

PRINCIPLES FOR AN INNOVATION AND COMPETITIVENESS STRATEGY FOR COLOMBIA¹

1. Introduction

There is a belief that in the globalization era, development is obtained when more knowledge is applied to production and further innovation is used, than with the simple accumulation of capital and work. However, we are conscious that innovation is an arduous and systemic problem that involves many society actors. To confront it, there must be a national belief that this is the correct path towards development and an open and balanced vision from the Government is required to guide the system across that path. Based on international experience, when trying to be innovative, the market cannot provide all the answers; therefore, public and private sectors need to work conjointly.

For this union to be fruitful, the roles of each Innovation System actor should be clearly defined beforehand. While the company's role is to successfully accomplish the task of transforming knowledge into wealth (innovate), governments are required to insure favorable environment conditions for the adequate operation of the Innovation System; as well as to correct systemic and market flaws inherent in the innovative process, which do not allow the country to reach its maximum potential.

This public task is not exempt of problems because it requires support tools to be designed and implemented. These tools must effectively solve market flaws in cost efficient ways and are required to be strong against eventual corporate group pressure. Scientists, universities, and entrepreneurs will be benefited by these tools that will provide intra marginal benefits and by the need of these tools to be maintained throughout time.

¹ Document base don Final Consulting Report (Jun. 2011) - Centro de Productividad Universidad Adolfo Ibáñez (Chile). Authors: Eduardo Bitrán, José M. Benavente, Claudio Maggi

This is why institutional design is relevant to avoid State flaws and allow national efforts in science, technology, innovation and other related activities being sufficiently crucial in able to reach better development stages.

Main State flaws which appear as consequences to public authority operation in its innovation support are discussed. Secondly, public architecture governance challenge in finding the above mentioned flaws is presented, as well as its adaptation in advanced countries highlighting its weaknesses and strengths. Finally, a plan of action is suggested for Colombia.

The Innovation Strategy for Colombia must have a hybrid approach that combines neutral tools and mechanism development that imply a broader selectivity in innovation policies. It must be acknowledged that total neutrality is not possible because not all public goods are generic, which leads its neutral provision to usefully satisfy sectors that have greater pressure power or historical importance. Although we must always measure the country in international competitive terms; being a small economy with limited resources, it's necessary to focus several efforts in activities that have the necessary potential to gain a place in international market with additional support to promissory sectors. A balance between neutral and selective policies must be achieved, designating a significant amount of public resources to the latter. To be neutral in assigning resources for science is to favor the a similar structure of actual academic supply without questioning the need of creating strategic capacities in Science to generate knowledge in development problem solving of our productive sectors.

For a country like Colombia, in which few sectors represent the majority of its growing export potential; where specific knowledge needs are present and are not available in any other country; and where the technology linked to these sectors may generate important innovation options, it is evident that one cannot be completely neutral. For that reason, the strategy must generate selective directions in the assignment of a number of resources to Science. This is known as Science with a purpose, always maintaining a value of excellence.

2. General diagnosis of the National Innovation System in Colombia.

2.1.1 Growth Challenge

By the end of the 70s, Colombia shows a structural decline in its economical growth because of the effect insecurity had over factor productivity. In the 90s, the capital accumulation rate was also affected. The report *Comisión de Crecimiento y Desarrollo de Colombia* concludes that the relatively low levels of trade liberalization in Colombia and the low levels of human capital accumulation have been responsible for maintaining moderate growth rates of the TFP and the GDP per capita. Last decade, a break is observed in the growth rates of the TFP, reaching an annual 1% from 2003 to 2010, similar to the previous levels observed during the 70s when the TFP collapsed. . The same study points out that a deficit in transportation infrastructure became an obstacle for commercial development and productivity growth in the last decades (Table 1).

Table 1: Total Evolution, Growth and Productivity of Factors in Colombia.

Period	Median Rate of Annual Growth	TFP Annual Average Growth
1950 -1974	5,2 %	1,1
1975 – 1989	4,1 %	-1,3
1990 - 2002	2,6 %	-0,6
2003 - 2010	4,8 %	1,0

Source: DNP

The new scenery in Colombia, with an income of USD\$10,000 per capita (PPP), with an improvement in levels of security and a complementary economy with China, generates a positive shock in exchange terms. It increases fiscal capacity, trade agreement advances; it allows stating a goal of reaching the development threshold 15 years from now. If a growth of 4% of GDP per capita is maintained annually, in 15 years we will reach an annual income of USD\$18,000 per capita. For this to take place, it is important that the total productivity of factors increases between 1.5% and 2% per year.

The question is how to increase the levels of TFP that Colombia has not had for prolonged periods of time. The only country in Latin America that reduced the productivity gap with the United States was Chile, which was able to maintain an annual TFP growth of 2% for a 12 year period, between 1986 and 1998. This allowed them to double their per capita income during that period. However, after its economical crisis of 1998-99, Chile could not maintain an increase in productivity remaining in a low rate and reducing economy growth by half. The greatest growth in the TFP was due to a structural change.

Economic and trade liberalization in goods and labor markets allowed a quick reassignment of resources for sectors with comparative advantages based on natural resources. Once obtained, these profits in structural change are not available to continue increasing productivity unless they act as a starting point to begin an exporting growth phase based on innovation and quality human capital. Chile was not able to maintain its growth in productivity because of external shocks in the energetic field; the exhaustion of an “easy export growth” phase destined to use natural resources and implement imported capital goods without generating an internal innovation dynamic, especially in leading natural resource sectors.

The risk for Colombia is to generate structural change that can reduce work productivity while trying to maintain work rigidness with increasing change and natural resource export enclaves and trade liberalization. This change in structure can lead to the irresponsible maintenance of a large number of workers or it can have a process similar to the one in Chile, in which a positive outcome in productivity is initially visible because the use of non renewable natural resources or environmental resources is not being measured correctly. Once these resources have been used, it is not possible to generate growth dynamic based on innovation and quality human capital. The challenge for Colombia is taking advantage of positive exchange terms to generate growth principles based on innovation and quality human capital.

2.1.2 TFP Growth Decomposition

Studies developed until the 90s decade for several countries, in the manufacturing sector, show that a change in the TFP in Colombia is the result of an increase of productivity within companies and; in a less relevant way, entry and exit of companies. In Chile's case, the net entry of companies explains the numbers in productivity (Graphic 1).

Figure 1: TFP Annual percentage growth per component breakdown.

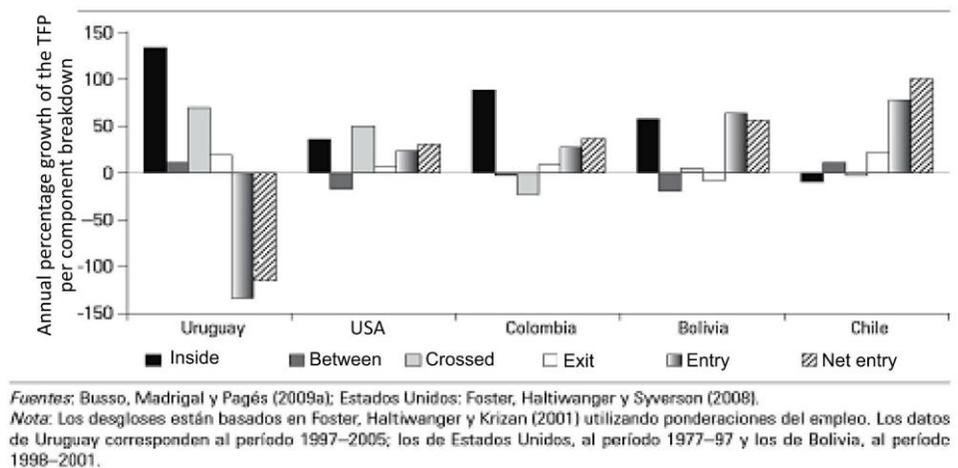
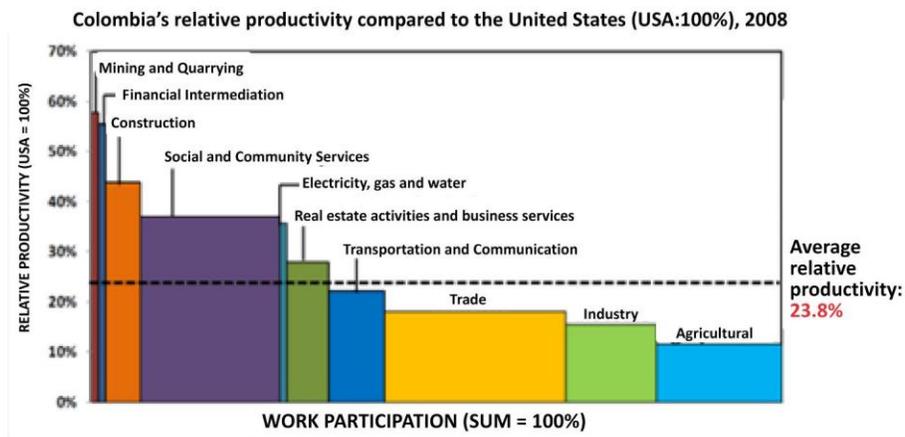


Figure 2: Colombia's relative productivity compared to the United States (USA: 100%), 2008



On the other hand, a recent labor productivity study on an inter-sector level shows that the industry in Colombia has low levels of labor productivity compared to agriculture and

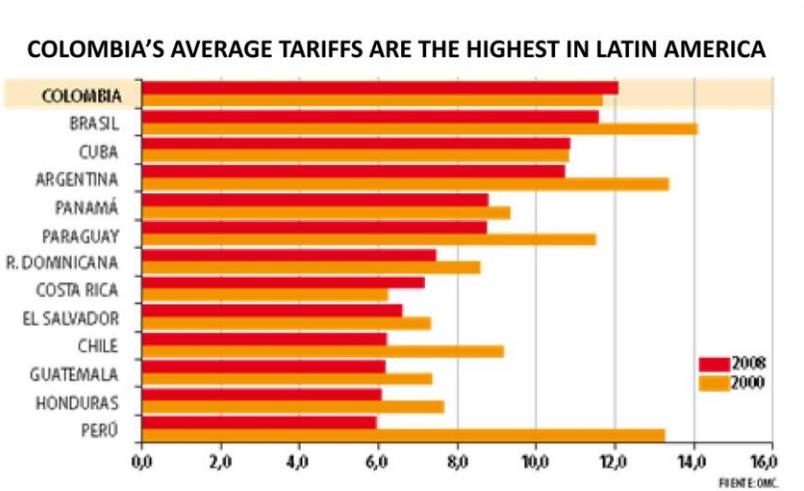
services. It is below economy average which is only 23.8% compared to United States' productivity (Figure # 2).

Another important aspect that needs to be emphasized is that in the manufacturing sector there is a huge dispersion of labor productivity. Colombia shows differences in labor productivity up to 300%, levels only surpassed by Venezuela where the dispersion is superior (350%). Regarding the labor issue, the main distortion in Colombia's case is the high non-wage labor costs exceed 50%, compared with 26% in the case of Chile. Also, the minimum wage is 56% of GDP per capita, compared with 11% in Mexico and 37% in Chile.

