Research, Technology and Innovation in the Private Sector of Panama

Carlos Aguirre Bastos, Lourdes Palma, Violetta Cumberbatch

Directorate of Management
National Secretariat of Science, Technology and Innovation
Panama City, Panama
caguirre@senacyt.gob.pa

Key words: Research, Innovation, Private Enterprises, Technology Transfer, Technology Management

Abstract

The innovative performance of 506 private firms of all sizes and covering different productive sectors in Panama has been measured through a survey. Of these firms, 53% did not conduct any innovation activity, while in those where these activities took place, investments were mostly addressed to the import of capital goods, while smaller resources were dedicated to internal and external R&D.

In terms of outputs, process innovations are the largest in number, a characteristic that does not change independent of sector, geographical location or size of firm, but the innovative rate does grow with firm size. In spite of growing innovation activities, outputs are still limited as evidenced by the small number of patents and reduced impact of innovations in the firm's performance. Further, activities of major or relatively major complexity in innovations are not pursued.

Only 17% of firms, mainly in the manufacturing and transport sectors, have conducted mostly internal R&D activities. In the former sector, firms count with laboratories and a larger number of employees dedicated to research. In general, laboratories employ 0.41% of the total firm's personnel. For the external R&D activities, the largest number was contracted to other agents of the local productive sector. Just over 34% of firms have hired S&T services, mostly concentrated in routine activities. On the other hand, the technology balance of payments for 2008 shows an important deficit.

Only 1.5 of each 10 firms has an international quality certificate or adheres to an international standard. Within this small number the most popular are norms under ISO 9000, applied by the larger firms, and particularly those associated to the energy, transport and manufacture sectors.

The main sources of financing are internal, basically reinvestment of income, and in second place are loans from commercial banks. The evolution of expenditures is strongly influenced by the purchase of capital goods by a handful of firms. In spite of the growing presence of public financing, a large number of firms are not aware of the existing support for research and innovation programs. If only SENACYT is considered such lack of awareness is even higher. Access to existing public funding reaches only 10% of the firms.

Several factors have been identified as limiting the innovation processes in Panama. A large number of firms (42.3%) point out at internal factors such as lack of trained personnel, a problem common to all developing countries. Exogenous factors are not ignored, a key limiting factor being the small size of the market. Some limitations have not only been omitted in the responses to the survey, but have also been pointed out as irrelevant, among them mistakes in public policies for the promotion of science and technology, the limited development of S&T institutions and factors related to the intellectual property system.

Out of the total number of firms surveyed in the study, 43% and 71% of the innovative firms has declared some linkage with other agents of the national innovation system. The more frequent linkages took place in the commercial chain and in second place with other firms. Only in the last place are the S&T agents, except universities which occupy a slightly larger rate of declared linkages. The latter had the objective of obtaining information, training and technical assistance. Objectives of higher complexity such as design of R&D have not been pointed out. Most linkages were conducted internally in the country, those with agents throughout the world were almost inexistent.

A small number of cooperation agreements have been found, and the existing ones are concentrated in a reduced number of firms. In 2008 there were only 44 agreements, out of a total of declared 783 linkages with national or international institutions, conducted by 15 firms, from a total of 217 that declared to have linked.

When compared to other countries, the manufacturing firms of Panama share common characteristics with those of developing countries, namely reduced efforts for innovation. Strictly at the regional level, although Panamanian firms show a better compromise with innovation (larger relative expenditures), this is strongly linked to the incorporation of technology through the form of knowledge embedded in capital goods.

In spite of the rather discouraging results found in this study, it is also observed that there are some virtuous strategies associated to differentiated innovation conducts. In effect, it is possible to find a direct relationship between innovation intensity, productivity and quality of employment, the larger being the expenditure in innovation, the higher the productivity level and the higher the number of qualified human resources.

It is also possible to observe that such conduct occurs in all firm sizes, sectors and geographical location which evidences that innovation is a viable strategy in all sectors, and on the contrary, belonging to a dynamic or high tech sector does not necessarily guarantee a virtuous strategy in terms of social or private benefit. The challenge to policy definition then resides in identifying each individual strategy; understand the determinants of the more virtuous processes and the obstacles of the rest, to increase the impact of the innovative dynamics of the system as a whole.

Introduction

The National Secretariat for Science, Technology and Innovation (SENACYT) of Panama, conducted a survey on the behavior of research, technology and innovation (RTI) of the Panamenian private sector in 2008 (SENACYT, 2010) /[1]. This paper resumes and analyses the main findings of this survey.

During the past decades, all developed and several developing countries have advanced surveys in order to understand the behavior of the innovation process in enterprises. For the purpose of conducting systematic surveys, the Oslo Manual was developed in 1992 and later, to better fit the conditions of developing countries, the Bogota Manual was also developed. Latin America has been pioneer in the execution of innovation surveys among developing countries (Anlló, 2001).

In the case of Panama, the survey whose results are analyzed in this paper is the first to be carried out, thus adding the country to the list of those where the behavior of innovation in the private sector is starting to be better known and understood.

