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University Company Government Interaction: FAPEMIG as Propeller Agent of the Scientific-Technological Development in Minas Gerais, Brazil

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This article aims to present the main indicators for Science, Technology, and Innovation (ST&I) generated by the Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG) in four years (2008-2011). The methodology used was a case study, with documentary research, held in the annual reports of activities of the foundation. The results showed that all indicators analyzed in aggregate form, evolved gradually. It is concluded that the FAPEMIG comes complying with their mission to induce and encourage research and scientific and technological innovation for the development of the State of Minas Gerais in the southeast region, maintaining the recognition as one of the main agents of development inductors ST&I in Brazil.

Keywords: development, innovation, university

Introduction

The constant promotion of science, technology and innovation (ST&I) allows a nation to achieve sustainable socio-economic development. Federal Law nº 10.973/04 of Brazil "establishes incentives for innovation and scientific and technological research in the productive environment, with a view to training and within the reach of technological autonomy and industrial development of the country" encouraging the construction of specialized environments and cooperative innovation (Brazil, 2004).

In Brazil, through agencies, foundations, and funds, to finance actions linked to ST&I happen to contribute to the development of the country. The foundations of ST&I are most representative in Brazil, which are linked to the federal government. These, according to some state laws are sponsored with 1% of all taxes collected, ensuring their activities.

According to Ministério da Educação (MEC) (2012), "The foundations are institutions created with the purpose of supporting the projects of research, teaching, and extension of institutional, scientific, and

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technological development, the interests of federal institutions of higher education (IFES) and research institutions also" (p. 1), thus being able to contribute faithfully to the achievement of national innovation systems in a nation.

In numbers, the Conselho Nacional das Fundações de Amparo à Pesquisa (CONFAP) (2012) Brazilian national territory confirms that there are 24 state foundations, these three have higher representativeness for funding, in large financial flows, ST&I. The Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ), and Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG) make up this trio.

In this context, choosing the FAPEMIG as a case to be studied, the research aims to present the main indicators for ST&I generated by the foundation.

For both the organization of the present study begins with this introduction, followed by section two "Innovation and Competitiveness", section three "National Innovation System", and section four "Cooperation Between: University, Company and Government". The sections two, three, and four contains concepts relevant to this research. In continuity, section five presents "The Research Method", which is the methodological procedure used to develop this research. Section six describes the "Studying Object", recounting a brief history of the foundation. Lastly, section seven show the "Results" followed by "Conclusions" in section eight.

Innovation and Competitiveness

Zaltman, Duncan, and Holbek (1973) defined innovation as an idea, practice, or a material that is perceived as a new and relevant application. Thus, Dosi (1998) confirmed that search involves innovation, experimentation, discovery, development, and adoption of new products, new production processes, and new organizational settings.

The ability to generate technological innovation is proportional to the economic development of a nation. The economist Joseph Schumpeter is one of the first proponents of this binding between a country's development and its ability to innovate. The original idea of Schumpeter guides the thought of a broad group of economists, called "neo-schumpeterian", is that technological innovation is the engine of economic development.

In the current environment, marked by competitiveness, innovation is seen as a way to overcome competition and achieve competitive advantage. From innovation strategies, opportunities can be converted into new ideas and put into widespread practical use (Tidd, Bessant, & Pavitt, 2001).

According to Rogers (2003), the "most innovations are created by scientific research, although they often result from the interaction between scientific methods and practical problems" (p. 140). Therefore, the "innovation is no longer perceived necessarily as a linear process, but as a result of the complex interaction of various actors and institutions that constitute a system of agents strongly interdependent" (OECD, 1999, p. 11).

Tidd et al. (2001) evidenced during the 1990s, through their researches in industrial organizations and English services, organizations can use innovation to differentiate their products and services, which are typically twice as profitable as the others.

Understanding innovation as an economic power at the end of 2004, the Brazilian Federal Government sanctioned the innovation law (Law No. 10.973). Barbosa (2006) explained that this law encourages the promotion of ST&I in the industry, seeking the improvement of technological skills and Brazilian industrial

development. This law covers important aspects as cooperation between science and technology institutions and enterprises, the division of laboratories, incubation of small enterprises in public research institutes, services of research and development for businesses for businesses, the establishment of technology transfer offices (TTOs), as well as the participation of researchers in economic gains generated by the inventions and innovative sponsorship (Maculan, 2005).

National Innovation System

Freeman (1995) set the national innovation system as a set of institutions, actors, and mechanisms in a country contribute to the creation, advancement, and dissemination of technological innovations. Simonini (2010) included the universities, companies, research institutions, and other associations as actors, which in turn relating to the market and the current financial system, converges to the formation of the innovation system.

