

# **Measuring The Development Of Science And Technology In A Changing Economy: The Case Of Albania**

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## **Introduction - The Measurement of S&T in a Developing Economy**

Science and technology (S&T) are an integral element of a nation's economic and social system. Leaving aside for the moment the social benefits science and technology have brought to the human race, there is clear evidence scientific and technical knowledge is a necessary input to a nation's economy in order for it to grow. The American economist, Paul Romer, has noted while national economic growth has measurable ups and downs, the long-term growth of a national economy, measured over decades, can only be attributed to investment in scientific and technical knowledge. This investment in

knowledge is as important as inputs of labour, natural resources and financial resources in the production function.

Investment in S&T knowledge occurs primarily through three processes:

- domestic development of new S&T knowledge through research and development (R&D) programs
- investment in intellectual property through the purchase of patents and licenses
- acquisition of knowledge through the technology embedded in imported capital goods, usually "high-technology" products.

These investments, while usually thought of in financial terms, also represent an investment in human capital. Thus measurement of these investments must include not only the financial resources devoted to them, but also the human resources assigned to the effort.

Governments, as managers of national investments in S&T, are interested in the effectiveness of their investments in this area. While some specific areas can be easily measured (such as the output of academic papers) it is usually difficult to measure the direct effect of investments in technology in the overall economic context. Some social benefits can be seen in the long term, such as the reduction of mortality and morbidity through investments in health technologies, or reduction in the concentration of specific pollutants through environmental technologies.

However, it is possible to measure, albeit crudely, the relative levels of innovation in many industrial sectors, and to be able to identify strong and weak sectors. Measurement of innovation is not an exact science, but it does give some quantitative data which enables policy-makers to pinpoint the strengths and weaknesses in their nation's economy.

On a more micro level, S&T data are part of the S&T policy formulation process and an integral part of policy advice provided to senior government officials and ministers. A democratic policy debate requires the existence of informed interest groups. In the case of S&T policy, data for stakeholders in the national system of innovation (scientists, engineers, private sector managers) as well as the general public are necessary so that all groups can participate knowledgeably in national S&T policy discussions.

In the public sector, statistics on S&T inputs and outputs, and the consequent S&T budget, should support the following activities:

- formulation of S&T policy, in support of economic and social objectives
- provision of advice to ministers and other senior officials
- support for and justification of S&T program expenditures
- information on scientific activities for elected officials, journalists and other stakeholders

- analysis of the national system of innovation

S&T policy management groups and the statistical activities required to support them are not solely a feature of the governments of large, developed nations. Smaller nations, whether developed or developing, need to understand their national system of innovation and how it contributes to national goals. The scale of effort may vary, but even within large economies, particularly those with well defined geographic regions, such as Canada, there are wide differences among regions in the level of S&T activities.

Regions of large countries and small nations often have much in common, both economically and socially~ both need to be able to assess their S&T policies and to measure their technical progress. Appendix A contains a list of S&T indicators which the government of British Columbia believes essential to the management of the regional economy. The indicators could apply equally to a small nation, whose economy is based primarily on natural resources (as is the economy of British Columbia).

### **Measuring Science and Technology or Research and Development**

UNESCO has developed a definition of " scientific and technological activities " . According to its *"Recommendations Concerning the International Standardization of Statistics on Science and Technology"* S&T activities are:

*"...systematic activities which are closely concerned with the generation, advancement, dissemination and application of scientific and technical knowledge in all fields of S&T: These include such activities as R&D, scientific and technical education and training, and scientific a11d technical services..."* .

Both UNESCO and the OECD define R&D as:

*"creative work undertaken on a systematic basis in order to increase the stock of knowledge, including the knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications"*

UNESCO defines scientific and technical education and training as:

*"...all activities comprising specialized non-university higher education and training, higher education and training leading to a university degree, post-graduate and further training, and organized lie-long training for scientists and engineers. These activities correspond broadly to the International System for Classification of Education levels 5,6, and 7."*

Scientific and technical services are defined as:

*"...activities concerned with R&D and contributing to the generation, dissemination, and application of scientific and technical knowledge. "*

They are divided by UNESCO into nine subclasses as follows:

- S&T activities of libraries, etc.;
- S&T activities of museums, etc.;

- translation, editing, etc. of S&T literature;
- surveys (geological, hydrological, etc. );
- prospecting;
- data collection on socio-economic phenomena;
- testing, standardization and quality control, etc.;
- client counseling including public agricultural industrial advisory services etc;
- patent and license activities by public bodies

In many small developing nations, such as Albania, there is often little S&T activity that would fall under the strict definition of R&D established in the OECD Frascati Manual. In virtually every country with some technical infrastructure there is some R&D; there is always some R&D going on in institutes and universities. Thus measurement of R&D by itself may not be useful. It is probably more helpful to policy makers and program managers to measure S&T in its entirety.