The survey has used the methodological base as presented in the Bogota Manual and the revisions of the Oslo Manual and also on the base of the experiences of the Ibero-American Network for Science and Technology (RICYT), and collects primary information on the innovative behavior of firms, with the main purpose of characterizing and understanding the firm's innovation dynamics, their expectations, results and linkages with the general business, government and academic environments.

This paper is divided into three main parts; the first presents the methodology followed by the survey, the second briefly notes the performance of the firms in the sample, and the third present and discusses some of the main results. On the basis of the results of the survey, the short conclusions of this paper are expected to support the definition of policies and strategies in both the public and private sectors, in order to advance in a national competitiveness agenda.

1. Methodology

The universe for the study was made up of all (3,368) firms of the national productive sector with yearly sales above 150,000 USD. The candidate survey list included 2,937 firms that had responded to the survey on Scientific and Technological Activities of the 2002 economic census and its update in 2005. From this basis the final sample was selected according to the following criteria:

/[1] The survey was conducted by the National Statistical Bureau and its results were processed and analyzed by Diana Suarez with the cooperation of Jesica de Angelis of the REDES/RICYT Center of Argentina with the support of SENACYT. The full text of the survey – study Indicadores de Innovación del Sector Privado de Panamá 2008) has been published by SENACYT in November, 2010 and can be located at www.senacyt.gob.pa/utilidades/proyectos

- Firms of strategic importance in the productive structure of the country by a joint decision between the National Institute of Statistic and Census and SENACYT.
- Firms directly related to a given technology area identified by SENACYT
- Stratification of the universe, as utilized by the Authority for the Micro, Small and Medium Size Enterprises, as shown in Table 1

Table 1: Stratification of Firms by Authority for the Micro, Small and Medium Size Enterprises

Strata	Income (USD)	Type of firm classified by income
01	150.001 a 1.000.000	Small
02	1.000.001 a 2.500.000	Medium
03	2.500.001 a 15.999.999	Large
04	Larger than 16.000.000	Very large

The final size of the sample was determined by category, applying the "optimal fixation" mathematical model

$$n = \frac{K^2}{E^2 + \frac{\sum W_h \frac{S_h^2}{}}{N}} \; x \; \frac{N \sum W_h \frac{S_h^2}{}}{}$$

Where:

n = size of the sample
K = value corresponding to the confidence level of 95% (1.96)
W_h = relative weigh of each strata
S_h^2 = variance
N = population
E = aceptable error limit

The choice of the sample responded to the need of covering all the country, while considering the high concentration of economic activities in and around Panama City. Further, the size of firm and economic activity were considered in the definition of the sample. Following this methodology, a total, a sample of 735 firms was identified, 431 intentionally and 304 by the method above. Because of difficulties in locating the firm the final sample was constituted by 711 firms to whom questionnaires were mailed and visited. Under these criteria, the sampling error is less or equal to 5%.

Of the total number of firms to whom questionnaires were mailed and visited, 506 valid responses were received (71.2%). Table 2 shows the distribution of economic activities of these firms and Table 3 their size distribution.

Table 2: Distribution of the Economic Activities of the Firms in the Sample

Sector	Number of firmas	Distribution (%)
Extraction of Stone, Sands and Salt	10	1.98
Manufacture	273	53.95
Generation, transmission and distribution of electric energy	9	1.78
Construction	23	4.55
Wholesale	66	13.04
Retailers	44	8.70
Hotels and Restaurants	32	6.32
Air, Water and Land Transport	28	5.53
Real Estate	16	3.16
Rest (Education, waste and residual water disposal, cultural, sports and entertainment activities)	5	0.99
Total	**506**	**100**

Table 3: Sample's Firm Sizes

Size	Number of firms	Distribution (%)
1-9 employees	106	20.9
10-24 employees	104	20.6
25-49 employees	76	15.0
50-99 employees	79	15.6
100-299 employees	78	15.4
Over 300 employees	63	12.5
Total	**506**	**100**

2. The General Performance of the Surveyed Enterprises

The firms surveyed declared a total of 10,952.5 million USD in sales for 2008, of which 1,073.7 million USD (9.8% of sales) were in exports. The manufacturing industry and wholesale activities explain more than 65% of the total of sales.

This relatively low participation in exports contrasts with the large volume of imports, which amounted to 3,120.1million USD (28.5% of sales), thus producing a large commercial deficit. In this same year, investments of these firms amounted to 2,227.6 million USD (20.3% of sales). Investments increased by 81.2% between 2006 and 2008, which is explained by a large increase in the purchase in capital goods. Some of the larger imports were in the construction and transport sectors, by the firms with 100 or more employees and those in the 10 - 24 employee range.

The above structure of economic activities follows the pattern of developing countries as in these, the productive structure uses processes below the technological frontier, and thus the higher imports of capital goods in the case of Panama provides a sign of the interest of firms for improving their capacities that is, looking for improvements towards more competitiveness.

The firms in the sample employ around 70,000 persons of which 97.8% are full time. As shown in Table 4, firms employ a small number of personnel with the highest academic degree, only 0.41% of the total, while 4.5% correspond to foreign employees. In spite of this distribution, 91.8% of persons employed with this high academic degree are nationals of Panama, as shown also in the same Table. The bulk of employees concentrate in the group of people having finished secondary education (61.1%), almost all of national origin (99.4%).