OECD (1999) presented a pattern of co-operation in national innovation systems, in which we highlight the following: cooperation between university and industry; geographical proximity; innovation depends on cooperation; knowledge-intensive services; informal cooperation and trust; and finally it is rising that the innovation system has different patterns of cooperation.

There is a diversity of systems because of their stage of development in each country. According to Albuquerque (1999), this diversity could be perceived by the characteristics of the configuration of each system, such as the specifics of innovative companies, the interaction between firms and universities or research institutions, and even the various forms of financing of research and innovation.

Cooperation Between University, Company, and Government

The cooperation between university, government, and company appears at the beginning of the 21st century as an instrument to promote technological development, dissemination, and uptake of innovations. According to Queiroz (2007), “The ability to innovate depends on the conduct of scientific research and requires human resources capable of generating and transmitting new knowledge” (p. 3).

In this context, the role of universities has been acquiring greater relevance, since they still present themselves as the main locus in the trainer of new knowledge (Rapini, 2007).

In this scenario, it is crucial to the existence of an academic institution that plays a role in the innovation system and in the social, technological, and economic development of the country. The university aims to be an enterprising demand creation of complex structures within it to house companies of technological base, promoting cooperation between researchers and local businessmen.

The effects caused by these changes drive the debate about what is the appropriate role that universities should play in matters related to technology and knowledge transfer.

Etzkowitz and Leydesdorff (2000) believed that, in response to this new environment, universities should take ownership of the “third mission”. In addition to contributing to the development of the country with the formation of high-level human resources and research, third mission would seek to incorporate the mission to contribute more directly to economic development through cooperative and collaborative initiatives with the productive sector in order to achieve greater applicability for the knowledge produced.

Within this context, the entrepreneurial university differentiates itself from others with regard to three

basic characteristics: support for entrepreneurial activities; the existence of mechanisms for interface, such as the offices of technology transfer; and a significant number of employees capable of creating companies (Dzisah & Etzkowitz, 2009).

Research Method

As to the nature, this research is classified as applied. In relation to the objectives, this research is descriptive and exploratory. As for the approach, this research is classified as qualitative using the case study method.

The survey took place in two stages. The first corresponded to bibliographical research, in which it was necessary to review the existing literature and define the scope of the search, creating products such as the theoretical and research basis identification. The second was the documentary analysis phase, in which it was necessary to verify the common indicators for ST&I, in the reports consulted, making possible the formation of the results.

The documentary analysis phase, covered the annual activity reports in the period from 2008 to 2011, accessed via the foundation's institutional website.

Studying Object

The FAPEMIG is a foundation of the State Government, linked to the Secretary of State for science, technology, and higher education, was created by Law Delegated nº 10, from August of 1985, which has the mission: "induce and encourage research and scientific and technological innovation for the development of the State of Minas Gerais", seeking "be recognized as the principal agent inductor scientific, technological development and innovation in the State of Minas Gerais" (FAPEMIG, 2011, p. 18).

Their performance is linked to the financing of scientific and technological research projects, in encouraging the training of human resources for science and technology, the establishment of scientific and technological research groups, in promoting the productive sector and integrative research institutions and development, supporting the organization of scientific and technological events, to carry out exchanges between Brazilian and foreign researchers in the routing and guidance of patenting and commercialization of innovative products and processes.

The beneficiaries of the actions performed by FAPEMIG consist of Minas Gerais-based institutions or researchers that they maintain bond that falls into one of the following categories: (1) scientific, technological entities, and Innovation—STEIs; (2) direct and indirect administration corporations of the government of the State of Minas Gerais, aimed at the development of ST&I or other related scientific and technological activities; (3) associative entities, not-for-profit whose objectives are geared towards the promotion of scientific and technological development; (4) private companies, enterprise companies, incubators, technology parks and the like, serving notices and specific programs; and (5) individual researchers to keep some ties to STEIs, the activities developed by FAPEMIG are ensured by the State Constitution, which determines the allocation of 1% of the current budget revenues of the State for the promotion of ST&I.

Results

In the quadrennium, the State Treasury provided USD 499 million, which added to external funds obtained, totaled USD 589 million invested in actions to promote the ST&I as shown in Table 1.

Table 1

Kept Financial Resources

Year	State treasure (US$ millions)	Own and external resources (US$ millions)	Total (US$ millions)	Growing (%)
2008	110	13	123	
2009	102	14	116	-5.6
2010	132	29	161	38.7
2011	155	34	189	17.3
Total	499	90	589	

As the targeting of funds raised in the quadrennium, the research projects, adding their natures (universal, induced, special, endogovernamental, and structuring) achieved major transfers, followed by investment in human resource training and scholarships, administrative costs, promotion of scientific and technical studies events and dissemination actions. Table 2 details the allocation of those resources.