### **The Measurement of S&T in Albania - Background**

Since 1992, Albania has gone through radical social, political and economic change. Albanians have seen the dismantling of its former, centrally planned economy and the establishment of a market-driven economy. At the same time their political institutions have been reformed to respond to the needs of a democratically elected government.

This has not been accomplished without pain, the main evidence of which has been a substantial erosion in the standard of living as the economy adjusts to international market conditions. Following the change of government in 1992, the GDP showed negative growth until 1994 (although it should be noted this fall in output was not nearly as marked as similar falls recorded by other former Communist states). Official figures now show positive growth rates of approximately 10% per annum with a GDP of approximately 280 billion lek in 1996 (Albania: Public Investment Program, 1996 - 98). The US dollar exchange rate is relatively stable at around 110 lek to the dollar. However, costs of goods and services suggests a purchasing power parity<sup>1</sup> rate of about 30 or 40 lek to the dollar (Holbrook, estimate). Per capita income (based on a population of approximately 3.5 million), suggests a per capita income of about 80,000 lek per person, or about \$2000 to \$2600 (US) per capita based on purchasing power parity. Given Albania's proximity to European markets and the demonstrated ability of its people to be economically innovative, the future is bright. Albania could easily follow the development paths of the "Asian Tiger" economies and prove itself as a formidable niche marketer in the European context.

Under the former government, the S&T structure was based on the Soviet model, with

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<sup>1</sup> Purchasing power parity is an effective exchange rate, rather than the bank exchange rate, which is constructed to reflect the relative differences in the prices of goods and services between any country and the United States, where the US is used as the basis for comparison.

S&T resources being directed primarily at satisfying the needs of the planned economy. Much of Albania's economic output to defense and investment in heavy industry resulting in a low level, even by Eastern European standards, of technological development. Albanian S&T activities were mostly imitative of Soviet practices, and the main contribution of the national system of innovation was to accept such technologies as its socialist partners chose to transfer to it.

There are currently three main elements in the Albanian national system of innovation:

- government ministries,
- S&T institutes, each of which (except the Academy of Science) is associated with a ministry and
- the university sector.

There are little current data on investment by the private sector in S&T on which to draw substantive conclusions, but the level is, at present, probably low. As Albanian industry develops, it will import technologies, initially embedded in production equipment and processes, before moving on to adapt and develop its own technologies. In the public sector, foreign donors are major sources of technologies and the funding to purchase these.

Although many of the Albanian institutes run by government ministries describe themselves as research institutes, it appears the bulk of their activities are scientific and technical services. Thus the Albanian national system of innovation is, at present, primarily an S&T services system (as defined by UNESCO). At this time the primary policy interest must lie in considering S&T investment and in measuring S&T inputs and outputs.

There are fifteen Cabinet-level ministries in the Albanian government. Of these eight have significant S&T programs. They are:

- Industry, Transport and Trade
- Health and Environment
- Minerals and Energy
- Public Works and Tourism
- Agriculture and Food
- Education and Sports
- Higher Education and Scientific Research
- Culture, Youth and Women

There are a small number of institutes which enjoy an arm's-length relationship to the line ministries with major S&T activities. These are:

- the Academy of Sciences
- the Institute of Statistics
- the National Directorate of Metrology and Calibration; the Directorate of Standardization and Quality

The Ministry of Higher Education and Scientific Research (MHESR) has both an S&T policy and coordination role, and responsibility for administrating a national S&T program funded through the Public Investment Program (PIP). In this latter role, it supports S&T programs in other ministries.

### Estimates of Albanian S&T spending

The use of quantitative measures of S&T activities in Albania has, until recently, been confined to the preparation of budgets for the institutes and for individual S&T projects. Table I shows 1995 estimates of S&T spending by ministry (and by imputation, by socio-economic objective - see Appendix "B "). The estimates of S&T spending were prepared by the ministries themselves, separately.