Table 4: Employment According to Nationality and Educational Level in 2008 (%)

(First Table: distribution of employment according to academic level; Second Table: distribution of employment according to the nationality of employees

	PhD	Master	Postgraduate	First University Title	Secondary	Other	Total
Employment Panama	0.41	1.74	1.03	17.44	61.11	18.28	**100**
Employment Foreign	4.55	10.62	3.20	36.76	38.11	6.75	**100**
Total	0.45	1.81	1.05	17.61	60.91	18.18	**100**

	PhD	Master	Postgraduate	First University Title	Secondary	Other	Total
Employment Panamanian	91.18	94.92	97.34	98.19	99.46	99.68	99.13
Employment Foreign	8.82	5.08	2.66	1.81	0.54	0.32	0.87
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Following the more traditional S&T indicators, Table 5 shows the distribution of employment according to gender and qualification of human resources. It is noted that women occupy a high percentage (42.2%) of employees in the qualified group (post secondary education), although still being a minority in the whole employment picture. In terms of size it is interesting to note that all Panamanian firms employ qualified human resources, as shown in Table 6, which might again indicate the search for genuine competitiveness, in line with the investment in capital goods.

When analyzing human resources at the disaggregated sector level, those firms in the energy sector, wholesale, transport and real estate show the higher number of qualified employees in their payroll. However, the three sectors that employ 72% of the total qualified human resources are the manufacturing industries[2], Wholesale and Hotels and Restaurants, if the transport sector is added it is possible to obtain a picture of the productive specialization of the country (in services) constituting an open space towards the search for

/[2] Further analysis would be necessary to disaggregate the manufacturing sector, which is not done in this study in order not to lose statistical significance.

sustainable development. These sectors do count a minimum of local competences that can be used to launch a strategy for the search of genuine competitiveness.

Table 5: Qualification of Human Resources by Gender (%) in 2008

	Qualified Human Resources	Human Resources with Basic Education	Total
Men	57.79	77.54	73.40
Women	42.21	22.46	26.60
Total	**100**	**100**	**100**

Table 6: Qualification of Human Resources and Size of Firms (%) in 2008

	Qualified Human Resources	Human Resources with Basic Education	Total
1-9 employees	28.80	71.20	**100**
10-24 employees	20.51	79.49	**100**
25-49 employees	19.18	80.82	**100**
50-99 employees	25.47	74.53	**100**
100-299 employees	19.36	80.64	**100**
300 and higher	20.85	79.15	**100**
Total	**20.93**	**79.07**	**100**

3. Innovation in the Panamanian Private Sector

3.1. Global Overview

Following the Oslo Manual (OECD, 2005) and the Bogota Manual (RICYT, 2001) the analysis of innovation efforts allow to classify firms as innovative, as those that invested and conducted innovation activities or non innovative. The analysis of innovation in firms consists in the study of the dynamics for the search of technological and institutional improvements in which the firm is involved. The innovation intensity (the ratio between expenditure on innovation with respect to sales) in particular allows quantifying the magnitude of such involvement. It is assumed here that the larger the relative expenditure on innovation, the larger the technological or institutional complexity of the desired innovation.

The distinction between innovative and non-innovative firms can be done more precisely by looking at output variables. It is then possible to place firms in three groups (Table 7):

- Innovative: firms that undertake innovation activities that declare having developed innovations
- Potentially innovative: firms that are conducting innovation activities but have yet to reach an innovation
- Non-innovative: firms that have not undertaken innovation activities

Table 7: Classification of Firms According to their Innovation Activities (2006 – 2008) and Results
(Out of the total sample of 506 firms)

	2006-2008	% of the Total
Innovative	220	43.5
Product innovation	*127*	*25*
Process innovations	*175*	*35*
Organizational innovations	*127*	*25*
Commercialization innovations	*102*	*20*
Potentially Innovative	17	3.3
Non innovative	269	53.2

Of the total number of both innovative and potentially innovative firms, the average effort on innovation activities was equivalent to 1.53% of sales. The distribution of expenditure shows a strong bias towards the incorporation of external knowledge, 73% explained by the import of capital goods and 9.45% by expenditures in technology transfer, as shown in Table 8. The Table also shows the large percentage of imports, noting that the import of capital goods and R&D has been increasing between the year 2006 and 2008, 32.1% to 89.1% in the first case and from 40.4% to 80.9% in the second case. Such situations shows the little recognition or distrust of firms of local research efforts.

In spite of the bias towards foreign imports it is noted an increase in R&D expenditure of around 6.5 times between 2006 and 2008. It must be pointed out however, that the increase of foreign R&D is due to only two firms, which together explain 96% of the total expenditure. A similar situation is found in the case of technology transfer, where a single firm accounts for 98% of the total. It is also noted the positive evolution of industrial design and engineering but a decrease in training efforts.