2.1.3 Low supply net business entry: loser protection and low quality of dynamic entrepreneurship

Wide dispersion of productivity in the manufacturing sector in Colombia and low contributions of net firm entries in the TFP, show evidence that there is some protection from low productivity firms in Colombia. In fact, Colombia has high levels of effective protection. In relative terms, Colombia has the highest average tariff level in Latin America.

Figure 3: Colombia's Tariffs in Latin America



Colombia also faces obstacles in domestic and trade development which relate to high freight costs. This reduces competition and maintains inefficient focus points. The cost for exporting a container is approximately USD\$1800 per container, only lower than Venezuela and significantly higher than most countries in the region. In Mexico the cost is USD\$1400, Argentina and Chile USD\$1200 and Chile USD\$700. The regulatory cost is the highest, reaching USD\$350 per container and the internal transportation cost is the highest in South America with USD\$900 compared to Brazil (USD\$500) and Chile (USD\$250). There is also evidence that enterprises with the greatest potential for growth are still very scarce. Experts in venture capital networks and angel investor networks indicate that the deal flow is still very low in Colombia (Prieto, 2011).

With this, we can conclude that the net entry of companies makes a modest contribution in increasing productivity in the manufacturing sector. The industry has low relative labor productivity levels in relation to other sectors and wide intra-sector dispersion. The increase in competition, generated by a liberalization process, simultaneously reduces distortions in the labor market and improves quality and regulations of transportation infrastructure, may develop a positive effect on productivity and growth over the medium term. However, to avoid rapid exhaustion of the benefits of structural change, it is important to assist this process with the formulation and implementation of a strategy of innovation and human capital investment that allows exploiting resources of mining rents and generate leader clusters in dynamic sectors through knowledge.

2.1.4 Productive Diversification and Structural Change

Colombia has a low level of export sophistication. The following Figure (4) shows how the export sophistication anticipates future growth of countries.

Hausman (2007) suggests that industries with higher value-added require development of capabilities that natural resource sectors normally do not generate in economy. He uses Euclidean metric to measure the distance between productive sectors which indicate the ease with which an economy can jump from the production of

specific goods to others. This system is based on the history of the production evolution in the world. The predictive capability of this methodology is questionable as it does not consider the service sector, which has enormous importance in today's hyper connectivity economy and does not consider that past development patterns that tended to be dramatically altered by new technological developments.

Figure 4: Export sophistications and the consequent growth.

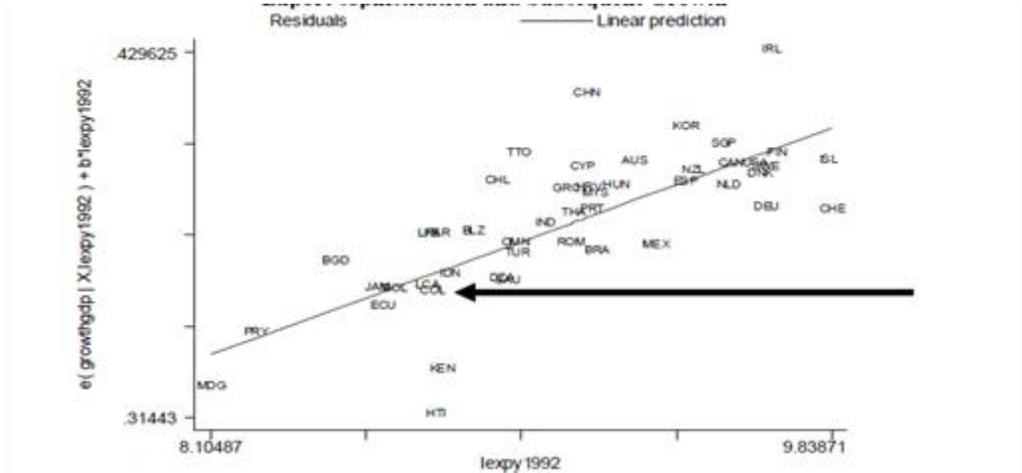
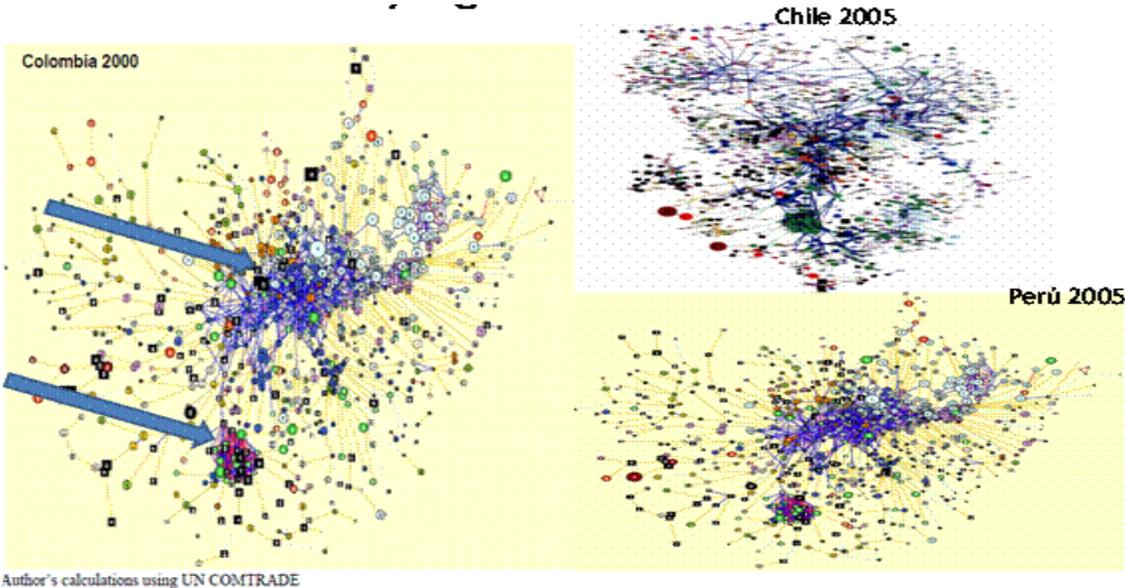


Figure 5: Production in Colombia, Chile and Peru



Natural resource clusters may develop highly intensive sectors in high transverse technology applications such as biotechnology, ICT, mechatronics and nanotechnology.

These innovation dynamics were not available twenty or thirty years ago. However, Hausman's figure is used to present and compare Colombia's production structure over time and with other countries. Until the year 2000, Colombia had maintained a stable production structure for 20 years unlike other countries in the nearby region which tended to focus on natural resources.

On the other hand; when compared with Chile, it shows greater participation in the manufacturing sector. This is explained by the presence of light manufactures, clothing and textiles. These industries have maintained themselves due to greater protectionism by the Colombian economy and the size of the domestic market.

In reference to services, Colombia has not developed the export of services unlike Chile. Chile has almost 9 times the level of export services per capita that Colombia has. In the trade development dynamic during the information era, the growth of exports services is an important factor. That is why factors that could affect the export potential of services in Colombia, must be analyzed.

The current complementary relationship between Colombia and China, with an important boost in the mining and energy sector, propels a dynamic increase of the economy in the short term; creates the risk of Dutch disease and the suffering of a regression in terms of productive diversification. In this context, a special effort should be made to develop the national innovation system. At the same time, a targeted strategy should be created to develop activities with higher added value, growth potential and skilled human capital content that will generate the basis for diversified growth.

One possible approach; although not the only one, is to use natural resource sectors with comparative advantages that are initially enclaves and are weakly connected to the local economy and develop clusters with particular emphasis on the development of derived demands with technologic content and services with high quality human capital content. The creation of innovation dynamics related to world class sectors, may

eventually generate a positive transformation for highly intensive sectors in technology and knowledge.

2.2 Diagnosis of the National Innovation System

An attribute that eloquently depicts the development of institutional support for innovation in Colombia, is the availability of a series of detailed statistics on investments in Science, Technology and Innovation during 2000-2001. This situation is rather extraordinary in Latin America.

The National Science and Technology System in Colombia is well known for being structured around a stronger institutional and regulated principle in the Andean region and for being above the average level compared to Latin American countries². This institutionalism establishes strategic coordination methods and; on the other hand, it establishes institutions responsible for the execution of policies and the implementation of tools to support other players in the system (universities, I+DT Centers, Companies and Entrepreneurs).

However, the evidence of national investment in I+D (0.16% of GDP in 2010), as well as the broader concept of ACTI³ (0.41% of GDP in 2010)⁴ placed the country below Latin American average and also lower than its income level per capita prediction. It is at a considerable distance from advanced economy levels, especially from rapidly developing countries.

According to estimates done by the Colombian Observatory of Science and Technology (OC&T), 58.1% of I+D expenses in 2010 correspond to an investment financed by public entities, 36.3% to an investment financed by private entities and the remaining 5.6% to international bodies. Additionally, in the successive surveys of Innovation and

² See: Penfold, Michael (CAF, 2009)

³ Science, Technology and Innovation Activities.

⁴Source: Indicadores de Ciencia y Tecnología, Colombia, 2010, OCyT

Technological Development I(1996), II(2005) and III(2008)⁵ low levels of innovation are seen in the level of processes and products by Colombian companies.

2.2.1 CIENCE AND TECHNOLOGY (CT+I) STRATEGIC LEVEL INSTITUTIONALISM

In strategic direction functions, coordination and policy implementation, the 1286 Law of 2009 provided the creation of three levels oriented to ensure the consolidation of the CT+I system on a national level. The National Council of Science and Technology was replaced by the Advisory Council for Science, Technology and Innovation. Then, the Tax Incentive Council and the Francisco Jose de Caldas Fund were created on a policy execution level.

The CT+I Advisory Council is an authority involved in the public sector (several Departments), private sector, leading academics nominated by the President of the Republic and two prominent members of the scientific community at a sub regional level. The Council holds meetings three or four times a year, during which, Colciencias hosts and organizes the council. Its role is to advise, and as such, it defines guidelines; strategic challenges and opportunities relevant for CT+I Colombian system; relevant material used in Colciencias tasks and coordination requirements between actors and initiatives.

The Tax Incentive Council is an independent tripartite collegiate body of *Colciencias*, Hacienda and the **DNP**. As its name suggests, it resolves the application approvals to obtain incentives or tax credits on CT+I, according to the current legislation. Finally the Caldas Fund is a Trust Fund administered by a private funding institution authorized to integrate public and private supply sources and optimize mobilization to finance diverse programs and initiatives to promote research, development and innovation, including the ability to establish or contribute to venture capital funds during an early stage for innovative enterprises.

⁵ See: Colciencias, OCyT, y varias Universidades (2009), y Salazar, J.C. DNP (2007).

An aspect of strategic management that requires attention in the design and governance is the need for mayor convergence or the strengthening of explicit and periodical communication channels between the CT+I Advisory Council and the National Competitiveness Council. The latter is a public-private authority organized and managed by the President of the Republic. Although the levels of government representatives and; to some extent, the levels of private bodies that participate in both authorities have important levels of overlapping and duplicity, both authorities work separately and do not have permanent communication channels. This does not guarantee the necessary integration of the visions and strategies that should guide innovation and competitiveness policies closely linked and interdependent. A first step towards this direction is to have a single High Presidency Council for both issues.

