

Scientific financial funding in Colombia, from 2000 to 2012

Original Research

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ABSTRACT

Colombian scientific funding has doubled in the past twelve years. This study evaluates the financial trends of Science, Technology and Innovation (STI), Research and Development (RD) and COLCIENCIAS (Administrative Department for Science, Technology and Innovation) between 2000-2006 and 2007-2012. Available data from The World Bank, OCyT (Colombian observatory of science and technology), DANE (National statistics department), Banco de la República and COLCIENCIAS was used to evaluate financial growth rate, funding source by sector (private, public and international), financial expenditure, and activity related expenses from 2000 to 2012. Regression models were used to fit financial trends. Colombian STI and RD funding increased from \$1,296.7 million US dollars in 2000-2006 to \$2,766.4 million US dollars in 2007-2012. Financial analysis showed a significant increase of public funding through the government ($p < 0.05$). However, government and firms expenditure did not change from 2000 to 2012. STI, RD and COLCIENCIAS funding has grown during the past years.

Keywords: Scientific research and technological development; Research financing; Health sciences, technology and innovation management; Colombia. (source: MeSH NLM).

Original Research

Presupuesto de financiación científica en Colombia, del 2000 al 2012

ABSTRACT

La financiación científica en Colombia se dobló en los últimos 12 años. Este estudio evalúa las tendencias financieras de Ciencia, Tecnología e innovación (STI), Investigación y Desarrollo (RD) y COLCIENCIAS (Departamento Administrativo de Ciencia, Tecnología e Innovación) entre el 2000-2006 y 2007-2012. Se usó información disponible del World Bank, OCyT (Observatorio Colombiano de Ciencia y Tecnología), DANE (Departamento Administrativo Nacional de Estadística), Banco de la República y COLCIENCIAS, se analizó la tasa de crecimiento, fuente (privada, pública, internacional) y ejecución financiera, así como ejecución por actividad del 2000 al 2012. Se usaron modelos de regresión para estimar tendencias financieras. La inversión en STI y RD aumentó entre 2000-2006 y 2007-2012 de \$1,296.7 a \$2.766.4 millones de dólares, respectivamente. Análisis evidenció un incremento significativo ($p < 0.05$) en la inversión pública, siendo el gobierno el principal partícipe. Sin embargo, la ejecución financiera del gobierno y empresas no mostró cambios. La financiación Colombiana en STI, RD y COLCIENCIAS aumentó en los últimos años.

Palabras clave: Investigación científica y desarrollo tecnológico; Financiación en investigación; Ciencias de la Salud; Administración de tecnología e innovación; Colombia (fuente: MeSH NLM).

Original Research

Captação de recursos científicos na Colômbia, 2000-2012

RESUMO

Nos últimos 12 anos, a captação de financiamentos científicos na Colômbia dobrou. Este estudo avalia as tendências financeiras da Ciência, Tecnologia e Inovação (STI), Investigação e Desenvolvimento (RD) e COLCIENCIAS (Departamento Administrativo de Ciência, Tecnologia e Inovação), entre 2000-2006 e 2007-2012. Dados do Banco Mundial, OCyT (Observatório Colombiano de Ciência e Tecnologia), DANE (Departamento Nacional de Estatística), Banco de la República e COLCIENCIAS foram utilizados para analisar: a taxa de crescimento nos investimentos, origem do financiamento por setor (privado, público e internacional), despesas, e atividades relacionadas às despesas, entre 2000-2012. Modelos de regressão foram utilizados para se chegar às tendências financeiras. O financiamento em STI e RD aumentou de US\$ 1.296,7 milhões de dólares em 2000-2006 para US\$ 2.766,4 milhões de dólares em 2007-2012. A análise mostrou um aumento significativo no financiamento público ($p < 0,05$), mesmo que as despesas do governo e das empresas não tenham se alterado entre 2000-2012. Financiamentos de STI, RD e COLCIENCIAS têm crescido nos últimos anos.

Keywords: Inovação, científico e desenvolvimento tecnológica; Financiamento de investigação; Ciências da saúde; tecnologia e gestão da inovação; Colombia. (source: MeSH NLM).