Table 8: Efforts in Innovation Activities (2006 – 2008)

	Distribution of Expenditures in Innovation Activities (%)			Accumulated 2006-2008	Expenditure Innovation Activities as % of sales 1]	% of Imports 2006-2008
	2006	2007	2008			
Internal R&D	5.12	1.88	4.18	3.86	0.07	17.98
External R&D	0.21	0.20	4.47	3.32	0.05	80.43
Capital Goods	69.59	79.17	71.94	73.00	1.08	79.64
Hardware	7.65	4.66	1.95	2.95	0.05	26.68
Software	8.19	5.21	1.76	2.96	0.05	26.42
Technology transfer	0.26	0.13	12.86	9.45	0.17	0.73
Industrial design and engineering	0.66	3.11	0.95	1.31	0.02	24.49
Management	0.11	0.79	0.25	0.33	0.01	3.10
Training	2.17	1.31	0.59	0.87	0.02	16.32
Consulting	6.03	3.55	1.05	1.95	0.04	3.89
Total	100.00	100.00	100.00	100.00	1.54	

Note 1] Total annual expenditure respect to the year 2008

As already noted 93% of innovative firms claim to have reached some positive results in their innovation efforts, meaning that 43% of the firms in the sample developed new products or processes or improvements in organization and commercialization in the period 2006 – 2008. One key indicator output indicator is patents and Table 9 shows the results of the innovation efforts as reflected by this indicator.

Table 9: Obtained Patents and Patents under Exploitation

	Number of Patents	% of Innovative Firms
Patents Obtained	42	6,4
Patents under Exploitation		85,7
Place of Granting of Patents (% of firms that obtained patents)		
In Panama	92,9	
In Central America and Caribbean	7,1	
In the USA	0	
In Europe	7,1	

Of the total number of innovative firms, almost 80% assigned a medium and high importance to the impact of innovation in commercialized products, especially due to quality improvements. A large number (86%) declared that innovations impacted in matters associated to the market, and 60% declared that innovations contributed to the access to new markets. If these results are contrasted to the fact that patenting is low or only that 17% of products were new in the international market, it is possible to affirm that a scenario exists where firms have not been able to reach the technological frontier, through improvements in productivity, or have not been able to access high value niches, through product differentiation. In general, in terms of total sales, existing percentages show the small impact of innovations in terms of performance.

Two explanations are possible for the above situation, on one hand, firms are having a more aggressive innovative attitude but without results, and on the other hand, firms are having a defensive attitude, where innovations have to do more with the defense of market, than with a strategy based on the search for sustained and genuine competitiveness

3.2. Research and Development

Table 10 shows the number of firms that have invested in R&D activities. Of the total number of firms in the sample 17% undertook in 2008 activities to generate new knowledge or new applications of existing knowledge.

Of the firms that conduct R&D activities areas of application were: 57% in engineering, 43% in the natural sciences (mainly chemistry, environment and mathematics and informatics), 25% in agriculture, 10% in social sciences, 6% in health and 1% in the humanities. R&D grows with respect to firm size, in those with less than 10 employees, 1 out of 10 conducted R&D activities, while in those with more than 300 employees this percentage goes up to 37%. In

regards to sector, those firms in manufacture and transport conduct the larger number of R&D activities, with average lower than that of the total sample.

Table 10: R&D Activities (2008)

Firms engaged in	**% of the total sample**	**% of innovative firms**
R&D activities	17	37
Internal R&D activities	15	33
External R&D activities	7	15
Firms that count on	**% of the total sample**	**% of innovative firms**
R&D Laboratories	8	18
Human Resources		
Employment in R&D (%of the total employment in the firm)	0,41	
Employment in R&D (% of average per laboratory)	6,6	

As noted in table 10, 15% of firms in the total sample have declared having conducted internal R&D activities, of which 55% declare having a laboratory. Only 0.41% of people employed are engaged with R&D activities, of which 40.8% are researchers and 38.7% technicians, while 20.4% are administrative and support personnel. Of the total, 57.4% have the first university diploma. Considering all employees, 19% of the total has postgraduate degrees, but considering researchers alone, 80% of employment has that level of education.

Of the total number of firms that conducted R&D activities, only 14 invested in education to prepare 21 males and 34 females (19.4%) of the total employment in R&D for an amount of USD 240,000. Near 50% of males attended postgraduate schools, while only 10% was awarded to females at this level. The latter mainly received support to obtain the first university degree.

There are two possible hypotheses to explain the above. The first is that education and training of personnel does not make part of the firm's strategies or secondly, employees with formal competences are contracted only after they have received their degrees. It is still open to study the way that education and training supply interact with human resources demands by firms.

Activities leading to technological development are dominated by R&D expenditures in natural sciences, engineering and health sciences, which together explain 70.5% of the total R&D and 96% of the expenditure in technological development. Table 11 shows the type of expenditure made by those firms active in R&D. It can be observed from this table, the large fraction of expenditure that goes to cover ordinary expenses and purchase of goods.

Table 11: R&D Efforts by Type of Expenditure

	R&D as % of sales	% expenditure in R&D
Ordinary expenditures	**0,45**	**64,1**
Personnel	0,32	45,3
Other current expenditures	0,13	18,7
Capital expenditures	**0,25**	**35,9**
Machinery, equipment, materials and instruments	0,25	35,1
Other fixed assets, including land	0,01	0,8
Total Expenditure in R&D	**0,70**	**100**

In relation to the socio – economic objectives of the R&D activities, Table 12 shows the distribution of expenditures. The higher percentage belongs to control and protection of the environment (47%) and agricultural technology (27%). In the first case it is possible that the existing legislation and the search for certification have generated incentives for improving the impact of the firm's activities on the environment, showing the importance of legislation as a mechanism that can trigger virtuous innovative conducts.