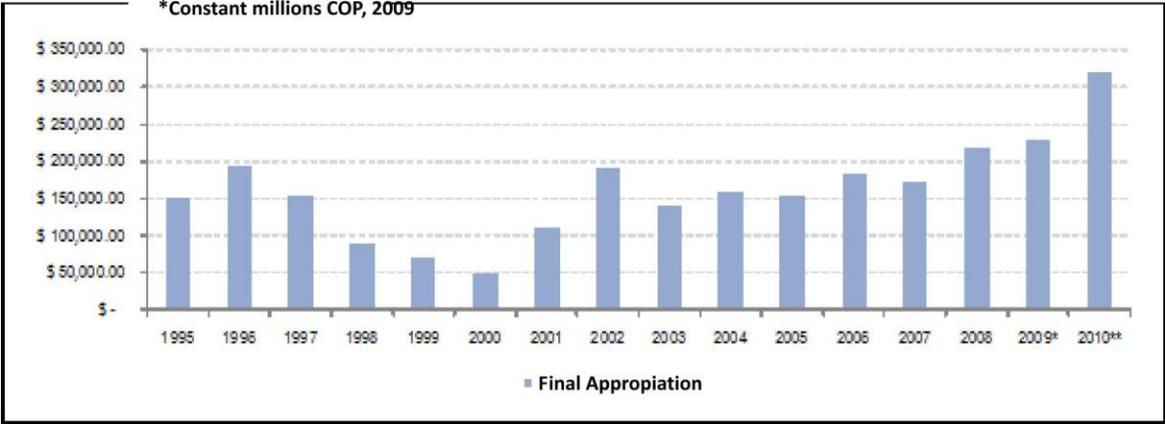
In the sub-national level, the Regional Commissions or Departmental Councils of Science and Technology continue operating. Evaluations of its own public sector (Colciencias, 2008; CONPES, 2009), agree that these entities had not successfully achieved their goals until 2009, specifically in the case of the C&T Departmental Councils. These entities operate unevenly between regions, and internally, it can be observed that the degree of participation levels of different actors is also very irregular. There is clear overlapping of functions and composition within these Councils, the Regional Competitiveness Commissions (CRCs) and the University-Industry-State Councils (CUEEs), especially in those departments where these three entities of animation and strategic coordination coexist.

2.2.2 Level of Design, Decision and Coordination of Innovation Policies

In terms of policy implementing institutions, one of the most important changes introduced by the 1286 Law in the CT+I institutional System, was the institutional reconfiguration of Colciencias as an Administrative Department, assuming a leading role in the sector and joining the Council of Ministers and the CONPES in accordance with its reinforced mission and legal mandate.

However, at this level, it can be observed that at least two problems need to be solved. The first problem is that the 1286 Law maintains former executive and operational responsibilities of Colciencias, limiting the necessary perspective to fully assume its quality leadership of **CT+I** policies and, additionally hampering the work of check and balance which Colciencias must seek to maintain with its new role. The second problem is that Colombian institutionalism, on both strategic and political levels; as well as in executing agencies, tends to bring more innovation towards science and technology than to innovation, development and competitiveness. This is not just a matter of form, as it has consequences in institutionalism and effectiveness of policies and support tools towards innovative efforts exerted by firms. Previous studies indicate that “the current incentive supply does not lead to the accumulation and consolidation of business skills for innovation (Echeverry, 2009).

Figure 11: Colciencias Budget evolution (Col\$ 2009 constant)



Source: Colciencias(2010). Includes third party transfers.

In any case, the main government institution in innovation matters in Colombia is Colciencias. Figure 11 illustrates the operating budget evolution of Colciencias in recent years, including transfers from other sources such as resources corresponding to Law 344 transferred from the SENA.

The growth *Colciencias* experienced starting from 2007, in terms of final budget disposition, does not translate into similar expansion in its different support options.

On the contrary, the strong budgetary pressure induced by scholarship programs for post graduate students in Colombia and abroad (Training for the Bicentennial), has led the institution to exhaust different financing options. Table 2 shows evolution seen in the last 4 years on the baseline budget suggested by Colciencias

Table 2: Colciencias Suggested investment budget evolution, selected options

Support Options	2007	2008	2009	2010
PhD Training Coverage (Number of new Fellowships Awarded per year)	145	187	331	453
Health Research Fund Contributions (Million COP \$)	50.000	45.000	40.000	40.000
Contribution to SNCTI capabilities (Million COP \$)	80.000	55.000	55.200	7.770
SNCTI Management (Million COP \$)	20.568	16.455	9.948	5.000
Innovation and Development Production Support* (Million COP \$)	300.000	150.000	12.587	1.000
*: Prior to the SENA resource transfer				

Source: DGOP Colciencias, 2010

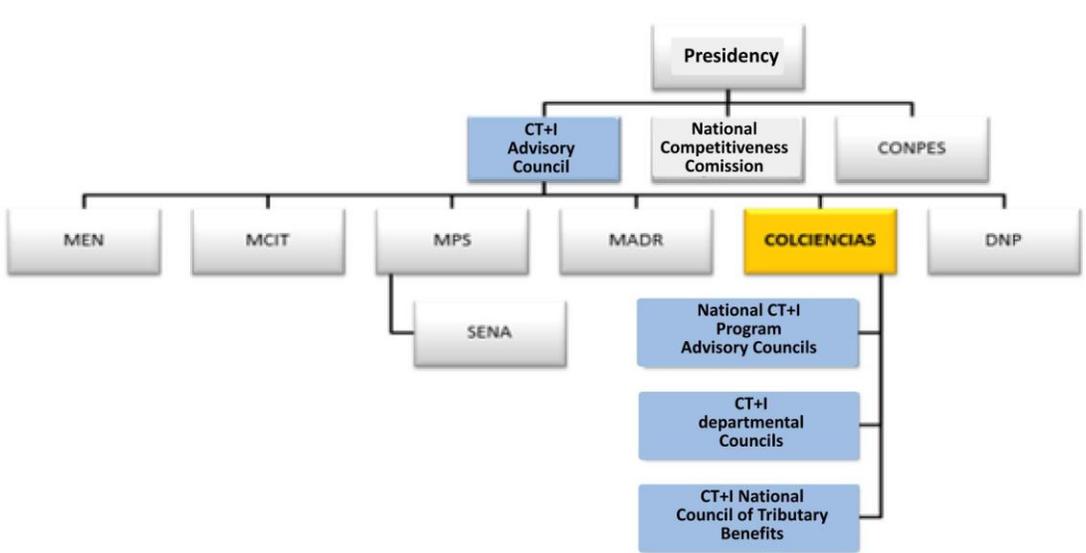
Financing levels provided by aid programs that support research in Colciencias in 2010, show an extreme underfunding situation which is inconsistent with the ongoing financing of more doctorate programs. University environment receives the message that there is no prospect in pursuing an academic career that combines teaching with research. New doctors do not receive an encouraging sign when returning, which increases the probability of human capital migrating from Colombia.

There are other public institutions that also play an important role, in offering a range of tools, support programs and resources to finance **CT+I** activities relevant to the productive sector. This includes Ministries such as the National Learning Service (SENA), the Colombian Fund for Modernization and Technological Development of

Micro, Small and Medium Enterprises (FOMIPYME) under the Ministry of Commerce, Industry and Tourism and Ministry of Agriculture. There are also other Public Law entities such as Bancoldex and the National Guarantee Fund that carry out complementary but relevant roles associated with granting financing options for innovative enterprises. It should be mentioned that in terms of specific portfolios like Defense and Telecommunications, there are funds or initiatives aimed at developing or technological transferring with potential capacity for the productive sector.

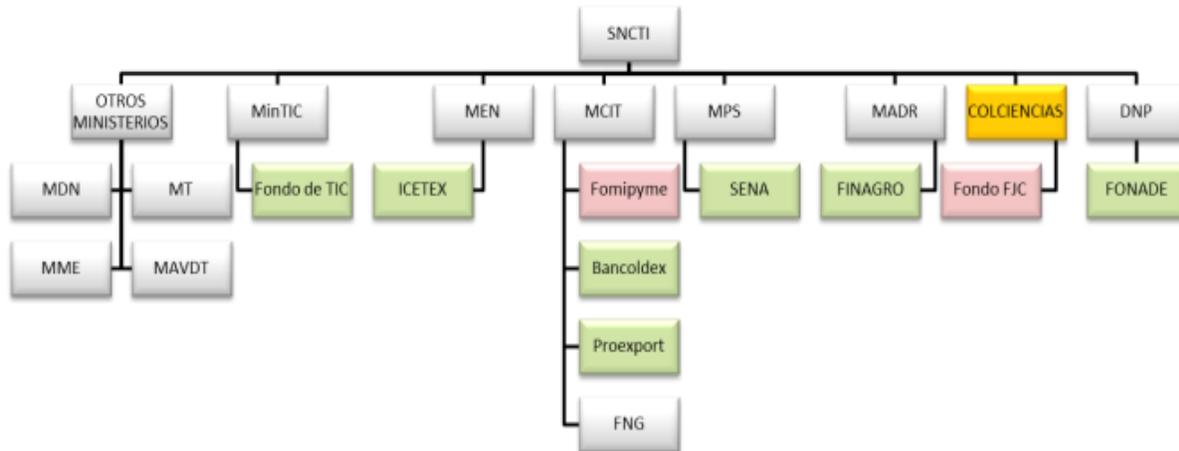
Figure 1 schematically shows the actual structure of political articulation of public institutions for innovation. Meanwhile, Figure 2 schematically shows current institutions and mechanisms to execute CT+I policies in Colombia. Most mechanisms shown, finance CT+I projects and initiatives superficially. In fact, the only mechanisms dedicated to CT+I are Colciencias, the recently created Francisco Jose de Caldas Fund and, partially, the SENA by anticipating resources for technological and productive development by the 344 Law (including the Entrepreneurship Fund administered by FONADE).