Introduction

Scientific and technology funding has led to secondary benefits in health, socioeconomic development, culture and education (Frank & Nason, 2009; North & Bárcena, 1993; Sachs, 2001). Funding for research comes from both public and private sources, with private funds usually directed towards commercial purposes and public with social interests; nevertheless, the goals and benefits of both are not mutually exclusive (Maceira, Paraje, Aramayo, Duarte Masi, & Sánchez, 2010).

Colombian science dates back to colonial times; a few notable historical examples include: in 1783, a botanical project with the main goal of describing nature in the Americas was begun under the leadership of José Celestino Mutis. Eventually, the areas of Santafé (currently, Bogotá D.C) and surrounds were explored. This expedition lasted over 30 years, and led to the collection and classification of thousands of animals and vegetables species. In the mid XIX (19th) century, a historical project involving the cartographic description of the current territory was completed under the supervision of Agustín Codazzi and Manuel Ponce de León (Obregón, 1991).

In the past, scientific projects were begun without major outside involvement or funding. Following the founding of several non-governmental institutions (Icetex, Sena, among others) and universities in the XX (20th) century, this began to change. In 1968, a public fund (Ospina Bozzi & Fondo Colombiano de Investigaciones Científicas y Proyectos Especiales Francisco José de Caldas, 1998) for science and technology was created under the name of COLCIENCIAS (Administrative Department for Science, Technology and Innovation); currently, COLCIENCIAS is in charge of development of science and technology in Colombia and is largest funding source in the country.

In order to provide better communication between COLCIENCIAS and government, the National Science Technology and Innovation Council (National Science and technology Council, Consejo Nacional de Ciencia y Tecnología - CSTIS) was founded. Legislation in the past two decades has made COLCIENCIAS and CSTIS the main regulators of policy in the Colombian Science, Technology and Innovation (STI) system.

In present times, increased attention has been given to STI and Research and Development (RD) due to its positive impacts on industry, education and culture (Frank & Nason, 2009; Sachs, 2001). However, few studies have focused on the changes in funding of STI and RD in Colombia in the last twelve years. Other studies have described this pattern by area of interest (Dorsey et al., 2010; Garro, Mormontoy, & Yagui, 2010; Maceira et al., 2010; Martínez-Martínez et al., 2012; Moses III, Dorsey, Matheson, & Thier, 2005; Yagui, Espinoza, & Caballero, 2010). The present work will assess: (1) patterns among the private, public and international sectors for STI and RD, (2) trends in Colombian STI for funding, activities, and expenditure, (3) trends in COLCIENCIAS funding.

Methods

Sources of data:

Reports from 2000 till 2012 were taken from public and non-profit institutions: OCyT (Colombian observatory of science and technology), DANE (National statistics department), Banco de la República and COLCIENCIAS. Also from profit organizations: World Bank Group. Some sources were published in both English and Spanish, others exclusively in Spanish.

Colombian scientific funding was divided into an early (2000 till 2006) and late (2007 till 2012) period. The main goal of the present study is to describe and characterize the differences between these periods.

The three sectors of STI and RD, public, private, and international. To identify further STI (no RD data is currently available) funding differences data were grouped as in OCyT 2012 (Lucio et al., 2012; Salazar et al., 2010), between: (1) Firms, (2) Government, (3) Education institutions, (4) International, (5) Research centers, (6) Medical centers, (7) Private non-profit and (8) Professional associations and NGOs. STI expenditure (excluding International) was also analyzed. Activity related expenditure was categorized as: (1) Research and development, (2) Innovation, (3) Administrative related activities, (4) Support for scientific training, (5) Scientific and technological services (Lucio et al., 2012).

Values reported in terms of the Colombian peso were converted to US dollars (annual exchange average). PPP conversion factor (GDP) to market exchange rate ratio (The World Bank Group, 2013a) was used for comparative purposes, as suggested by other authors (Bénassy-Quéré & Roussellet, 2012; Martínez-Martínez et al., 2012). Currently, there is no data or source related to the Biomedical Research and Development Product Index - BRDPI- (Dorsey et al., 2010; Moses III et al., 2005).