Table 12: R&D Efforts by Socio-Economic Objective

	% of. Expenditure in R&D
Exploration and Exploitation of Earths	0,14
Infrastructure and Land Tenure	0,00
Control and Protection of Environment	47,01
Protection and Improvement of Health	5,26
Production, distribution and rational utilization of energy	1,66
Production and agricultural technology	26,91
Production and industrial technology	13,86
Social Structures and Relations	0,28
Non – oriented research	4,84
Other civil research	0,02
Defense	0,02
Expenditure in R&D	100

In relation to agricultural technologies and industry, it is evident that the creation of comparative advantages generates incentives to technological improvement. It is then possible to think that firms investing in these activities are aiming at the generation of more value added and productivity so as to transform static comparative advantages into dynamic ones. In order to formulate a more definite conclusion it would be necessary to study micro-conducts, instead of structural aggregates, and determine how these innovative firms are different from the rest.

In relation to external R&D activities, these being considered a relatively strategic and in occasions classified information, many firms have not answered the questionnaire fully, further as already discussed not many firms have in practice conducted external R&D activities. In spite of this limitation, it is

possible to draw some conclusions from the existing information. In the first place most firms that have indicated conducting external R&D efforts, have also developed internal R&D, so it is considered that both complement each other and generate learning during the process of transfer.

In a consistent way with what is observed in dealing with linkages, as discussed further on, most of the R&D was contracted to other agents of the productive sector (93.4%), a figure that is explained by their interaction with research and technology institutes. If to this is added that 77% of contracts was done with local agents, and then there is observed a strong interaction with the firm's immediate surroundings. It is also quite worrisome that expenditures for external R&D are very small when dealing with universities. Table 13 shows the expenditures made by firms in the execution of external R&D.

Table 13: Expenditures of External R&D (% of expenditure of the total)

	% expenditure in R&D
Productive Sector	**93,4**
Subsidiaries	0,1
High risk partnership	0
Associated or affiliate companies	14,6
Research and Technology cooperation institutes	70,7
Others	8,0
Other institutions	**6,6**
Higher Education Institutions	1,1
Non profit private institutions	0,0
International Organizations	5,3
Others	0,2
Total	**100**

3.3. Scientific and Technological Services

Table 14 provides an overview of the way firms access S&T services. It can be observed that slightly more than 34% of firms have invested in contracting such services, to which 0.32% of sales were destined. The higher percentages of the distribution concentrates in consulting and technical assistance, routine tasks of programs or informatics systems, standards, metrology and quality control and market studies. This information shows a high degree of concentration in the firms' central routines and also access to knowledge that is readily applicable (market studies) and rapidly capitalized (ITCs). No mention is made of foresight activities or longer term planning strategies.

Table 14: Contracting of Scientific and Technological Services (2008)

	Number of firms		Amounts	
	Number	% of the total sample	% of sales	Distribution
Consulting and technical assistance	85	16,8	0,11	34,8
Market studies	41	8,1	0,05	14,3
Routine collection of datas	14	2,8	0,0001	0,6
Specialized medical care	11	2,2	0,00	0,2
Patents and licenses	18	3,6	0,00	1,1
Standards, metrology and quality control	38	7,5	0,01	2,1
Feasibility studies	16	3,2	0,00	0,3
Collection of general purpose information	6	1,2	0,00	0,3
Routine development of programs or informatics systems	58	11,5	0,02	6,9
Mining and Petroleum exploration	5	1,0	0,00	0,4
Reverse engineering	3	0,6	0,00	0,1
Documentary services, information and consultation to data banks	23	4,5	0,01	3,5
Translation and presentation of publications	21	4,2	0,08	26,4
Others	10	2,0	0,03	9,0
Total	**174**	**34,4**	**0,32**	**100,0**

3.4. Technology Transfer

Table 15 shows the income generated by the transfer of technology from the sampled firms and the expenses incurred for this same purpose. From the point of view of a developing country what is interesting to analyze is the dynamics of the incorporation and absorption of transferred technology and also the spillovers of such transfer. The latter was not the purpose of this study.

As already noted, the technological balance of payments of Panama is negative. It is highlighted however that the transfer abroad (income for sales vs. expenses) gives a positive result. In the table it is convenient to state that the income is the amount declared by four firms and that 99.9% of income is explained by the transfer of techniques, and the rest for technological services.

In spite of the deficit situation, the fact that firms are investing in technology transfer shows their interest in the incorporation of knowledge, which might eventually reverse the present situation. It may also be added that such investments can support the development of local suppliers as well as promoting more intense knowledge generation.

3.5. Quality Standards

As firms advance into more standardized and formalized work or pretend to gain access to more complex markets and clients, it is obliged to optimize its productive processes, which in a methodological approximation is frequently

analyzed in terms of national or international standards, most frequently the well know ISO norms.

Table 16 shows the number of firms with a quality certification, showing the very small percentage of firms which holds them, a situation that must be modified in the short term. The fact that responses include "other" as a single standard, in a high proportion, can be interpreted that there is a problem in the firm to detect which certifications are more valued.