Figure 1: Current Political Articulation of CT+I Institutionalism



Source: DNP

Figure 2: CT+I Policy Implementation Agencies and Mechanisms

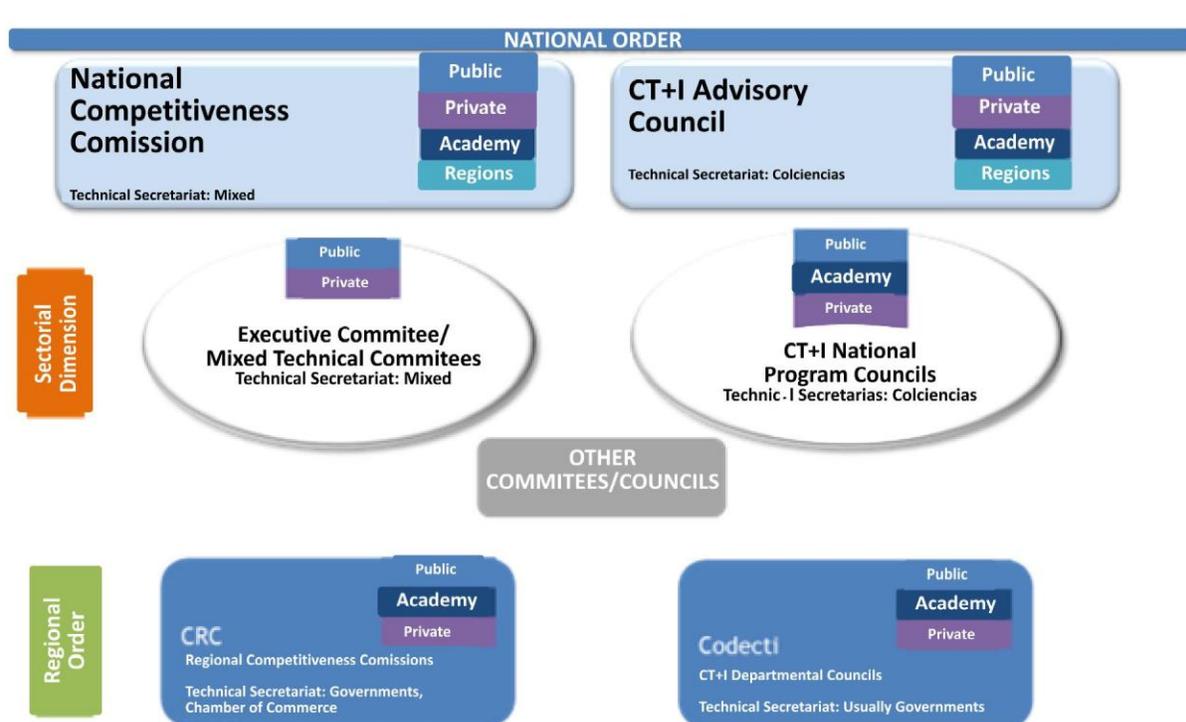


Source: DNP

The innovation program proposed by SENA is particularly worrying. This institution is required, by law, to allocate 20% of their income to innovation. This equates USD\$300 million; of which, until 2010, a 25% was destined to Colciencias. Starting from 2011, SENA is not obliged to do so. Resources maintained by SENA are assigned to a savings capital (Entrepreneurship Fund) and to different programs that strengthen technologic capacities in the SME environment.

In regard to the political articulation in a sub national level, an overlap of national policies for competitiveness and CT+I can be observed. Figure 3 shows the current institutional composition.

Figure 3: Articulation of National and Regional Politics, Competitiveness and CT+I



Source: Agreement for Prosperity, Table 5, Medellín 2011

The proliferation of public-private coordination entities, in areas with significant interface such as Science, Technology, Innovation and Competitiveness, in addition to University-Industry-State (CUEE) Councils. All of these share the same private actors which reduce the efficiency of these public-private dialogue mechanisms. Our vision is to move forward and become a meso level with strong public-private articulation on a national and departmental level of competitiveness and innovation. This is specially relevant given the importance of coordination flaws in emergency processes of new emerging sectors of rapid growth.

2.2.3 Diagnosis Summary of National Innovation System and CT+I Institutional Support

Although its development is undeniable on political articulation and execution mechanisms, the institutional support system for the innovation in Colombia faces obstacles and raises questions that must be resolved within a nation strategy of

innovation and competitiveness. The following is a summary of the main diagnostic elements for this dimension:

- There is no clear differentiation or complementarity of roles between institutionalism from competitiveness and innovation. This results in possible duplicity in a strategic level with overlapping agendas and tends to generate higher coordinations costs between actors, even within central-level public institutions.
- The sub national entities (Department and major municipalities) amplify this dispersion with redundant spaces of public-private coordination and is weak towards operational capacities (aside from exceptional cases such as Antioquia and, to some extent, Atlántico).
- The policital decision-making level coexists with the execution level within the same institutions (Colciencias, Ministry of Trade). This hampers the proper check and balance of policies, and weakens the monitoring of the latter provided by entities responsible for its formulation because they are responsible for their operation (agency problem).
- Gaps in priority areas (dynamic entrepreneurship, innovation in business) are detected as well as fragmentation and overlapping of functions.
- There are no execution capacities in most regions, which weakens the decentralization process. There is no decentralized execution capacity at agency level.
- Budget growth in recent years has not been accompanied by operational platform strengthening and management capabilities of support options.

- There is an excessive dispersion of programs with small budget (this means excessive use of meeting organization mechanism, which generates important transaction costs with higher risk of low continuation of meetings in the future. This restrains the sustainability of efforts and capacities.)
- Establishing the issue of royalties is an opportunity to mend articulation relationships between national and sub-national levels. Moreover, it may also risk (i) aggravating the fragmentation and duplicity of entities and functions and (ii) destroying advances in social capital reached by the Regional Commissions of Competitiveness and in some cases by the University-Industry-State Councils (CUEEs).

3. Innovation Strategy Recommendations

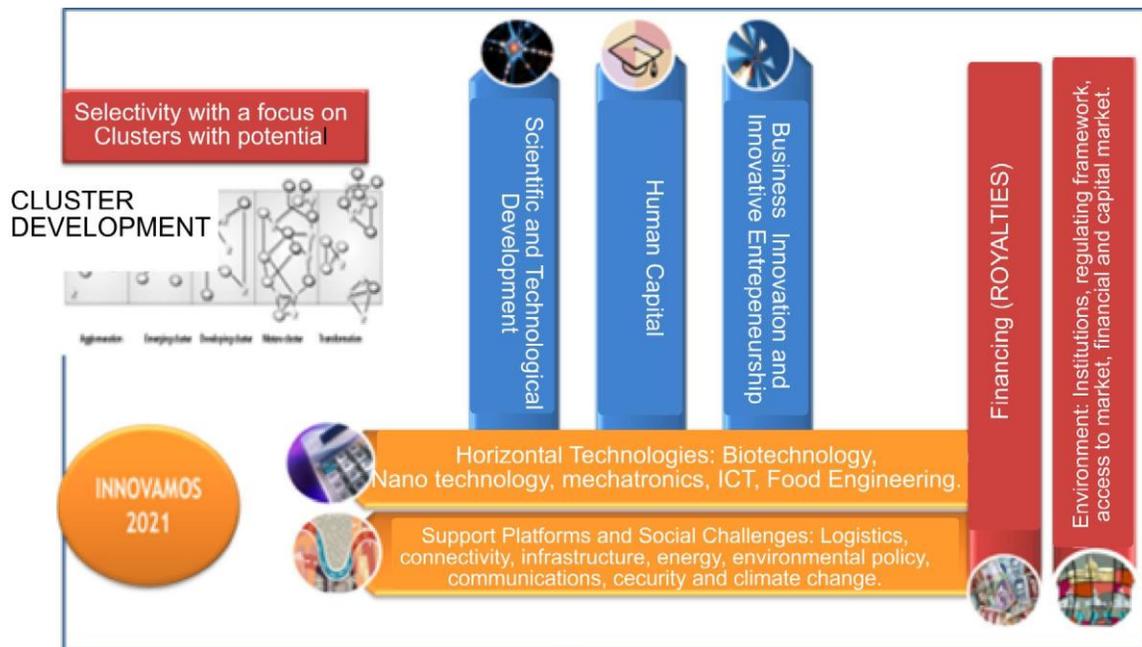
Colombia's innovation strategy should combine the integration of a selective set of initiatives destined to develop the National Innovation System and make an effort that allows linking the **SNI** with specific sectors and clusters on national and regional levels, in order to solve coordination flaws that prevent the development of high potential dynamic activities. It is also essential creating conditions to induce synergy between the **SNI** components.

In Figure 4 the strategy is outlined. The **SNI** development must strengthen three fundamental pillars: Quality Human Capital at a different level, Technical and Advanced Human Capital; business innovation and innovative entrepreneurship manifested through a critical group of companies with innovation routines and a dissemination dynamic of better management practices and an ecosystem that encourages innovation. Finally, the development of Scientific and Technological capacity which is important in able to approach the challenges of productive, economic and social development in Colombia. These three pillars require key enabling platforms and social challenges for the development of innovative businesses in Colombia. Among the

enabling, it should be considered, that there are certain factors that limit the dynamic development, logistics, telecommunication gaps and broad band.

The pillars that support the strategy are: (i) scientific and technological development, (ii) human capital, (iii) business innovation and innovative entrepreneurship and (iv) selective strategies that are analyzed focused on high competitive potential clusters.

Figure 4: National Innovation Strategy in Colombia



3.1 Scientific and Technological Development

The formulation and execution of a National Innovation and Competitiveness Strategy seeks to create conditions so the Colombian economy in the near future, may make a change and decisively move towards an economy based on knowledge, innovation and quality human capital. This enforces the need to promote scientific and technological development as a priority.

Establishing it as a priority, the country must increase its expense on **I+D** and advanced human capital formation; decisively promote excellent scientific research with network links and realign incentives for academic careers.

A fundamental condition of the Scientific and Technological model is that the country must direct its efforts towards the production field. This involves building a consistent set of **I+D** incentives, directed to strengthen the academic-business relationship as well as the strengthening of **I+DT** Institute System.

The starting point is far from the anticipated progress level for Colombia, according to its current level of income per capita, as mentioned in section 2.3., it has:

- Low effort investment volume in **I+D** (0.16% of the GDP in 2010)
- Effort fragmentation and scientific capacities (up to 2010, Colciencias recognized 4,075 registered research groups; of which, 491 scored in categories A and A1 in Colciencias)
- Low number of doctorates in National Superior Education Institutions (In 2010, 152 Doctors received their degree; of whom, 89 graduated in Science and Engineering fields).
- Emerging progress and potential development of the University-Industry collaborative effort. Colombia stays behind Argentina, Costa Rica, Uruguay, Brasil, Panama and Chile in business cooperation for innovation. (OECD, 2009).
- Poor scientific performance indicators (Colombia stands 12th in **ALC** in publications indexed per capita, and 18th in citations per indexed publication (OECD,2008)).
- Academic underfunding in research programs: USD\$1,300 per active researcher; compared to Mexico: USD\$13,000 per active researcher; and Chile: USD\$40,000 per active researcher. (Source:Colciencias, CONAYCT and Conict respectively).

- Insufficient effort to support collaborative scientific research and insufficiently linked to excellency levels and former trajectory of former research groups. Existing excellence centers are only available in very specific fields of Science and Technology.
- Currently, there is a serious budget inconsistency between doctorate program support, resource provision and academic degree development program.
- The country lacks an effective policy of formulation and maintenance of capabilities in I+DT
- There is no systematic effort to identify scientific and technological demands from strategic choices (roadmapping)

The above recommendations for the strengthening of the scientific and technological subsystem can be structured in;

- (i) Political elements
- (ii) Institutional and governance aspects

i) Political Elements:

- Significantly increase I+D national efforts
 - Conditions should be created and measured adopted in order for the I+D national expense to increase steadily, reaching 1% of the product in 2021. This implies a sustained aid by the public sector, which will be relevantly supported if the resources coming from royalties are destined for the investment of science and technology. There is a bigger challenge in terms of generating conditions capacity, incentives and institutional support to raise and maintain I+D expenses of companies and the private sector in general.
- Strengthen Academic Career and Excellence Scientific Research:

- Guarantee the sustainability of effort input in research through a multi-annual budget planning meeting for recovery contingency programs in *Colciencia*. This program is the basis that generates a belief that is possible to pursue an academic career in Colombia, where excellence is awarded with research resources. This is the base of the pyramid; therefore, it is necessary to reverse the current underfunding situation of the program. In 2011, total financing of this program will not exceed USD\$5 million. In the past it amounted up to USD\$20 million. This fluctuation is inexplicable. Financing should be increased, in a two year period, up to USD\$50 million per year. Of the 15,000 academics, of which, 20% are dedicated to research, generate a financial aid of USD\$15,000. The ideal is to reach an amount of USD\$15,000 per year for 40% of the academics.
- Strengthen the insertion and academic commencement program, promoting its association with building strategies of postgraduate and doctorate national programs. Two programs should be structured: one for post doctorate fellowship funding with a minimum aid of USD\$25,000 per year for two to three year periods and contests for the Contingent Recovery Program aimed for young researchers with financial aid of up to USD\$25mil per year for two year periods. This program should start with at least USD \$10 million per year to be able to increase in subsequent years when doctorate graduates return.
- Mission oriented synchronization of scientific and I+D program budgets with increasing coverage of doctorate program fellowship. When the doctorate graduates return and national programs expand, it is necessary to increase the number of programs that were originally proposed which is now bigger than the anticipated budget for 2011.