Statistical methods:

Data was analyzed on a MATLAB 7.13 platform (MathWorks, Natick, MA). Financial trends were analyzed using a polynomial regression model. A two tailed t-test with a significance of 5% was applied to compare the periods of 2000-2006 and 2007-2012.

Results

Colombian GDP (adjusted for purchasing power parity exchange rate ratio) almost doubled between the early and late period. Financial STI support as part of the GDP ranged from 0.27% to 0.47%, while RD showed a more stable pattern, 0.11% to 0.18%.

During the period of 2007 to 2012 the scientific financial budget increased significantly for STI ($p < .001$), and RD ($p < .001$) when comparing to the 2000-2006 period. As shown in Figure 1, STI and RD increase steadily. Total funding for STI and RD doubled in the periods evaluated (Table 1). Annual growth rate for STI, RD and COLCIENCIAS had a constant increase tendency for both periods.

COLCIENCIAS funding increased (adjusted for purchasing power parity US\$ exchange rate ratio) dramatically from \$70.3 US million dollars in 2000 to \$323.8 US million dollars in 2012. COLCIENCIAS and STI funding followed a similar trend (Figure 1.): a significant increase ($p < .001$) was found in the late period (Table 1.).

Private funding:

The private sector contributed approximately 51.43% (± 8.22) of STI from 2000 till 2006, compared to a 42.92% (± 6.41) from 2007-2012 period ($p = 0.064$), indicating a decrease proportion of private funding (Figure 2). On the other hand, private contribution to RD was stable: 40.64% (± 4.18) vs 41.20% (± 5.52) ($p = 0.838$) (Figure 3).

Public funding:

Current political efforts had led to a steady grow in this area. STI public funding significantly increase ($p = 0.0486$) increase from 44.87% (± 7.92) in 2000-2006 to 53.72% (± 6.10) in 2007-2012 (Figure 2). By comparison, RD continues having a steady trend in each period ($p = 0.4961$) (Figure 3).

International funding:

Although international investment is not a significant contributor to scientific funding in Colombia, there was a significant decrease ($p = 0.009$) in international RD funding between 2000-2006 (6.53% ± 1.83) to 2007-2012 (4.11% ± 4.7) (Figure 3). International funding of STI showed no significant change in this periods ($p = 0.526$) (Figure 2).

STI funding per institution:

Government and firms provided most of the funding resources from 2000 till 2012 (Table 2). There was a noteworthy increase ($p < .05$) in government funding during the period of 2007-2012 period. On the other hand, a decrease ($p < .05$) in firms funding was observed, likely contributing to the decrease in the STI private funding (Figure 2.). Funding from minor sources such as medical centers ($p < .05$), private nonprofit institutions ($p < 0.001$) and ONG ($p < 0.01$) showed a significant increase during the late period. However, university contribution decreased ($p = 0.001$), while international ($p = 0.527$) and research center ($p = 0.822$) funding showed no significant difference.

STI expenditure institutions:

The institutions spending most of STI funding (Table 3) from 2000 till 2012 were firms, government, universities and research centers. Firm ($p = 0.119$), government ($p = 0.094$) and research centers ($p = 0.280$) expenditures did not change, while university expenditure showed a decrease ($p < 0.001$). Medical centers ($p < 0.05$), private nonprofit institution ($p < 0.001$) and ONG ($p < 0.01$) expenditures showed significant increases.

STI expend by activity:

From 2000 till 2012, research and development, innovation, and scientific and technological services made up the majority of STI expenditures (Table 4). During the 2007-2012 period an increase was seen in research and development ($p < 0.05$), support for scientific and technological training ($p < 0.05$), and scientific and technological services ($p < 0.01$). On the other hand, a significant decrease in innovation ($p < 0.05$) and administrative related activities ($p < 0.01$) was found.

Discussion

The previous analysis described the funding and expenditure trends for scientific research in Colombia between 2000 and 2012. Since 2004, a steady increase in funding in Colombia was observed in STI, RD and COLCIENCIAS (Figure 1). Also, the annual growth rate for STI, RD and COLCIENCIAS increased in both periods.