Table 15: Income and Expenses Generated by the Transfer of Technology

	Income (a)		Expenses (b)		Superavit/Deficit (a-b) Million USD)	
	Million USD	% Origen	Million USD	% Origen	Total	Origen
Exchange of techniques	**72,0**	**100**	**94,15**	**60,3**	**-22,14**	**15,2**
Patents	72,0	100	55,00	100,0	17,00	17,0
Non patented inventions	0,0	0	0,00	0,0	0,00	0,0
Revealed Know-how	0,0	0	1,04	100,0	-1,04	-1,0
Patent licenses	0,0	0	8,57	0,6	-8,57	-0,1
Other industrial property rights (design, models, trademarks, franchises)	0,0	100	29,54	2,3	-29,53	-0,7
Technology Content Services	**0,2**	**96,8**	**9,58**	**70,9**	**-9,36**	**-6,6**
Technical studies, consulting and engineering	0,1	93,6	8,29	80,3	-8,18	-6,6
Technical assistance services	0,1	100	1,28	10,5	-1,17	0,0
Independent contracts	0,0	0	0,00	10,5	0,00	0,0
Total	**72**	**99,99**	**103,72**	**61,3**	**-31,50**	**8,7**

Table 16: Firms with Quality Certification

	% over the whole sample	Number of firms
ISO 9000	7,91	37
ISO 14000	1,98	10
ISO-IEC 17025	0,40	2
Other	8,89	47
Total	15,42	79

3.6. Sources of Information for Innovation Activities

Frequently the access to information sources is highlighted theoretically as a market failure that requires some type of intervention. In Panama, the access to information is limited strongly to the firms' internal sources as shown in Table 17, followed by clients and suppliers which are closely related. Other important sources such as universities or fairs and even less patent data, are not traditionally sought by firms as sources of information. This may be interpreted by the weak or disarticulated innovation system which characterizes the country.

Table 17: Sources of Information for Innovation

Sources of Information	% over the total sample
Internal sources	33,6
Executives - managers	12,71
Engineering or production departments	10,67
Strategic plans	8,04
Commercialization department	7,74
Initiatives of tem R&D department	4,38
Design department	3,94
Clients	11,5
Suppliers	8,6
Competitors	5,1
Fairs and Expositions	4,1
Consultants	3,9
Universities or research centers	1,8
Other sources	1,6
Patents	0,6

The search for internal information is not just a characteristic of Panamanian firms, but also from other developing economies, although with less emphasis in more technological developed countries. Table 18 shows a comparison between a few selected countries.

Table 18: Sources of Information for Innovation Activities (%)

Agents	Argentina	Brazil	Chile	Mexico	Uruguay	Panama	Germany	France
Internal sources	78	65	60	41	82	71	55	51
Clients	46	61	28	63	78	36	39	25
Competitors	42	43	8	47	60	18	11	8
Suppliers	46	64	26	40	78	24	23	20
Consultants	35	12		30	39	4	2	5
Universities	24	12	10	13	39	4	5	3

3.7. Financial Resources for Research and Innovation

Table 19 shows the distribution of the sources of financing for innovation used by the Panamanian firms. For the case of sources for financing R&D activities, Table 20 shows those existing sources and the degree of access by firms.

Table 19: Sources of Financing for Innovation Activities (% of expenditures)

	2006	2007	2008
Own resources by reinvestment of income	52,1	57,0	45,8
Own resources by contributions of shareholders	1,7	1,0	11,4
Resources of Head Office	2,7	3,3	5,1
Resources of other forms in the group	4,0	0,6	10,9
Resources of suppliers	0	0	6,4
Resources of clients	0	0	0,1
Resources of other firms (of the same sector or others, competitors or not)	0	0	0
Resources of universities (public or private)	0	0	0
Resources of foundations, nonprofit associations and NGOs	0	0	0
Resources of promotional public organizations	0,03	0,14	11,2
Resources of the private commercial bank – private or public -	39,4	37,9	8,8
Resources of international organizations (IADB, World Bank, European Union, etc.)	0,1	0	0,2
Other sources	0	0	0
Total	**100**	**100**	**100**

Table 20: Sources of Financing for R&D (% of the total expenditures in R&D) (over 78 firms that conducted R&D activities)

	2008
Productive Sector	**50,31**
Own resources	50,31
Other firms	**47,05**
Public firms	0,07
Private firms	46,90
Research Institutes	0,08
Government	**1,49**
Central government	1,49
Non profit prívate institutions	0
Foundations	0
Others	0
Higher education institutions	**0**
Private	0
Public	0
Foreign resources	**1,16**
Foreign firms	1,16
International agencies	0
Other organizations	0
Total	**100**

From the table it can be concluded that self-financing continues to be the preferred source of financing, which evidences the strong limitation that firms face when large scale or more complex projects are envisaged. On the other hand re-investment encounters limits in the rate of return, which is affected when processes and products are modified. It is also a threat that the firm can become trapped in a vicious circle where the lack of investment limits its performance and its poor performance attempts against investments.