- Encourage oriented mission scientific research and collaborative I+D:
 - Collaborative research programs increase scientific productivity and facilitate multidisciplinary research, which can stimulate solving complex problems of great relevance for the Colombian society. *Colciencias* must have a gradual scheme of increasing funding from collaborative groups to excellence centers. These centers must use Basal Financing Systems in long periods of up to 10 years with intermediate evaluations. The selection criteria should include a trajectory of collaborative work with measurable results, academic excellence in scientific teams, relevance and impact on the Colombian economy. Specifically, we propose the following:
 - Ensure continuity and extension of the co financing *Colciencias* program for I+D project between Universities or I+DT centers and companies.
 - Structure medium-sized associative scientific programs by mission.
 - Develop infrastructure and major scientific equipment programs that incorporate shared scheme services.
 - Promote the establishment of technological consortia that associate I+D capacities in Universities or Institutes with innovation and productive industry development challenges and opportunities, following the CRC model in Australia.

- Support the consolidation of Excellence Centers with basal financing as a second consortia stage of successful associative programs.
- Enhance the Economic and Social aspects of Science:
 - Support the establishment of protection offices and technology commercialization throughout associative funding. Following the example of consorted Technological Transfer Offices (TTO) like Uniquest in Australia and Ontario in Canada, with a clear definition of a common policy on intellectual property in participating Universities.
 - With the support of the TTO, promote technological packaging and generation of spin offs from the results obtained in scientific development investigation.
 - On **PI** and patents, Colciencias should seek to expand coverage and move to an open window, stimulating when obtaining provisional US patents.
 - Improve and expand vocational and scientific spreading programs such as trends and young researchers.

ii) Institutional and Governance Issues

- At a strategic level, it is suggested to maintain Science and Technology Advisory Council as a superior inter institutional entity, strengthening its member's integration in the Innovation and Competitiveness National Council (see section 5).
- At the policies level, it is essential to reinforce Colciencias, trying to separate design functions from operational platform policies and it can be

structured around the Francisco Jose de Caldas Fund. Colciencias must separate several functions such as the normative, strategic and the administration and execution of programs. It must employ an executive secretary in a separate Colciencias directive, managed by the Colciencias director but including representatives from other bodies and well known prestige external individuals in science and technology.

- *Colciencias* should primarily focus on strengthening the scientific and technological competency of the country and the human capital. To attain this, the main decisive factors are excellence, relevance and the impact in the Colombian society. Within this context, it should develop an strategy to emphasize the *third mission* of Universities) providing the human capital in addition to relevant and quality research.
- - *Colciencias* contribution to innovation should be based on demanding that Universities link national post-graduate programs with the creation of research besides encouraging the development of intellectual property policies in Universities, motivating the protection of intellectual property and also creating platforms for technology transfer and commercialization of associative character. The U.S. Model, initiated with the Bay Dole Act, and the creation of the TTO (Technology Transfer Office) could be adapted to the needs of Colombia like it has been done in Canada and Australia.
- Colciencias should also help, in coordination with the Governing Innovation and competitiveness Committee, create a National System of I +DT institutes, with a program of Basal Financing and unemployment contracts (including sector public Institutes). The institutes can play an important role provisioning public goods for innovation and can serve as a bridge between the University and enterprises. The Creation of prototypes and pilots are crucial in the stimulation of University research *spin off*.

Also, the Institutes can play a role disseminating technological packages to SMEs in various sectors.

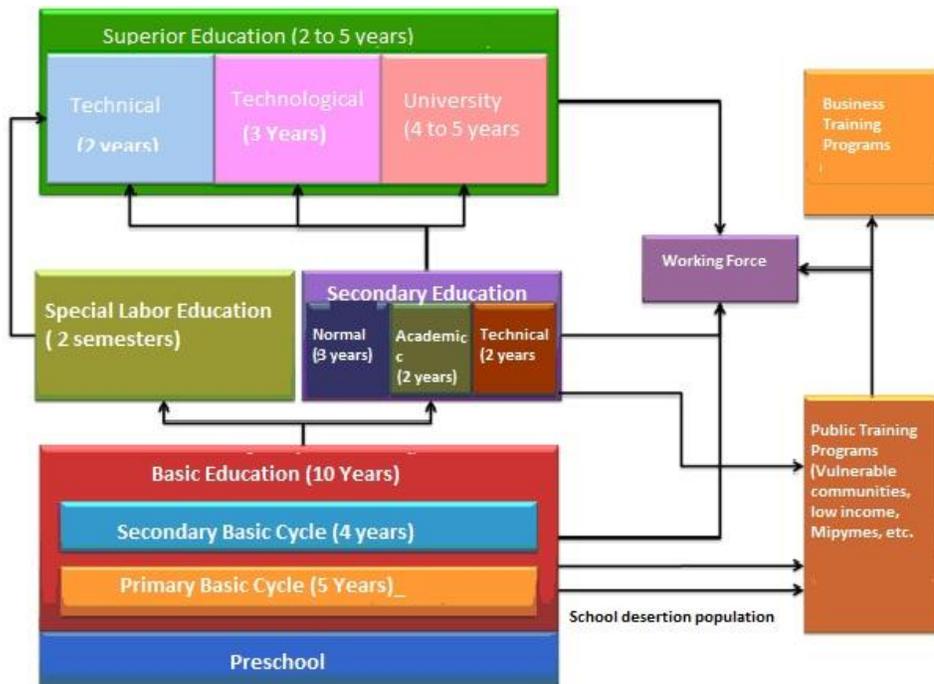
- It should be required an accuracy of the mission of every I+DT institute in relation to the production of public goods for innovation, the regulation, development and technological packaging, the promotion of *spin offs* or the diffusion and technological extensionism. The financing scheme depends on the kind of strategic orientation of each institute. An Institute that basically creates public goods should have a higher level of secure financing. A Technological institute that is oriented towards the technological development and the diffusion of such technology, in an ample way and through *spin offs*, should have a financing scheme divided into three thirds: One third for basal financing, for the creation and maintenance of capacities: another third for I+D programs cofinanced by the Government and companies, for ample technology diffusion programs, financed primarily by the Government, and clusters of associate companies; the last third for technological services for the private sectors and contacts of regional I+D with the private sector.
- To destine royalty payments to finance the capacities of the I+DT regional institutes. To promote the three thirds financing model with a greater Basal component for institutes whose mission focuses in activities of public goods.
- To establish systems of independent and continuing evaluation that takes into account the regular formation of international peer review committees, and impact evaluation that complies with international best practices

3.2. Quality Human Capital

Quality human capital is an extremely important feature in the advancement towards the development of a more diversified and knowledge based economy. The WEF Competitiveness index ranks Colombia in the 79th position in health and basic education and in the 69th position in instruction and higher education, out of a universe of 139 countries, which could be considered a modest accomplishment. However, in Latin America very few countries are better positioned in both values; these are, Uruguay, México, Costa Rica, Chile y Argentina, which has a better per capita income.

Figure 5 shows the structure of the Colombian Educational system. The system contemplates 10 years of basic Education, including a preschool year. Then, the Educacion Media (Secondary Education) offers an option of technical training in two years, academic education in two years and elementary school teacher training (Normal) in three years. The Tertiary education involves one year specializations, two years for technical training, three years for technological and 4 to 5 years at the college or university education level depending on the career choice. In the last 20 years there has been an important development of a more ample offer of Magister and Doctoral programs: around 400 programs with 25 thousand students enrolled for the year 2010

Figure 5: Structure of the Colombian Education System



The coverage of basic education in Colombia is at least 10 percentage points less than the region average. The coverage of secondary Education (Educacion Media) and years of schooling is also considerably below the average of the region. However, in the last decade, an important effort to increase the coverage of basic and secondary education has been made, which coincides with a relative recuperation of the economy in relation to the last two preceding decades, and a decrease of violence, which has allowed strengthening the governmental basic services throughout the territory.

In relation to the quality of education, Colombia is compared with other countries using the **PISA** test. Colombia scores both in Science and Reading around 400 points below Brasil, Uruguay, Mexico and Chile. This last country obtains in both tests a 10% of greater compliance. The advancement of Colombian during the years 2006 and 2009 in reading and writing is very modest. The totality of Latin American countries is far from the OCDE average which is approximately 500 points. The coverage of Tertiary education, as in the majority of the Latin American Countries, displays a vertiginous

increase in the last decade. Between 2002 -2010 it increased from 24,4% to 37%, however there is a high level of desertion, around 45%.

One of the problems of Higher Education in Colombia is that, as in the rest of Latin-American countries, it presents an inverted pyramid, with around 70% of the student population in University level education and only 30 % in the technical and technological education. This situation stands out against the tendency observed in various OCDE countries, especially those from the European continent, in which the technical formation reaches up to 70% of the tuition. On the other hand, the desertion rates above 40% are extremely high, which implies important social costs as there is not an modulated structure that allows students to obtain intermediate degrees, which generates frustration among the student population who cannot obtain any type of title or diploma after investing several years on Tertiary education.

An analysis of the education expense in Colombia, reveals that it spends 6% of the GPD, which 4% corresponds to the public Sector and 2% to the private sector. This level is higher than Chile and various OCDE countries such as Corea, Australia and Canada among others. However, it is important to compare the expense with the per Capita GDP percentage of the school age population.

Colombia has an indicator of 15% - which is somewhat above the expected level according to per capita income- an indicator higher than Chile, that has a greater per capita income and very close to Corea that doubles the per capita income of Colombia. In conclusion, we can affirm that the relatively low human capital performance obtained in Colombia, despite the reasonable social expense in education, is reasonable for the per capita income of the country. The above demands the need of a profound education expense efficiency evaluation in Colombia.

3.2.1. Objectives and Goals in Respect of Human Capital for Innovation.

The aim of public policy on human capital for innovation is to move forward on "Shaping

a quality and accessible learning system throughout life, that will allow Colombia to count with the human capital that demands a more diversified economy, inserted in the global economy and strongly based on knowledge and technology." Learning throughout life is essential and individuals should have the possibility to go from education to work and return to the field of training; moreover, learning and acquiring skills on the job should be recognized to ensure mobility and to efficiently close the competency gaps identified through training, at different the stages of the working life.