Table 1 The Albanian Science Budget  
(Million Lek, 1995)

Science-based Ministries	Ministry Budget	National Program	MHESR Projects	Contracts & foreign aid	total
Industry, Trans.& Trade	5	2	-	n/a	7
Public Works	8	2	-	n/a	10
Health & Environment	52	4	1	n/a	57
Mineral & Energy Resources	n/a	15	12	n/a	27
Agriculture & Food	88	12	-	n/a	113
Education & sports	17	-	-	n/a	17
Higher Ed. & Sci. Research	33	1	-	n/a	34
Culture, Youth & Women	40	-	-	n/a	40
Academy of Science	138	7	-	n/a	145
Independent Institutes	n/a	-	-	n/a	n/a
<b>Total</b>	<b>381</b>	<b>43</b>	<b>26</b>	<b>n/a</b>	<b>450</b>

*n/a = not available at this time*

*- = zero to 500,000 lek*

A first step in preparing reliable estimates of S&T spending would be to develop a standard Albanian definition of science and technology based on the UNESCO

definition. This definition, with Albanian examples would be used by ministry budget and science officials in preparing budget documents (in which there is already a line item for S&T). Virtually all of the ministries and institutes fall into only one socio-economic objective (see Appendix "B" for a list)

The second step would be for: MHESR, in cooperation with INST AT, to create an S&T budgetary data collection, analysis, and dissemination group. This group would collect S&T expenditure data and human resource data from all publicly funded S&T performers, including ministries, S&T institutes and universities and prepare an S&T budget. While this budget would not be a formal expenditure plan, necessarily requiring parliamentary approval, it would be a statement of intent by the government as to how it intends to allocate resources to S&T activities.

The Albanian government budgetary system is effectively broken into two parts: the operating budget and the PIP. The PIP identifies investments in infrastructure eligible for support through bilateral and multilateral concessional financing facilities. It is important to know which S&T programs are eligible for such support, and which are not. Data collected for an S&T budget should clearly identify which programs are included in the PIP and which are not.

### **Highly Qualified Personnel**

Human capital invested in a nation's S&T effort is as important as the financial resources devoted to the program. Implicit in this investment is an understanding of the supply of human capital and the demand for it. The level of financial resources available for a national S&T program usually sets the level of demand, but factors affecting the supply, such as university and technical school enrolments, are often completely unconnected to meeting the demand leading to shortfalls or overabundance.

MHESR, with its responsibilities for higher education, as well as S&T policy, thus has a double interest in this subject. Estimates of both supply and demand for HQP, by level and discipline, will be an important input to its planning for investment in the higher education system.

It would be useful to have a census of all engineers, scientists, technicians and other scientific support staff, by level of training, subject area and location in order to establish the supply side of the equation. Matching this, a survey of employment of scientists, engineers, etc. would give data on the demand for HQP. This census would likely reveal the existence of a pool of technically trained labour not currently employed in S&T activities. The size of this pool is important, for technical training is an investment that diminishes with time if not used. Identification of some of the characteristics of this pool (such as age, type of training etc.) would enable planners to develop programs to make use of this existing source of technical talent.

On a more immediate basis, knowledge of the mobility of this labour force, the migration of HQP both within the country and emigration/immigration, is important for policy makers. Information on the female participation rate in S&T training is also important for social policy formulation.

While a complete census might have to wait for a few years, it should be relatively easy to measure the number of S&T HQP employed in the public sector - in government

ministries, institutes and the universities.

### **Quantitative Analysis of S&T Activities: the Albanian Context**

The above data provide only information for an S&T budget. As the Albanian economy develops, S&T planners, policy-makers and budgeters will require more sophisticated information. INSTAT and MHESR will need to develop a multi-year implementation plan to collect a variety of indicators of inputs and outputs of S&T activities.

The S&T budgetary data collection, analysis and dissemination group needs an economic analysis and planning capability to advise INSTAT on future data needs and to provide analysis and policy advice to: MHESR.

One of the first tasks of this group would be to establish priorities for the measurement of S&T activities in the private sector.