3.8. Public Support to Innovation

Public support to innovation has been proven to be an effective instrument for its promotion in both developed and developing countries. In the case of Panama, and in spite of inconsistencies in the responses to the questionnaire, the situation of the knowledge of public support to innovation by firms in the private sector can be resumed as follows.

A 40.1% of firms know of at least one government program, and if the analysis is done on those which have actually accessed such programs the percentage drops to 9.7%. Even though it should not be expected that all firms access public finds for innovation, the difference between knowing a program and access is highlighted and can be a situation related to access conditions or lack of communications of opportunities, as well as refusal of firms to relate to other agents of the innovation system.

In relation to SENACYT's programs, 33.8% of firms declared knowing them and 7.1% had accessed them at one point in time. Many firms know the "Calls for promotion of entrepreneurial innovation" (9.1%) followed by the firms who know the fellowship programs (7.5%) and finally the "Calls for R&D" (7.1%). For other government agencies, 30% of firms know of the program for "Promotion of SMEs" and 20% the program "Compite Panama". However the rates of access to these two programs are very low 0.4% and 0.8% respectively. Such low rate of access maybe due to the short term visions of firms without the intention of innovating, risk aversion or what is very worrisome the cost benefit analysis that is made by firms of the effort that access supposes (bureaucratic procedures, filling forms, etc) against the small amount of resources that can be obtained (credit, information or knowledge).

3.9. Obstacles to Innovation

The identification of obstacles to innovation are key to determine future policies to promote research, technology and innovation, it can be said that the success of innovation policy will absolutely depend on how accurate is the definition of the obstacle countered that needs to be eliminated. Here, obstacles that have been faced by both innovative and non innovative firms have been identified. In the latter case, such obstacles were in many cases determinant as to why the firm did not engaged in innovation activities.

Table 21 provides a list of the obstacles (both endogenous and exogenous) pointed out by firms and Table 22 the reasons why firms (those in the non innovative group) do not carry out innovation activities.

To provide a comparison of the obstacles for innovation that are found throughout the world, Table 23 shows the obstacles observed in a set of selected developing and developed countries.

Table 21: Obstacles to Innovation

Obstacles	% of firms	Average by category
Endogenous		**41,30**
Lack of trained personnel	51,45	
Organizational rigidities	33,33	
Risk to innovate	48,91	
Period of return	31,52	
Exogenous		**38,87**
Reduced market sise	53,26	
Market structure	49,64	
Little dynamism of technological change in the sector	42,03	
Few possibilities of cooperation with other firms or institutions	36,23	
Easy imitation by third parties	32,97	
Insufficient information en market	39,13	
Insufficient information on technology	40,22	
Errors in public policies that promote R&D	29,71	
Little development of Science and Technology related institutions	32,36	
Physical infrastructure	36,23	
Intelectual property system	23,55	
High cost of training	51,09	

Table 22: Reasons for not innovating (% of firms that provided medium and high importance)

	% of the total sample	% of non – innovative firms
Do not consider necessary to innovate	21,5	40,5
Lack of trained personnel to execute innovation projects	12,5	23,4
Lack of private financing to execute innovation projects	11,1	20,8
Market does not require or value new products	10,5	19,7
Small market size	9,1	17,1
Lack of knowledge of public support to innovation projects	9,1	17,1
Innovate does not pay out	8,1	15,2
Lack of public financing to execute innovation projects	5,9	11,2
Others	3,6	6,7
Difficulties to access public support mechanisms	3,2	5,9

Table 23: Obstacles to Innovation in Selected Countries (% of firms)

	Argentina	Brazil	Chile	Colombia	Mexico	Uruguay	Panama	Germany	France
Lack of trained personnel	76	5	32	66	23	30	60	5	17
Risk of innovation	56		25	16			60		
Period of return	73		35	64		25	36		
Small market size	72			44		45	58		
Market structure	78	3				27	54		
Little dynamism of the sector's technology change	69		12	58			48		
Difficulties to access financing	86	7	38	60	40	20			
Few opportunities to cooperate with other firms / institutions	58	3	36	54		18	43	3	11
Easy to be imitated by third parties	54		22	48		15	39		
Insufficient market information	39	4	26	45	30	14	46	3	7
Insufficient information on technology	40	4	26	37	18	11	46	11	5
Failures in S&T public policies	68				29	19	34		
Little development of S&T related institutions	64		23	70		16	38		

3.10. Linkages of Firms with other Agents of the National Innovation System

Lundvall (1992) and Tether (2000) consider that firms cannot innovate in isolation, but there is empirical evidence emanating from innovation surveys that shows that many firms both in developed and developing countries do not link with other agents. Panama is not the exception to the rule as only around 7 out of 10 innovative firms linked with other agents of the system, while only 17% of non innovative firms did. Table 24 provides a more precise overview of the inter - agent linkages and Table 25 the objectives pursued.

Considering the characteristics of linkages and taking as reference the 127 firms that declared having linked with another agent of the innovation system, it is observed that the most frequent interaction is produced in the commercial chain. It is also interesting to note the high positioning of the universities, which are just behind suppliers and clients. It is also noted that linkages with government promotion agencies, technical training institutions and technology centers have a much reduced linkage with firms.

