resources but their isolation (Schmitz, 1995).

Modern science and technology was introduced in SSA in the beginning of the 20th century. After independence in the early 60s, international agencies (especially UNESCO) helped to build national structures in new SSA countries devoted to the production of science and technology related to the needs of people (Gaillard and West, 1988; Davis, 1983; Eisemon et al., 1985). At the end of the 60s, almost all of the SSA countries had a national structure for science and technology (Forje, 1988). At the end of the 80s, the majority of them had a ministry of science and technology (Odhiambo, 1996).

Despite these efforts in organizing science and technology the results are still weak, inhibiting productivity in enterprises and reducing their absorption capabilities of imported technologies. However, as Forje noted that there is a large disparity in the efforts deployed in the production of science and technology in SSA. In fact, in a study conducted on the production of research in SSA (outside the Republic of South Africa) Nigeria produced 47% of total research production during the period between 1981 and 1986 followed by Kenya with 15% during the same period (Zymelman, 1990). This underlines the disparities in investments in R&D between the SSA countries.

Current science and technological policies (STP) in SSA accent inputs and forget that innovations do not occur in the aggregation of the technological infrastructures but in the quality of the organization and the circulation of available resources (Cisse, 1992). The isolation of researchers and R&D institutions is cited by many African scholars as one reason for the weak performance in building technological capabilities.

The lack of the links between the needs of enterprises, communities and the R&D institutions is a real problem in SAA enterprises (Ayiku, 1990). Despite the concentration of R&D in agriculture and medical treatment, community services remain a peripheral appendage to the university system (Saint, 1992). For example, a recent study on the ratio between the annual average needs of qualified employees and qualified employees produced by the educational system in Congo (Zaire) found that enterprises needed 120% of the available labour on the market for the maintenance of machines. The same problem exists for computer, metallurgy and mines sectors while there are excess qualified employees in the agricultural and textile sectors (Jonnaert, 1993).

Another problem in the efforts in science and technology in SSA countries is the economic exclusion of a large percentage of the population. Inequalities in the distribution of incomes have destroyed the internal demand of manufactured goods (Stiglitz, 1996; Grabowski, 1994). For example, in South and East Asian countries the proportion of population living under poverty passed from 40% to less than 10% between 1965 and 1990 (Sakong, 1993) while in the same period inequalities grew in SSA, excluding the mass of population from the economy (Allen and Thomas, 1992). That paralyzed the internal market needed for the manufactured goods, which in turn inhibited the learning process of enterprises. These factors also had huge consequences on the brain drain of scientists and qualified manpower (Apraku, 1991).

In conclusion, NSI in SSA countries are characterized by low investment in science and technology, a concentration of investment in public large enterprises concentrated in big cities and an exclusion of the large mass of population to the formal economy. It is clear that these economies must adopt new indicators to evaluate skills and competencies acquired in traditional sectors, the ability to promote inter-linkages between actors in their process of adopting and absorbing new technologies (UNCTAD, 1996).

## Implications of the concept of NSI on science and technology policies

The previous description of the weaknesses of NSIs of SSA countries can allow us to identify potential policies for strengthening the process of innovation. The concept of NSI provides a new perspective for policymakers to elaborate new mechanisms, which will integrate SSA NSIs in global economy. The task of each NSI is to identify its specificity, weaknesses and strengths in order to tailor efficient policies for science and technology.

*Focus on technological capability:* Limited resources force innovation managers and policy makers to set priorities according to the specificity of a NSI and stress more on how to build collective technological capability rather than how to transfer technology to an individual enterprise (Nakaoka, 1993). They must try to achieve equilibrium between the investment in technological capabilities related to high and low level of knowledge intensity coupled with the knowledge of local cultures and systems that only native-born export can apply. This will require the repatriation of African professionals distributed around the world (about 100 000 experts and professional have migrated to western countries (Inukai, 1993).

*Lessons for international co-operation:* The circulation of resources among enterprises is important in the process of innovation. In SSA countries the isolation of researchers and enterprises is known nationally and internationally. The future orientation of technical co-operation should promote resource networking: a strategy that emphasizes the interaction actors and the interplay of institutions within a NSI. In the same direction, technical support for SMEs must be a priority because they employ the large part of the economically active population. It is known that SMEs in SSA create more jobs and train more employees than large enterprises.

*New conception of the space:* The concentration of investment in large cities discriminates against local centres. But there is irony in the fact that geography is an important topic because the process of learning is fundamentally affected by cultural proximity (Feldman, 1996; Malecki, 1995). From that point of view, efforts must support SMEs and enterprises in the informal economy distributed throughout a country to adopt and absorb new technologies. Special attention must be put on the interconnection of local centres in order to promote the exchange of their experiences and stimulate national social capabilities. This approach is one way to redistribute incomes and develop an internal demand for manufactured goods.

## Conclusion

Even all countries have a NSI differences remain in their efficiency of resource production and their distribution power of knowledge. Innovation in less developed countries is not about the creation of new technologies or processes but about the strategic promotion of resource networking for adoption and absorption of available technologies. In this perspective, science and technological policies analyzed under the concept of NSI will promote the development of local centres of knowledge through decentralization, the repatriation of experts and the inclusion of the informal economy in strategies of technological capability building. In others words, SSA government policies must be re-oriented to correct systemic weaknesses of their specific NSIs.

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