Three areas that could be developed quickly are:

- measurement of the use of advanced manufacturing equipment and processes. An initial assessment could be done when a firm comes into the INST AT Business Register;
- measurement of the investment in S&T knowledge through the acquisition of high-technology equipment. This can be done by ensuring there are appropriate classifications for high-technology goods in the existing INSTAT trade data system. Various approaches to define high-technology products exist (see, for example, CPROST report 95-11 on a seminar on the measurement of high technology trade)
- measurement of innovation in small and medium sized enterprises. An inexpensive survey can be done with only a few questions. Appendix "D" provides sample questions that could be attached to a larger survey of activities in enterprises (it need not be restricted to small and medium-sized enterprises, although this is the area of interest of most policy-makers)

### **Measurement of S&T for non-economic objectives**

Most measurement of S&T activities is directed towards improving economic performance. However, investments in S&T have provided many social benefits which indirectly improve economic performance. Increased life expectancy and better understanding of management of the environment are but two examples. Measurement of S&T investments in social objectives, particularly by the public sector, which invests for the public good, must not be ignored.

These investments should be linked to specific social benchmarks, so S&T investments can be measured against the resulting social improvements.

In addition, there is a need to provide data for an S&T information program. Albanians need to have basic information on the levels of investment in S&T and the results (both economic and social) that accrue from that investment. It is part of the consultation process necessary for an informed debate on public policy issues.

MHESR, with the assistance of INSTAT and other ministries, should publish an annual report on the state of S&T in Albania. This report should be small and aimed at educated, but non-science oriented, individuals. It should be readily understandable by teachers, journalists, public officials and politicians. It should cover both policy and programs, and give an overview of the growth of Albanian S&T and its future directions. Such a document would be the basis of MHESR S&T information programs and public policy statements. It would also provide the basic reference document for public policy debates on S&T by stakeholders and the public at large.

### **Future Work on S&T Indicators in Albania**

As already stated, S&T policymakers and planners need data for the future development of S&T. There are S&T measurement activities which, while not needed now, will in time be needed for the planning process. As one of the projects of the S&T economic analysis group, a census of R&D performers should be carried out, in all sectors of the economy, to establish a base for further measurements of R&D activities.

The S&T data collection and analysis group should be tasked with preparing comparative economic studies, comparing Albanian S&T activities against similarly sized nations, at the same level of economic development.

While Albanian R&D efforts are undoubtedly low, it would be useful to know where such activities do exist. An estimate of R&D activities would enable Albanian S&T policy makers to benchmark Albanian R&D against other similarly-sized nations and regions. Indeed, in his recent address to Parliament, the Prime Minister called for a comparison of Albanian S&T activities with those of other nations. To this requirement must be added a note of caution: such comparisons are heavily influenced by economic structure, and overall size of the economy. Much of study would have to go into the preparation of appropriate benchmarks, whether they are S&T spending levels or social outcomes resulting from S&T investments.

As industrial R&D programs develop, there may well be initiatives to provide tax relief for private investors in R&D. Such tax relief is another form of investment in S&T. The creation of an R&D tax credit program should also provide for the collection of data on the amount and distribution of R&D expenditures and personnel (by industrial sector, type of expenditure, etc.) in order to ensure the tax credit program is functioning as its proponents forecast.

### **Conclusion**

As Albania works to become a full economic partner in Europe and the Mediterranean area, it will need an S&T policy infrastructure as part of its overall development strategy. This S&T policy infrastructure will require accurate and timely data for policy development. An S&T data collection and analysis capability is something that cannot be created overnight. By investing a small amount in this activity now, the government of Albania will have the solid foundation needed to assist in the management of a strong and competitive Albanian economy, thus ensuring the improvement of the quality of life for all Albanians.

The case of Albania is not unique. There are many other smaller economies in transition.

Each has its particular set of problems, but most share the same needs for development. The Albanian situation provides a good case study, and with it the expectation that significant changes will be seen over the next few years.

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## Appendix " A " - S&T Indicators for a Small Economy

The government of BC has a strategic plan for S&T. This plan includes:

- S&T programs to strengthen the resource sector,
- strengthening competitiveness in other economic sectors,
- development of the high-tech sector, and,
- development of technologies to be applied to services provided by the public sector.

Indicators are required to measure:

- the degree to which various sectors of the economy are developing,
- the use of and adaptation of technologies,
- the strength of the underlying R&D and science infrastructure,
- activity in the high technology sector, and,
- the skills and quality of highly qualified S&T personnel.