Regarding objectives, it should be noted that the execution of design and R&D as well as financing occupy the lowest ranks. These results are consistent with the above observations regarding the importance of the commercial chain, and point out to activities which have to do more with routine procedures than the search of technological or organizational improvement, which require the search of more complex objectives, which in turn demand more information and investments and higher degree of competences.

Table 24: Linkages by Type of Agent (% of firms over the total that have declared a linkage in the period 2006 – 2008)

Agents of the innovation system	% of responses
Suppliers	57,14
Clients	42,86
Universities	33,18
Consultants	32,26
Firms in the same group	28,11
Other enterprises	23,96
Laboratories and R&D enterprises	16,13
Head Office	16,13
Technology Centers	10,60
Government agencies or promotion programs	8,76
Technical training institutes	8,29
Technology linkage units	6,91

Table 25: Objectives of Linkages

Objectives	% of firms
Information	68,66
Training	43,78
Technical Assistance	41,47
Financing	27,19
Design	22,58
Advisory tasks	21,20
Essays	14,75
R&D	14,29

The results obtained also point out to the need of advancing towards a strategy for the strengthening of the dynamics of the innovation system, as well as a strategy capable of exploiting existing linkages between agents of the system. In this way the latter could be used to advance towards new linkages and the identification of non – linkages as inputs for the design of policies that are capable of contributing to the innovation system as a whole.

Several studies, in particular those dealing with open innovation systems maintain the importance of geographical location of the agents with who firms link. In the case of Panama, the largest fraction of linkages is with Panamanian agents (67.4%), while the rate of linkage with other countries and regions being quite small. The second most important linkages occurred with USA and Canada (10.3%), Latin America (8.8%) and Central America (6%)

In terms of the agent and localization, being the universities, suppliers, clients and consultants the most mentioned by firms, it is observed that for all the preeminence of Panama prevails, although the relation with suppliers in the USA and Canada also stands out. This is of course natural as the largest expenditures for innovation activities are in the purchase of capital goods.

In the survey firms were also asked with respect to the existence of cooperation agreements with the innovation system agents. The results are not very positive. For 2008, only 6 local agreements were declared for innovation, which are concentrated in three firms and only 4 international agreements were declared, two of which belong to one firms that had local agreements. In total, there were only 44 cooperation agreements, out of a total of 783 declared linkages with both national and international institutions, explained by 15 firms, out of a sample of 506 and of a total of 217 that declared having linked with the systems' agents.

In spite of the small number it is convenient to analyze the agreements' characteristics. Out of the local agreements (72.7% of the total), 13.6% were signed with producers of goods and services, 15.9% with higher education institutions and 27.3% with non-profit private institutions. The international agreements are mostly geared towards producers of goods and services and non-profit organizations.

These values show the scares formality of the linkages, which also sheds doubts on the technological complexity of interactions as well as the sustainability of existing interactions. This is because informality is in general more associated to personal relations than institutional arrangements. In the first case continuity depends on persons, and in the second, it is a scheme that reinforces itself with time.

Conclusions

The analysis made in this study shows the limited innovation efforts that are made by firms in the private sector of Panama, in spite of existing public support. It is thus necessary that organizations as SENACYT define improved policies in the promotion of research, technology and innovation for this key economic sector. Further, it can be maintained that the Panamanian system of innovation is characterized by a low density mesh, with scarce linkages to more complex technological developments and little formalization of such linkages.

In spite of the rather discouraging results found in this study, it is also observed that there are some virtuous strategies associated to differentiated innovation conducts. In effect, it is possible to find a direct relationship between innovation intensity, productivity and quality of employment, the larger being the expenditure in innovation, the higher the productivity level and the higher the number of qualified human resources.

It is also possible to observe that such conduct occurs in all firm sizes, sectors and geographical location that evidences that innovation is a viable strategy in all sectors, including traditional, and on the contrary the belonging to dynamic or high tech sector does not necessarily guarantee a virtuous strategy in terms of social or private benefits. The challenge resides then in identifying each strategy; understand the determinants of the more virtuous processes and the obstacles of the rest to increase the impact of the innovative dynamics of the system as a whole.

References

Anlló, G. (2001) An Overview of Latin American Innovation Surveys, in Measuring Innovation in OECD and non-OECD countries (W. Blankley, M. Scerri, N. Molotja, and I. Saloojee, editors), Selected Seminar Papers of an OECD – DACST (South Africa) joint Seminar, Pretoria, March

ECLAC (2008) Economic Statistics of Latin America and the Caribbean, Economic Commission for Latin America, www.cepal.org

Lundvall, B. Å. (ed.) (1992) "National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning", London, Pinter.

OECD (2005) “Oslo Manual: Guidelines for collecting and interpreting innovation data”. OECD, Paris, France.

RICYT (2001) "Manual de Bogotá: Normalización de Indicadores de Innovación Tecnológica en América Latina y el Caribe", OEA/ RICYT/COLCIENCIAS/OCT.

SENACYT (2010) Encuesta de Investigación, Desarrollo e Innovación en el Sector Privado de Panamá – Año 2008, PricePrint Editores, Noviembre

Tether, B. (2000) "Who co-operates for innovation within the supply-chain and why?: An analysis of the United Kingdom's Innovation Survey" CRIC, The University of Manchester & UMIST Discussion Paper Nº 35