Analysis of 2000-2006 vs. 2007-2012 showed the proportion of funding from public sources increased in the later period. The economic recession in 2009 may have caused the increased variability in funding of the late period. The recession may have had a more pronounced impact on private sector funding, which had its lowest contributions to STI (37.03%) and RD (30.85%) during this year (Figures 2 and 3).

Analysis of STI funding institutions showed that firms and government supplied the majority of funding. Interestingly, by 2000 firms provided the majority of funding (51.75%); by 2012, perhaps due to government initiatives, government has become the major funding source (51.73% in 2012). Public funding is characteristically seen in developing countries (Ladenheim, 2011), a trend that seems to be establishing in the last century due to budget volatility. STI expenditure overall is funded largely by firms, government and research centers, the combined proportional contribution of which has remained relatively constant.

As shown in the OCyT 2012 (Lucio et al., 2012), firms expend most of their funding in innovative activities and in research and development. On the other hand, government focuses on scientific and technological services and innovation activities. Finally, research centers tend to focus mainly on research and development.

The legislative acts of the past 12 years have increased STI expenditure in research and development, support for scientific and technological training, and scientific and technological services, but not in innovative activities.

Some of the previous improvements and changes were triggered by criticisms directed at the CSTIS. In 2003, an exploratory study found administrative and coordination failures between government institutions which led to deficient public funding for innovation projects of small and medium-sized businesses (Matlin et al., 2009). The study argued that legislative changes were needed to promote positive results in Colombian STI (Matlin et al., 2009). An evaluation of government initiatives (1990, 1991, 1992 and 2001) was done over the years.

Legislation in the past decade has increased scientific funding and reorganized Colombia's scientific budget. By 2009 (Senado de la República de Colombia 2009), the scope of COLCIENCIAS (Departamento Administrativo de Ciencia, Tecnología e Innovación) had changed, increasing the entity's autonomy and power regarding different aspects of STI and RD. In parallel, communication with the CSTIS (the main scientific policy regulator) was markedly improved (Senado de la República de Colombia 2009).

In 2009, CONPES (Economical and Social Politics Council, Consejo de Política Económica y Social) adopted the promotion of STI as one of their goals, with the aim of improving cooperation with the CSTIS. CONPES promoted high-value goods in scientific and technological policy. A focus on energy, natural resources and biotechnology led to the creation of the Green Innovation which focuses on topics such as biofuels, alternative energy and biodiversity (OECD, 2012; UNESCO Regional Bureau for Science in Latin America and the Caribbean 2010). Other areas such as genetic and agricultural research also benefited from the increased cooperation between private and public sectors (OECD, 2012; UNESCO Regional Bureau for Science in Latin America and the Caribbean 2010). Another legislative act in that time period created the Francisco José de Caldas Fund, which mobilized over 138 million USD to the COLCIENCIAS budget during 2010 (Restrepo Cuartas, 2010).

In 2011, another significant legislative act was passed regulating the exploitation of non-renewable natural sources. According to this act, 10% of royalty incomes will be directed to a national STI fund; in 2012 this fund totaled approximately 429 million USD (Maldonado Castañeda & Sanchez Vargas, 2012).

The current decrease in STI innovation activities ($p < 0.05$) has led to political efforts to stimulate the sector. As stated by the Colombian National Planning Department (DNP, Vision Colombia 2019), the promotion of small to medium Colombian businesses will lead to an increase in innovation and entrepreneurship. These ongoing efforts hope to propel Colombia's future economic competitiveness.

Over the years, the Colombian diaspora has slowed and domestic support for graduate study has greatly improved; financial aid became accessible for many more candidates than before (Lucio et al., 2012). In parallel, during the past decade the "Policy for social Appropriation of STI" has increased community participation in STI (UNESCO Regional Bureau for Science in Latin America and the Caribbean 2010). Today, the community works as an active mediator in the regulation of STI, promoting the cultural value of science. Colombian society has actively influenced the selection of projects and the creation of laboratories, institutions and new programs during the past decade.