3.2.1.1. To strengthen the base of the Pyramid

The first objective to advance the knowledge economy is to strengthen the base of the pyramid: dramatically increasing the coverage of secondary education and improving the basic skills of those who attain this level of education is essential. In this context, secondary level technical education, should be maintained only in cases of connections with institutions that ensure its relevance.

Colombia has a unique institution in the field of education and training known as SENA, which is financed with a para-fiscal scheme derived from companies that generate formal employment. The budget of the institution is about 0.7% of GDP and is financed by a payroll tax. The SENA law establishes that 20% of revenues should be destined to invest in innovation activities, the remaining 80% in vocational training activities. The main activity of the institution is conducting continuous short term information, orientation and training programs for the job. These programs are generally free of charge and are aimed primarily at people with incomplete secondary education or even incomplete basic education. On the other hand, with the innovation resources the institution invests heavily in high-cost equipment, used in training programs and preparation for the jobs.

The increased coverage of secondary education in the coming years will reduce the demand for open training programs, like those currently performed by the institution. In this context, it is necessary to plan the reorientation of the SENA in order to fulfill an

important role in the development of the human capital strategy of the country. The possible reorientation of SENA we will be discussed later on this paper.

3.2.1.2. Skills Certification System.

The first stage of the development of this system, involves rising and validating working competencies or skills of the main occupations in key sectors. This process is currently being developed with the momentum of the SENA, which in the future can continue to play an important role as in the technical development of the country. Once the skills have been validated there are three directions: i) To offer those competencies for vocational and technical training and adapt the curriculum accordingly; ii) To develop capability of skills certification programs and to structure programs for closing skill gaps in key sectors or clusters that need to be e privileged, and iii) to develop accreditation schemes to the training supply.

3.2.1.3. National Qualifications Framework System

The qualifications framework is crucial to establish higher education and secondary vocational training and Tertiary education. The important thing is that it should draw upon the competency standards, incorporating aspects of generic skills that are specific to training programs. The main objective for developing a national qualifications framework is to support the development of a quality training offer that is standardized, relevant and responsive to changing needs on demand.

Colombia has set the goal of developing a qualifications framework as a system of quality assurance for the excellence of training. whic demands a proper linkage between the National Qualifications Framework and the Certification system of job competencies. Furthermore, affiliation with the development of prospective capacity in human resources, becomes an important issue to feed the formative demand and supply offerings.

3.2.1.4. Horizontal and vertical articulation in higher education systems

The horizontal and vertical articulation of the training system is crucial for establishing an effective system of learning throughout life. This requires the modulation of the educational formation and in order for this to happen, a major effort to standardize training based on competencies is needed. In Colombia, the Ministry of Education should encourage this initiative, but in coordination with the Competencies System.

A key area that needs to be addressed is the articulation between the secondary level, the secondary technical education, the higher technical education and the university education levels. At the Tertiary level it is essential to reduce the duration of the careers to allow the development of post graduate degrees. Additionally, advancement in this subject, allows an international articulation so that Colombia can attract the Colombians that have left their homeland back to the country.

.2.1.5. Information systems and labor intermediation system

To make advancements towards the implementation of a labor competencies system, that standardizes occupations, facilitates collecting information on the labor market, developing foresight skills, obtaining specific market information related to occupation and levels of qualifications over employment and remuneration rate. Job intermediation systems, which operate on the basis of certified occupations, based on competencies, need to be promoted. At the present time, SENA executes labor intermediation activities. Ideally, such effort, should match up the guidelines of the future Ministry of Labor and it could be structured in collaboration with business associations and local governments, linking the system to the users. SENA can constitute an important factor in the labor intermediation system.

3.2.1.6. Ensure quality and relevance of higher education

In brief, the fundamental objective is to ensure the quality and relevance of higher education. This requires strengthening the system of quality accreditation of higher education, differentiating the parameters of technical and university level education.

Likewise, a qualifications framework to clearly differentiate vocational training and university education needs to be developed, The Accreditation of Universtiy Careers must be in concordance with international standards. The accreditation of vocational training institutes should be certified according to the adapted qualifications framework curriculum. Public financing systems should be tied to performance (accreditation), and finally, an information system on graduates, unemployment rates, salaries earned depending on number of years after graduation and institutions offering jobs should be implemented.

3.2.1.7. The SENA Reform

As stated above, SENA carries out different important functions. A single institution in charge of developing such strategies directly, based on para-fiscal funding, becomes an exceptional example among middle-income countries. However, a sole institution of this size, with independent funding, runs the risk of becoming political loot. This is why it is essential to reform and reorganize its role to become a major player in the politics of the country's human capital.

The core elements for the reform proposal are briefly exposed here:

- SENA should tend to operate as a *holding* company with its Centers of Vocational and Technical training and related Technical Institutes, allowing more autonomy and increased administrative independence to integrate co-sponsorships.
- Serve as technical secretariat for the development of a system - national framework for job skills, under the future Ministry of Labor.
- Establish a system of scholarships for technical and technological education aimed to students from vulnerable socio-economic sectors (up to the third quintile).

-Create a "Curriculum Development Center" in order to develop and promote the continuous updating and relevance of the methodologies, techniques, materials and learning environment.

-Generate a web-based system for intermediation and job placement.

3.2.1.8. Synchronize the growth of the doctoral fellowships Program coverage with the absorption capacity of the SIN

There is now a dramatic imbalance between the resources to fund research and doctoral training efforts, which makes the reinsertion of a high proportion of PhD graduates impractical, and stimulates the emigration or *not returning home* of the future PhD graduates. It is essential to develop a post doctoral program and an academic career initiation research, along with the generation of a resource base for academic research.

3.2.1.11. To facilitate the mechanism to sponsor the placement of PhD graduates back into business or companies

Integration programs of PhD graduates back to business should be virtually automatic. If a company is willing to hire a PhD graduate in the areas of science or engineering, it should be a legitimate reason to obtain a governmental copayment for a period of 18 months. The calling mechanisms, which involves the presentation of elaborated projects generates high transaction costs and discourage business participation.

3.2.1.12. Specialized Human Capital Attraction

In areas where the country needs to quickly reach critical mass of advanced human capital and cannot wait for the training of PhDs, it is necessary to stimulate the attraction of advanced human capital from abroad. In such case, mechanisms for this

type of initiatives can be structured based on supply and demand. From the perspective of human capital supply, generating an income tax exemption for a limited period (three years) seems an appropriate scheme. From the perspective of business demand, co-financing a proportion of salary for up to 18 months is an attractive instrument.

3.2.1.13. Strategic direction in the formation of Advanced Human Capital

A controversial issue is whether the formation of PhDs should be directed. Regarding the national doctoral programs there must be a strategic planning effort of universities, to connect doctoral programs to the needs of economic and social development. In order to strengthen these programs, the government should force the connection with the third mission of Universities, both in human capital formation and conducting relevant research. This implies promoting interdisciplinary work to address, for example, problems such as adaptation to climate change, reducing violence or the development of biotechnology for national agriculture.

3.3. Business Innovation and innovative entrepreneurship

3.3.1. Business Innovation

The Colombian business innovation effort is below the expected level in relation to its income level. In short, innovation is not within the *"top of mind"* of the business strategies of most Colombian companies, including industry leaders. According to data from the National Innovation Survey IV (2007-2008), only 11.8% of Colombian companies innovate in product or process. Given the level of income per capita in the country, in a comparative perspective with other nations, this percentage should be around 30%

There is an inadequate supply of public support; only 5% of the companies that innovate in product or process make use of public financial instruments to support innovation. This is a consequence of rather fragmented, programs, calls and

instruments that reach low coverage. Besides, inadequate support schemes for business innovation in the early stages are offered, mixing credit and subsidy simultaneously.

According to its coverage and scope, the existing instruments to finance or support the innovative effort in the productive sector can, in rough terms, be grouped into three broad categories or "constellations" of instruments currently available:

A first group of instruments that have achieved low coverage and therefore have generated a very narrow impact (which opens a reasonable doubt about their effectiveness) or created problems with their design or operational mode. This group accounts for the vast majority of the instruments currently deployed by Colciencias:

- Lines of credit Bancodex-Colciencias-and Finagro Colciencias.
- An agreement between the *Fondo Nacional de Garantías* -FNG-and *Colciencias* for providing warranties for loans for innovation
- Shared technological risk projects
- Financing of patents or protectable technologies
- Technology business missions
- Linking researchers in enterprises

The review and probable redesign of these instruments will involve revision and improvement of its conceptual design, its operational design, institutional base administration, or specific functions such as promotion and deliberate animation of the demand.

A second group of tools or programs that have achieved greater coverage, serving directly to final users, and that yet raises questions regarding how effective has been the allocation of resources and the resultant impact. Within this category the following instruments are included:

- *Fondo Emprender* (SENA)
- Lines of contingent recovery and cofinancing of I+D+I projects (Colciencias)
- • RTD lines to enterprises (SENA) Líneas de I+DT a empresas (SENA)
- • Annual Call for Projects (Fomipyme)
- Projects of Agricultural Production Chains (Ministry of Agriculture)

Finally, a third group of instruments include those aimed at strengthening capacities of support platforms and services for entrepreneur or innovation projects. The challenge associated with this type of instrument is to be able to estimate its real impact, its efficiency and focus on the use of resources and the ability to project sustainability over time. This group may include the following instruments:

- Support to platforms and *Technopark* network (SENA)
- Capitalization of venture capital funds for innovative in early (Fomipyme)
- Young researchers and innovators (Colciencias)

From a general perspective, the current supply of public development tools for business innovation and innovative entrepreneurship has obvious limitations and high fragmentation, leading to poor performance in terms of coverage and effectiveness. Some of these specific shortcomings are:

- Low coverage. The convenience of having direct instruments to support an innovative business process has to do with the projected economic value over time of a portfolio of innovation projects, favored or anticipated because these incentives; it also has to do with the clear effect of a critical mass of companies adopting a systematic way of innovation in their competitive strategies. The low coverage achieved by the instruments to support business innovation weakens both arguments.

- Poor coordination between instruments. Each instrument defines its logic transactional access limited to their specific objectives, which interrupts the desirable sequence or correspondence among them.
- The current range of instruments does not lead to the accumulation and consolidation of business skills for innovation. The promotion of business innovation requires a great effort from the government, not only to convince the business sector of the importance of innovation, but to provide companies with the necessary skills and competencies to do so.
- Current incentives are inadequate and insufficient to address the preparatory work and investment involved in the grounding and formulation of an innovation project. An innovation project is not the starting point of an innovative process, but the result of a previous process that requires the mobilization of pre-investment capabilities and resources.
- Design of tools and support models unreasonably complex. The rules and operating procedures of current instruments generate high transaction costs, to the user, when needed.: times of resolution of calls, limited types of projects eligible for funding, with monitoring financial accounting rather than results, the conflict of the appropriability through **PI**
- Poor leadership and mobilization of entrepreneurial talent for innovation. The current portfolio of instruments does not consider forms of support designed to identify and build on these skills and innovative potential mobilization of wealth.
- Based on the abovementioned, we propose, as general recommendations, the following measures and initiatives to articulate a robust and integrated policy to promote business innovation:

- a) Establish an institutional platform for specialized business innovation services, recognizing contributions of royalties for the implementation of programs in Regions. The main programs to be developed would include
 - i. Dissemination and extension technology for SMEs.
 - ii. Co-financing repayable innovation projects.
 - iii. Generation of public goods for innovation in clusters agendas.
- b) Strengthen programs to incorporate specialized human capital (engineers or related to small businesses, postgraduates in large and medium enterprises) to boost innovation "intra-walls" (with a temporary wage subsidy, declining progressively over two years).
- c) Develop enabling capabilities to innovate: to encourage the generation of public sector, build capacity for technological extension. This requires a mechanism to address coordination failures (link to program clusters agendas and new route maps (road mapping) for groups of companies).
- d) Review the definition and parameters of the tax credit for R & D, to make it consistent with all countries that use this mechanism to narrow the definition of R & D, with a general tax credit rate of 25% you can upload up to 40% for the company R & D contract with an accredited entity.