Table 2

Percentual Execution of the Financial Resources

	Item	2008 (%)	2009 (%)	2010 (%)	2011 (%)
01	Research projects—Universal	23.9	24.3	17.5	19.5
02	Research projects—Inducted	16.0	20.1	29.3	27.3
03	Scholarship and HR formation	23.9	24.3	17.0	17.8
04	Scientific events	2.4	2.0	2.2	2.0
05	Special projects, endogovernamental, and structural	29.3	24.3	29.0	28.6
06	Other activities (technical studies and disclosure)	1.2	1.0	1.0	1.0
07	Administrative expenses	3.3	4.0	4.0	3.8
Total		100	100	100	100

As for the number of research projects included in the universal demand (independent-inducing themes), gradual growth in submission of these during the quadrennium, and even noting a reduction in the hiring of the projects in the year 2009, the remaining year's recovery was reaching maximum hiring 750 projects in 2011. These numbers are detailed in Table 3.

Table 3

Universal Research Projects Submitted and Hired

Universale edital	Submitted quantity	Submitted growing (%)	Hired quantity	Hired quantity (%)
2008	1,436		737	
2009	1,546	7.6	703	-4.6
2010	1,799	16.3	720	2.4
2011	1,866	3.7	750	4.1
Total	6,647		2,910	

As the number of research projects included in the induced demand (with induction of subjects by state organs), the growth of the submissions of the other years from the year of 2009 was significant, as shown in Table 4. The data from 2008 and the quantities contracted for other years were not disclosed in the reports consulted.

As the training of researchers in the quadrennium to FAPEMIG offered 5,811 shares the scientific initiation within the school through the “Scientific Initiation Scholarships Jr.—BIC Jr.”, 15,077 dimensions to scientific initiation within the undergraduate program “Institutional Program for Scientific Initiation Scholarships—PIBIC”, 3,379 units in mastering, 2,315 in doctorate, 1,143 in post-doctorate, 128 at 542 and a visiting scholar program on technological development, totaling 22,640 quotas directed the training of researchers. The distribution of these shares and the percentage growth rates compared to the previous year are detailed in Table 5.

Table 4

Submitting of Inducted Research Projects

Inducted edital	Submitted quantity	Growing (%)
2009	1,610	
2010	4,143	157.3
2011	3,173	-23.4
Total	8,926	

Table 5

Shares of Financial Assistance for Training of Researchers

	2008	2009	Growing (%)	2010	Growing (%)	2011	Growing (%)	Total
Bic Jr.	819	1,133	38.3	1,273	12.3	1,383	8.6	5,881
PIBIC	2,510	2,944	17.2	3,064	4.0	3,495	14.0	15,077
Mastering	608	645	6.0	675	4.6	776	14.9	3,379
Doctorate	429	436	1.6	453	3.9	544	20.0	2,315
Post-doctorate	347	288	-17	222	22.9	64	-71.1	1,143
Researcher visitor	30	18	-40	26	44.4	28	7.69	128
Technological development	93	125	34.41	112	10.4	100	-10.7	542
Total	4,836	5,589		5,825		6,390		28,465

As the number of higher education institutions benefited from mining shares made available the scientific initiation programs, PIBIC program directed graduation contemplated more institutions that the BIC Jr. program which is targeted to high school. Already the quotas directed the graduate (*stricto-senso*), the master of most institutions that encompassed the doctorate as details in Table 6.

Table 6

Institutions Benefited by Financial Aid Quotas

Benefited institutions	2008	2009	Growing (%)	2010	Growing (%)	2011	Growing (%)
Bic Jr.	30	35	16.6	42	20.0	43	2.3
PIBIC	60	65	8.3	71	9.2	76	7.0
Mastering	32	34	6.2	35	2.9	35	0.0
Doctorate	13	16	23.0	17	6.2	18	5.8

As for the support of scientific events in the quadrennium, the foundation has promoted 1,016 events, and provided participation in 3,420 events, 1,210 collectively, 1,145 individually in international events, and 1,065 individually in Brazilian events. Table 7 details these numbers.

Table 7

Support the Organization of and Participation in Scientific Events

Organization and participation in events	2008	2009	Growing (%)	2010	Growing (%)	2011	Growing (%)	Total
Organization	234	236	0.8	238	0.8	308	29.4	1,016
Group participation	246	287	16.6	337	17.4	340	0.8	1,210
Exterior individual part	291	230	-20.9	303	31.7	321	5.9	1,145
Individual Brazil part	269	231	-14.1	260	12.5	305	17.3	1,065

As for the evaluation of projects undertaken in the quadrennium (5,504), 57.41% evaluated projects were recommended, 36.35% condicioned (needs improvement), and 6.23% rejected. Points out that in the year 2008 the project evaluation Committee was not yet established, what justifies the absence of data in that year. The numbers of reviews are detailed in Table 8.