Previous studies have shown that Latin American countries have a similar scientific and technological structure (Ribeiro, Albuquerque, Franco, & Moura, 2009). Despite current efforts, Colombian RD expenditure is still behind from other Latin American and developed countries (Table 5), the latest have at least 1% RD GDP funding (The World Bank Group, 2013b), mostly by the private sector (Grueber & Studt, 2009; Ladenheim, 2011; Wadsworth, 2010). Over the last decade Colombian funding pattern trends towards the public sector, resembling developing countries (Ladenheim, 2011).

Conclusions

Although this study is based on financial trends, current data obscures how the STI, RD and COLCIENCIAS budget was directed by sector of interest (biomedical, education, environment, engineering research, among others), addressing this issue will eventually help to understand how the research portfolio match or not Colombian needs. One of the greatest challenges is to get 1% of the GDP for science and technology (Dorsey et al., 2010; Lucio et al., 2012; Moses III et al., 2005), nevertheless the continuous increase seen in the Colombian scientific budget will lead to not just economic but to social and educational improvements. A constant appreciation for science (reflected in several policies) might indicate a change in perspective in the understanding of STI and RD as main actors in the development and continuation of Colombian culture.

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Table 1. Statistics of Colombian STI¹, RD² and COLCIENCIAS³ financial budget, from 2000 to 2012.

	2000-2006	2007-2012	Statistics
Colombian CPG in billion US Dollars	116.7 ± 27.3	279.0 ± 62.2	p<0.001
Colombian CPG growth rate	2.91 ± 13.07%	8.29 ± 10.2%	Non-Significant
STI budget in million US Dollars	948.0 ± 244	1,988.0 ± 263	p<0.001
STI budget growth rate	7.15 ± 18.66%	9.5 ± 16.28%	Non-Significant
Public funding	44.87 ± 7.92%	53.72 ± 6.10%	p<0.05
Private funding	51.43 ± 8.22%	42.92 ± 6.41%	Non-Significant
International funding	3.69 ± 0.99%	3.34 ± 0.88%	Non-Significant
RD budget in million US Dollars	348.6 ± 83.0	778.3 ± 92.4	p<0.001
RD budget growth rate	7.74 ± 10.7%	8.84 ± 13.25%	Non-Significant
Public funding	52.81 ± 4.24%	54.67 ± 5.26%	Non-Significant
Private funding	40.64 ± 4.18%	41.20 ± 5.52%	Non-Significant
International funding	6.53 ± 1.83%	4.11 ± 0.47%	p<0.01
COLCIENCIAS budget in million US Dollars	73.7 ± 21.0	215.4 ± 77.5	p<0.001
COLCIENCIAS budget growth rate	19.92 ± 33.2%	9.5 ± 22.35%	Non-Significant

Values adjusted for purchasing power parity (US\$ PPP) exchange rate ratio.

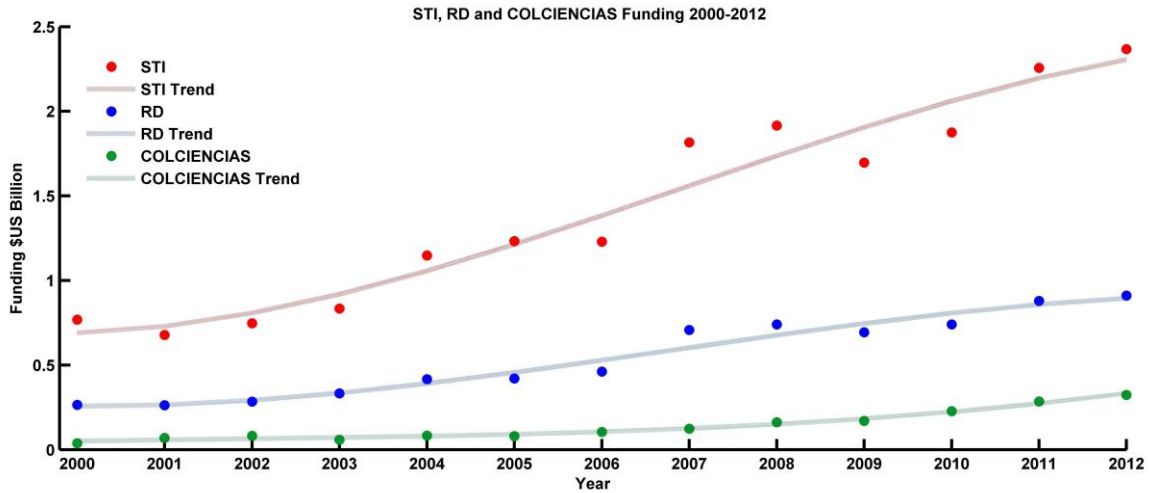
STI¹: Science, Technology and Innovation.