3.3.2. Dynamic Entrepreneurship

Among the diagnostic elements of the current support policies for innovative entrepreneurship in Colombia, there are:

- Weak policy framework, with scattered and sporadic actions from the public entities.

- Discontinuous support framework towards entrepreneurship platforms. The answer to poor incubator results and other promotion platforms of dynamic entrepreneurship has been the suspension of support lines, instead of its correction based on a performance metric (incubators, parks, accelerators).
- Very limited development of the venture capital market, and in general, of the ecosystem of financial and non-financial support to innovative entrepreneurship.
- Scarce packaging and transference of results of university or academic I+D, towards the conformation of possible *spin outs* from investigation.
- Difficult connection between the I+D in Universities and the initiatives that promote the «*market outreach*» of possible *spin-offs* or other type of transference (sale of patents, licenses, etc.).

In Latin America, unlike what happens in countries such as Israel or Singapore, the financing offer for entrepreneur innovators in early stages is still very weak. Colombia is not the exception; there are 2 institutional networks, one of public origin (Creame) and another of private origin (Bavaria). The results of these institutionalized networks are poor, being that there are very few “closed” businesses. For example, the Red Creame shows, up to the present, 2 closed deals that add up to less than USD 100,000, and the Network of the Fundación Bavaria is just materializing the closure of their first investment.

The focus of the current support instruments for the innovative Entrepreneurship is characterized by:

- Emphasis in support to projects of business creation, through incubators.
- The main objective is the Business Plan and the prototypes.
- Scarce attention to the teaching of entrepreneur capacities and abilities
- Insufficient (or incomplete) attention to the market.
- Initiatives that are focused neither on the creation of technology-based businesses, nor on the more dynamic entrepreneurship models.

The recommendations aim to consolidate the basis of an entrepreneur ecosystem, with the following institutional specialization:

- **Colciencias:**

- Support mechanisms for the generation and packaging of *spin off* from I+D projects.
- Define co-financing mechanisms for EBT Incubators, based on the commitments and the measurable development.

- **Bancoldex:**

- Financial mechanisms to create funds of venture capital (almost equal to startup capital and venture capital).
- Subsidies to the administration of Funds of the startup capital; and conformation of networks of angel investors.

- **SENA:**

- Narrow down gradually the Fondo Emprender, reducing the subsidy amounts and incorporating a previous mentoring face to the allocation of resources. (Ley 344).

3.4. Clusters and Horizontal Platforms

The Innovation Strategy has a group of horizontal instruments and programs that allows resolving the appropriability failures that inhibit “*self discovery*”, which allows developing new innovative businesses. However, as well as appropriability failures, there are also coordination failures that generate multiple balances in the economy.

The State could have a mechanism that allows it to evaluate selective actions in specific verticals, based on any evidence of markets of latent comparative advantages, high

sector dynamisms at a global level, coordination failures and lack of social capital that inhibits the actors from resolving the failures through the autonomous provision of club goods. The selectivity key is to resolve the coordination failures and generate a critical mass of resources to move to a new balance of greater value for society.

The sectors in which the country is big at an international level, for example the sectors of natural resources, constitute a space in which demands derived from high sophistication can be generated, and these can generate spaces for innovation. Initially these businesses are oriented towards the natural resource, but they rapidly acquire competencies that allow them to compete at world-class level in products and intensive services in technology, human capital and knowledge. In a superior phase, they evolve to new innovative activities that do *spin off* from the original nucleus.

What are the instruments that can be used to address the coordination failures?: to give orientation in the allocation of resources for I+D, to reduce the costs of accessing information to promote the development of clusters, to develop public goods specific to the clusters, to invest in physical infrastructure linked to the needs of the clusters, regulation/deregulation.

This public policy focus requires the coordination of different sectors that normally work as state monopoly. In consequence, it is recommended to start with a *top down* focus of the sectors in which the country is outlined as world class. Simultaneously, an institutional scheme that allows identifying, in a *bottom up* focus, the emerging sectors in which there are coordination failures that prevent form jumping to a more active balance. However, neutral horizontal instruments must be maintained in order to focus on the appropriability failures that affect innovation.

3.4.1. Selectivity in the Productive Transformation Program of the Ministry of Commerce, Industry and Tourism

The Productive Transformation Program of the Ministry of Commerce, Industry and Tourism development program has been structured with the support of the McKinsey consultant. This selectivity effort followed a hybrid focus. On one hand, it was sought to identify sectors with a high growth potential, and on the other hand, it was defined which the established sectors that face difficulties to compete in a more open economy were. The risk of this last focus is that employment in the sectors that do not have advantages ends up being subsidized, and delays the restructuring processes.

Noneheless, the resources given to this program are insignificant, hence it appears more as a political declaration to reassure the sectors that face serious difficulties to be able to compete, than a situation in which the allocation of resources is effectively distorted. Nevertheless, this reduces credibility to a selective policy to generate innovation dynamics, just as we explained at the beginning of this chapter.

The selectivity model must be restructured to a scheme in which, at a national level, a few sectors that comply with the requisites that we have mentioned are prioritized. The requisites are: latent comparative advantages, sophisticated demand, dynamic global demand, coordination failures clearly identified, and lack of social capital to address them, potential to generate dynamic clusters with significant confinement and transformation potential in innovative activities beyond the original central activity. These sectors cannot remain static, they must be revised.

3.4.2. Clusters and Emerging Businesses

The process must leave spaces for “*self discovery*” and the emergence of new sectors with potential, where there are critical mass problems for the development of untradeable services and supplies with scale economies. There must be a scheme that identifies, at an early stage, the opportunities of these emerging sectors, observing early signs of market and establishing incentive to *roadmapping* the sector. In order to do this, an institution must be established to allocate legitimacy and transparency to the

decision to support the implementation of the *roadmapping*, and have evaluation systems of the action plans.

In the case of sectors that are world-class leaders, such as Mining, Energy, Coffee, Flowers and such, the identification of derived demands with common technological requirements must be promoted. This generates the opportunity of developing technological services businesses that use these tools in diverse sectors.

Together with evaluating the *top down* selection of the sectors, the difference between sectors must be clarified. The objective is to generate growth dynamics with international insertion of the horizontal platforms, whether of a general enabling character or cross-application technologies, and fundamental pillars that we have identified. The combination and confusion of the different categories affects the strategies and tools of their implementation.

From the perspective of the implementation, it is necessary to deepen the articulation between sector managements and cross-directions, to allow a dual vision as a sector and platform in some cases. Logistics is a fundamental enabling platform that impacts on competitiveness of diverse sector activities, and on international commerce. Likewise, the TICs are a fundamental technology, but at the same time the BPOs with the use of TICs can constitute a sector of elevated growth potential in the case of Colombia.

A fundamental aspect that must be advanced is the mapping of the expression at a territorial level of the clusters that are prioritized by the national innovation strategy, to commit the regional collegiate bodies in the process of allocation of priorities for the royalties. Moreover, one central topic is the institution that allows the coordination of the generation of specific capacities at a national or regional level, and at a regional framework. On this, the plan contracts or programming agreements are an instrument that is interesting to structure in the context of the Royalties program.

To address these different dimensions, it is fundamental to structure, at a Ministerial level, a Governing Commission for Competitiveness and Innovation that plays the role of a priority decision-making body and of articulator of ministerial and regional initiatives, using plan contracts as multi-ministerial and regional management tools. This institution is key in the solving of the static form in which the State works in these fields.

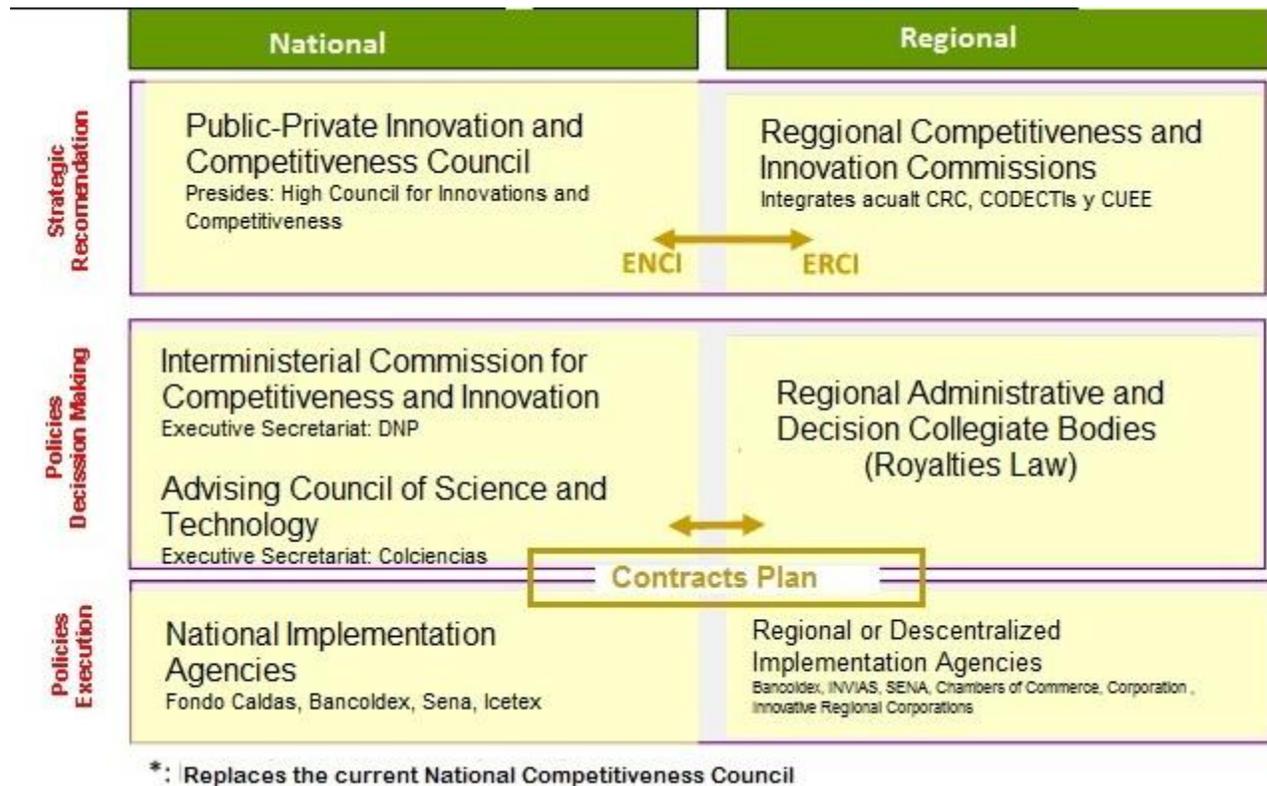
4. Institutions for the National Innovation Strategy

The institutional model that is proposed in this section responds to the integrated vision of the National Innovation and Competitiveness Strategy expressed in the Agreement for Prosperity (Medellín, May 2011). Said vision is inspired by a first strategic decision that seeks to converge the current national competitiveness and development policies of science and technology.