As an adjunct to the issue of supply and demand for highly qualified S&T personnel, there is a need to measure (and compare against international standards) the quality of secondary and post-secondary graduates.

With this in mind, there are S&T indicators, *each of which should be capable of being benchmarked*; that can be collected within the confines of a small regional economy. This list is by no means exhaustive, but represents what is easily measurable by a regional administration. The benchmarks are also proposals: there may be other ways to benchmark the associated indicator.

These are:

- investment in knowledge through R&D expenditures in each of the governmental, business and higher education sectors,

*Benchmark:* R&D expenditures as a percentage of GDP

- production and trade of high-technology products

*Benchmark:* revealed competitive advantage by sector

- output and trade in high-technology services

*Benchmark:* balance of trade in services

- investment in knowledge through the training of scientists and

engineers, including social scientists and health care professionals

*Benchmark:* ratio of students (who are citizens) to labour force or population

- productive use of knowledge (human capital) through the employment of trained engineers and scientists (including social scientists and health care professionals)

*Benchmarks:* trends in real economic growth, mortality and morbidity

- census of innovating firms by sector

*Benchmark:* Rate of increase of the number of innovating firms

## **Appendix "B" - OECD Socio-economic objectives of Government S&T spending**

The OECD Frascati Manual describes twelve socio-economic objectives for classifying public sector S&T spending. The manual notes that governments may subdivide these objectives to meet their particular needs. The following is the Canadian version:

### 1. Agriculture, forestry and fishing

- a) agriculture
- b) forestry
- c) fishing

### 2. Industrial development

- a) food and beverage industries
- b) information processing technologies
- c) advanced materials
- d) other manufacturing technologies
- e) other

### 3. Energy

- a) nuclear
- b) renewable energy resources (including hydro-electricity)
- c) non-renewable energy resources ( oil, coal, gas)

### 4. Development of infrastructure

- a) transportation
- b) telecommunications
- c) urban and rural planning

### 5. Environmental protection

- a) air
- b) land
- c) water
- d) other

### 6. Health ( except pollution related disease)

### 7. Social development and services

- a) culture and recreation
- b) law and order
- c) public administration
- d) other

### 8. Exploration and exploitation of the earth and the atmosphere

- a) oceans

- b) fresh water resources
- c) mineral resources
- d) geodesy, including surveys and mapping
- e) geophysics, including upper atmosphere
- f) other

9. General advancement of knowledge and research training

- a) specific grants for R&D in universities and colleges
- b) general university funding (S&T component of education ministry funding)

10. Civilian space programs

11. Defense

12. Other

## Appendix "C" - Sample questions on innovation for a survey of enterprises

[These questions assume the following questions have been asked elsewhere in the questionnaire:

- ownership of enterprise (state, sole proprietor, legal person, foreign subsidiary)
- number of employees
- sector of industry
- total value of sales
- value of exports
- sales less cost of inputs, or value added]

### Question 1

a) Does the enterprise supply or deliver products that are routine in nature, or,

b) Has the enterprise, in the past two years:

1. developed or improved products or services
2. developed or improved manufacturing or production processes
3. used or combined technologies in new ways
4. carried out a research program?

(Specify one or more of items 1 through 4)

### Question 2

If yes to part b) of question 1, what was the source of the innovation(s)? (Specify one or more from list below):

1. Production unit(s)
2. Research and development unit
3. Marketing unit
4. Proposal from parent company, owners or management
5. Purchase of patent or license
6. Customers
7. Government institute or ministry
8. Information centre or service
9. Suppliers of material or machinery
10. Competitors

### Question 3

If yes to part b) of question 1, can you estimate the cost of developing this innovation? If so, how much did you spend in the last year?

### Question 4

If yes to part b) of question 1, how many employees ( full-time equivalent) took part in

the activity? How many had university degrees?

**Question 5**

Where did the employees counted in question 3 get their most recent training?

1. Internal training
2. Recent graduate from university or technical school
3. Transferred from state institute
4. Recent graduate from a retraining program
5. Hired from a competitor
6. Short-term training abroad
7. Returned from residency abroad

**Question 6**

What, in your opinion are the impediments to developing new products or processes?

1. Lack of domestic technical information
2. Lack of foreign technical information
3. Lack of domestic financial support
4. Lack of foreign financial support
5. Government regulations
6. Lack of trained personnel
7. Lack of economic incentives