RD²: Research and Development.

COLCIENCIAS³: Administrative Department for Science, Technology and Innovation.

Source: The World Bank, Banco de la República, OCyT [2010, 2012], DANE and COLCIENCIAS

Figure 1. STI¹, RD² and COLCIENCIAS³ financial budget, from 2000 to 2012.



Values adjusted for purchasing power parity (US\$ PPP) exchange rate ratio.

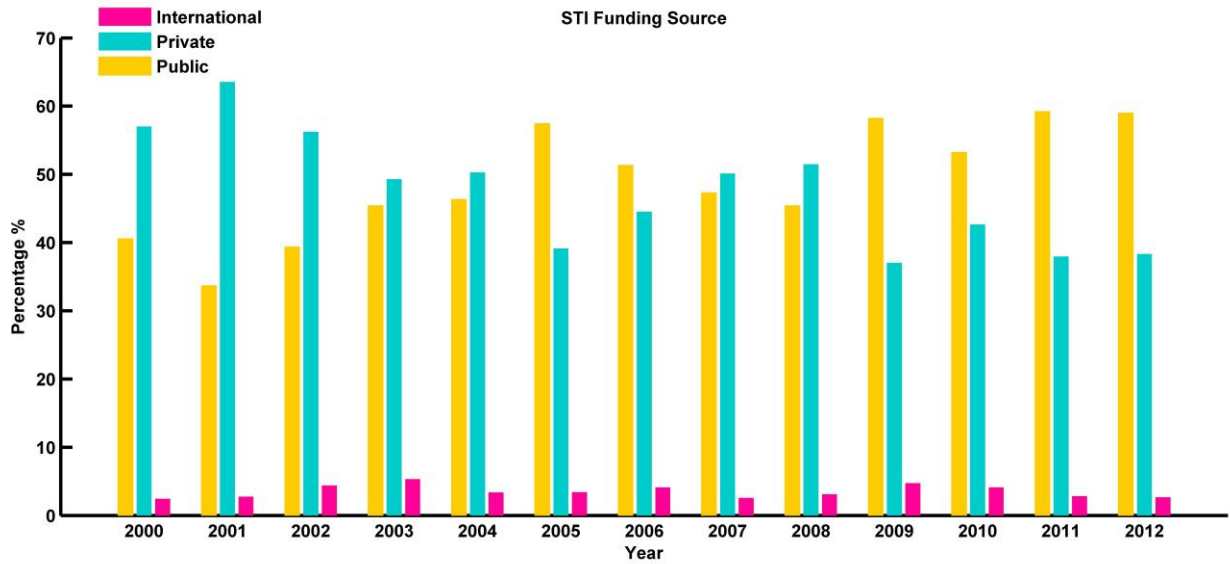
STI¹: Science, Technology and Innovation.

RD²: Research and Development.

COLCIENCIAS³: Administrative Department for Science, Technology and Innovation.

Source: The World Bank, Banco de la República, OCyT [2010, 2012] and COLCIENCIAS.