The integration of both national policies allows a greater convergence between instances of strategic level, executing entities, and mechanisms that currently operate separately, with institutional leaderships and different emphasis and focuses, which will benefit in a fragmentation of efforts, and at the same time duplication and overlap of coordination instances and strategic coordination, nationally as well as regionally.

Moreover, a clearer separation of functions and responsibilities between the instances of strategic level, the conducting team and the coordinator of the policy inside the Executive must be established, and the agencies responsible for the operation of the different programs and instruments are under the national science, technology and innovation policy.

Figure 6: Model of Institutional Governance



The model of institutional governance that is proposed to sustain the strategy is presented in Figure 6. It considers the three decision-making levels referred to, as well as the axis of the relationship between the national-level institutions and those that are sub-national. At a national strategic level, it is proposed to integrate a National Competitiveness and Innovation Council, public and private, with members from the productive, academic and work fields, convened because of their merits and experience, and not in representation of specific entities. This Council would replace the current National Competitiveness Council, integrating several of its current members.

It is proposed that the National Competitiveness and Innovation Council be presided by the High Council for Innovations and Competitiveness, and have a reduced and qualified professional support team, established in the Counseling, in charge of the role of Technical Secretariat Office of the Council. The public members of this Council would be the Directors of the DNO, Colciencias, and the Ministers of Treasury, MEN, MCIT,

MTIC and MT. The non-public members would be people that stand out with a recognized experience from the academic, business and work fields, as well as experts in public microeconomic, innovation and human capital policies.

The main functions of the Council would be: to define a national competitiveness and innovation strategy with a 12-year horizon (to be revised every 4 years), to define criteria for strategic priorities, to watch over the continuous improvement of the institutions, and to evaluate the consistency and the impact of the policies with the strategy. To carry out their work efficiently, the Council requires: long-term vision, vision of the innovation system as a whole, independence from corporative interests, composition by experts (with a minor participation from universities, businesspeople and workers).

Meanwhile, at a political decision-making level, it is proposed to establish an Interministerial Commission for Competitiveness and Innovation, formed by the Directors and Ministers that participate in the National Competitiveness and Innovation Council, as well as other sectorial Ministers (MADR, MME, MDN, among others). This Commission should be presided and convened by the DNP, with a technical secretariat office as support. This Commission would be in charge of: approving the strategy proposed by the Council; defining policies, articulating the work of the agencies, prioritizing and consolidating budget framework; defining priorities and establishing the allocation of the resources of royalties for science, technology and innovation at a macro-program level.

4.1. Institutions for Scientific and Technological Development

The institutions for support to scientific and technological development should continue supporting themselves from Colciencias as a governing institution, advised by the Advising Council of Science and Technology, complying with the Law 1286. One fundamental condition to guarantee an adequate coordination between this pillar and

the other components of the strategy is that several of the members of this Advising Council integrate the Public-Private Innovation and Competitiveness Council.

A second fundamental condition to strengthen the support institution for this pillar is that Colciencias separates its role of design and decision of policies (mandate established in the Law 1286) from its role of operation, which in the future can be administered from the administrative structure of the Fondo Caldas. This allows an adequate capacity of monitoring and evaluation of the efficiency and impact of the policies, and feedback for the corrections to their design by Colciencias.

4.2. Institutions for Training and Development of Human Capital for Innovation and Competitiveness

The challenge that Colombia faces is how to strengthen and modernize the institutions for the training of human capital in the different qualification segments: technical, professional and advanced (postgraduates). This implies assuming a strategy that must emerge from the primary and secondary education cycles, advancing into the obligatory nature of Secondary Education and emphasizing the training of basic and generic competencies. On the other hand, in the cycle of Tertiary Education, the objective has should be to revert the pyramid that is currently inverted between university and technical-professional education.

Evidently, the SENA network has a fundamental role to play, but the perspective of a greater impact and effectiveness goes through an important modernization and a greater decentralization, with the possibility of strengthening territorial alliances that aim to maximize the relevance and the scope of the training by competencies.

4.3. Institutions for Business Innovation and Innovative Entrepreneurship

In this pillar, a clear gap in public institutions is adverted, in what is relative to the development of innovations as well as the dynamic entrepreneurship. Therefore, it is necessary to cover the current links that are unattended in the chain of value of innovation.

To correct the institutional gap that was detected, it is proposed to establish an institutional platform that specializes in business services for innovation, which can, as much as possible, admit inputs from royalties to increase its coverage, especially in Regions. This platform, that is expected to be developed in the Development Unit of Bancoldex, would be oriented towards developing a permanent offer of programs aiming towards:

- Dissemination and technological extension for the SME;
- Lines of *matching grants* (non-refundable co-financing) to business innovation projects executed by the businesses;
- Support and co-financing lines for the generation of public goods for innovation and technological dissemination.

Additionally, it is proposed to articulate efforts from the Development Unit of Bancoldex, as well as from Colciencias, to establish and complement the basis of a venture ecosystem, with institutional specialization.

- In charge of Colciencias and the Fondo Caldas:
 - Support to the generation and packaging of spin-off from projects of I+D
 - Co-financing for EBT Incubators, based of measurable development commitments
- In charge of Bancoldex:
 - Financial mechanisms to create funds of venture capital.
 - Subsidies to the administration of Funds of start-up capital
 - Conformation of networks of angel investors

4.4. The territorial dimension of the institutional base

The implementation of a national innovation strategy imposes a clear challenge in matters of connection and articulation between institutions and policy mechanisms that operate nationally, and the actors that are distributed in the territory. This challenge is greater when, as in Colombia, there is no capacity of execution of the policies at agency level.

Therefore, it is required to establish a clear correlation at the three decision-making levels. In the strategic level, it is proposed that the Regional Competitiveness Commissions integrate the different instances, such as the State Councils of Science, Technology and Innovation (CODECITI) and the Committees University Business State (CUEE), and assume the mandate of elaborating and agreeing upon regional innovation and competitiveness strategies.

In terms of policy coordination, it is proposed that the collegiate bodies that are established in the Law of Royalties for Science and Technology be the ones to assume the interlocution with the Interministerial Commission, while in terms of executing agencies, it is proposed to advance towards institutional models through establishing regional capacities or generating operation formulas in which the national agency operates in a 2nd floor and is linked to executing bodies of the first floor with a territorial capillarity.

With the coming into effect of the regional resources from the royalties, it is proposed to promote the promotion of plan contracts on a multi-year basis, that allow to address the objectives and prioritized aspects in the regional innovation strategies, through the leveraging of resources from inputs and institutional capacities of the central level, to strengthen the regional capacities, to generate public goods that are relevant to the chains or clusters in the territories, and to amplify the coverage of the regular support lines that operate via demand.

5. Bibliography

- Arnold, E. et al, (2009). Evaluating the National Innovation Strategy for Competitiveness. Technopolis Group.
- Ayuda de Memoria Acuerdo para la Prosperidad N°32. Innovación – Medellín (2011)
- Banco Mundial (2007). Colombia 2006-2010: Una ventana de oportunidad. Notas de política presentadas por el Banco Mundial.
- Benavente, J.M. (2006). Bases para el Diseño de una Política Tecnológica Nacional. Serie Documentos de Trabajo. FEN, Universidad de Chile.
- Cárdenas, M. y S. Pozo (2007). Crime and Growth in Colombia. Working Paper. Fedesarrollo.
- Colciencias (2008). Colombia Construye y Siembra Futuro. Política Nacional de Fomento a la Investigación y la Innovación. Documento para Discusión
- Colciencias (2010). Presentación Institucional del Fondo Nacional para el Financiamiento de la CTI Francisco José de Caldas. PPT.
- CONPES N°3547. Política Nacional de Logística.
- CONPES N°3582 (2009). Política Nacional de Ciencia, Tecnología e Innovación.
- CONPES N°3668 (2010). Informe de Seguimiento a la Política Nacional de Competitividad y Productividad.
- Consejo Privado de Competitividad (2010). Informe Anual de Competitividad 2010-2011.
- Consejo Privado de Competitividad (2011). Posición del CPC frente a una Profundización de la Política de transformación Productiva para el País. Documento para Discusión.
- Corp. Bucaramanga Emprendedora, CreaMe, Incubar Manizales (2010). Lineamientos de Política de Apoyo al Sistema Incubador de EBTs en Colombia. Recomendaciones para un CONPES. Documento de Trabajo.
- DNP (2011). Plan Nacional de Desarrollo 2011-2014.
- DNP (2011). Presentación Sistema Nacional de Competitividad e Innovación. Secretaría Técnica Comisión Nacional de Competitividad, PPT.
- Echeverry, J.A. (2008). Innovation as an Investment: Maximizing Colciencias Impact to Catalyze the Structural Transformation of Colombia. Informe para la Maestría de Desarrollo Internacional y Gestión Pública, John F. Kennedy School of Government, Harvard University.
- Echeverry, J.A. (2010). Programa Nacional de Fomento a la Innovación. Propuesta de Estrategia Integrada. Documento interno de trabajo.
- Hausmann, Ricardo, Jason Hwang and Dani Rodrik (2006) “What you Export Matters,” in Journal of Economic Growth, Vol. 12. No. 1 (March 2007), pp. 1-25.

- Hidalgo, C. A., B. Klinger, A. L. Barabasi, and Ricardo Hausmann. "The Product Space Conditions the Development of Nations." *Science* 317(5837): 482-487, 27 July 2007.
- Indicadores de Ciencia y Tecnología, Colombia, 2010, OCyT. http://www.ocyt.org.co/html/archivosProyectos/COLOMBIA_2010.pdf
- Maggi, C. (2010). Instrumentos y Fondos para promover la CTI en Colombia. Informe de Cooperación Técnica N° ATN/IP 11415-CO, BID – Colciencias.
- Penfold, Michael (CAF, 2009) http://pac.caf.com/upload/pdfs/9_Michael_Penfold.pdf
- Prieto, Fernando. 2011. Presentación en Taller Colciencias “Construyendo el Ecosistema de Apoyo a la Innovación y al Emprendimiento en Colombia”
- Rodrick, Dani. 2003. "Growth Strategies," Economics working papers 2003-17, Department of Economics, Johannes Kepler University Linz, Austria.
- Sabel, Charles F. (2010). Self-Discovery as a Coordination Problem. En Sabel, Hausmann, Fernández-Arias, Rodríguez-Clare, Stein (Eds.). Forthcoming in *Self-Discovery as a Coordination Problem: Lessons from a Study of New Exports in Latin America*. BID.
- Velásquez, Ma.C. (2010). Redes de I+D: Una Respuesta al Reto de la Titularidad y la Explotación de los Resultados de Investigación. Documento Interno Colciencias.
- World Bank (2008). Chile: Toward a Cohesive and Well Governed National Innovation System.