Table 8

Evaluation of Projects

Year	Recommended	Condicioned	Rejected	Total
2009	341 (23.2%)	1,015 (69.1%)	113 (7.7%)	1,469 (100%)
2010	1,540 (75.3%)	434 (21.2%)	71 (3.5%)	2,045 (100%)
2011	1,279 (64.3%)	552 (27.7%)	159 (8.0%)	1,990 (100%)
Total	3,160 (57.41%)	2,001 (36.35%)	343 (6.23%)	5,504 (100%)

In the quadrennium, 40,224 scientific products were developed, 18.30% of these are articles published in magazine, 40.58% Congress presentations, 2.36% book chapters, 0.49% published books, 1.09% electronic publications, 1.19% newspaper publications of dissemination, 18.02% summaries published, 8.27% works published in annals of events, 2.95% doctoral theses and 6.75% master dissertations. These numbers are detailed in Table 9.

Table 9

Scientific Products Generated in Finished Projects

Products	2008	2009	Growing (%)	2010	Growing (%)	2011	Growing (%)	Total
Articles published in magazines	875	2,453	180.3	2,144	-12.6	1,890	-11.8	7,362
Congress presentations	1,747	5,436	211.1	4,620	-15.0	4,520	-2.1	16,323
Books' chapters	87	314	260.9	270	-14.0	280	3.7	951
Published books	12	60	400.0	61	1.6	63	3.2	196
Electronic publications	61	172	181.9	88	-48.8	156	77.2	477
Publications in disclosure newspapers	69	124	79.7	136	9.6	111	-18.3	440
Published abstracts	675	2,467	265.4	2,119	-14.1	1,985	-6.3	7,246
Works in events annals	327	1,017	211.0	1,024	0.7	960	-6.2	3,328
Doctorate theses	137	408	197.8	361	-11.5	281	-22.1	1,187
Mastering dissertations	320	897	180.3	793	-11.5	704	-11.2	2,714
Total	4,310	13,348		11,616		10,950		40,224

Table 10
Intellectual Property Protections

Year	Trade marks	National patents		Patentes internacionais		Computer programs
		Institutional	Independent	Institutional	Independent	
2008	7	17	4	6	0	3
2009	20	36	2	5	0	9
2010	13	38	1	19	0	8
2011	10	32	9	6	1	21
Total	50	123	16	36	1	41

As intellectual property protections, FAPEMIG provides approval of computer software, patents, and trademarks (national and international) divided into two fronts: institutional and independent. In the quadrennium, 50 brands, 176 patents, and 41 computer software's have been developed through the support of the foundation. These numbers are detailed in Table 10.

Conclusions

According to the indicator developed by the Economist Intelligence Unit (EIU) that analyzes 25 indicators in eight categories to form the ranking of the best places to invest, the State ranked third in General, being recognized as the third largest economy in Brazil, with positive indices of political stability, market growth, incentives for investment, provision of skilled labor and the promotion of research and development (EIU, 2011).

The prominent position reported is worth much to the growing performance of FAPEMIG in actions development ST&I. The developing mining economy providing an increase in worker income, increasing their purchasing power, causes an increase in consumption levels. The state benefits from this growth (Increase in consumption levels) collecting more taxes, and the foundation too, because it gets 1% of this taxes. This sequence of facts allowed the foundation to increase the resources invested in 2011 to record fundraising.

The allocation of these resources during the quadrennium are mostly directed to research projects, provision of scholarships to aid research and training human resources, shares these priorities of the foundation. Both priorities observed positive growth, based on the first year of the quadrennium compared to others.

On the research projects, it was noted the latent concern foundation in follow projects funded, in order to verify that the desired results were achieved, justifying the expenditures made and providing subsidies for public managers to guide and refine the policies of science and technology.

It was noticed that the foundation held concern to cover its actions between higher education institutions in the State, looking for spraying among them the quotas available to researchers, avoiding concentrate resources, seeking joint development of these institutions.

Aiming to disseminate and share the knowledge generated by the projects and researchers, the foundation also listed in its priorities the promotion of scientific events, noting during the quadrennium increasing in a number of events promoted. In this same framework, the foundation through its researchers, concentrated efforts on the elaboration of scientific products, where in all of their natures, there was a plausible growth, highlighting the increase in publications of articles in scientific journals.

Not only looking for share, but also protecting the knowledge produced, the foundation created the intellectual property management, aiming at the advancement of intellectual property policy, recognizing the strategic importance for technological innovation in the State.

In summary, the results make it possible to infer that the management of FAPEMIG happens in a structured way, realizing that the funds obtained for the actions of ST&I follow normal levels in every year, showing that the foundation has clear strategies regarding the determination of priorities, which is recognized as fundamental for the scientific and technological development of Minas Gerais State.

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