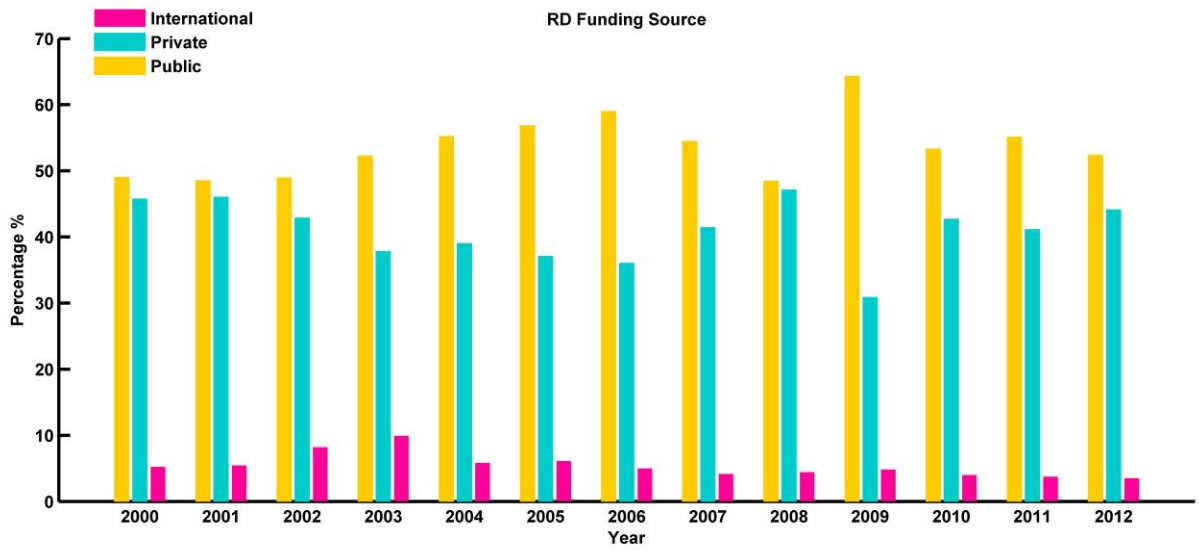
Figure 2. STI¹ financial budget by sector, from 2000 to 2012.



STI¹: Science, Technology and Innovation.

Source: OCyT [2010, 2012].

Figure 3. RD¹ financial budget by sector, from 2000 to 2012.



RD¹: Research and Development.
Source: OCyT [2010, 2012].

Table 2. Statistics of Colombian STI¹ funding source by institution, from 2000 to 2012.

	2000-2006	2007-2012	Statistics
Firms	45.41 ± 8.52%	35.62 ± 6.36%	P<0.05
Government	36.01 ± 7.70%	46.28 ± 6.05%	P<0.05
Education institutions	11.77 ± 0.59%	10.13 ± 0.49%	P<0.001
International	3.69 ± 0.99%	3.34 ± 0.88%	Non-Significant
Research centers	2.38 ± 0.82%	2.47 ± 0.32%	Non-Significant
Medical centers	0.46 ± 0.69%	1.14 ± 0.22%	P<0.05
Private nonprofits institutions	0.09 ± 0.03%	0.65 ± 0.29%	P<0.001
ONG	0.16 ± 0.02%	0.33 ± 0.11%	P<0.01

STI¹: Science, Technology and Innovation.

Source: OCyT [2010, 2012] and DANE.

Table 3. Statistics of Colombian STI¹ expenditure by institution, from 2000 to 2012.

	2000-2006	2007-2012	Statistics
Firms	42.89 ± 7.45%	36.59 ± 5.67%	Non-Significant
Education Institutions	26.16 ± 1.1%	22.86 ± 1.16%	P<0.001
Government	16.9 ± 7.4%	23.03 ± 3.8%	Non-Significant
Research centers	10.7 ± 2.07%	11.8 ± 1.2%	Non-Significant
Medical centers	1.4 ± 0.7%	2.4 ± 0.4%	P<0.05
Private nonprofit institutions	1.3 ± 0.3%	2.3 ± 0.3%	P<0.001
ONG	0.6 ± 0.08%	1.03 ± 0.3%	P<0.01

STI¹: Science, Technology and Innovation.

Source: OCyT [2010, 2012] and DANE.

Table 4. Statistics of Colombian STI¹ expenditure by activity, from 2000 to 2012.

	2000-2006	2007-2012	Statistics
Research and development	36.9 ± 2.1%	39.2 ± 0.9%	P<0.05
Innovation	41.4 ± 5%	34.5 ± 3.7%	P<0.05
Support for scientific and technological training	6.2 ± 0.9%	7.5 ± 1.3%	P<0.05
Scientific and technological services	6.9 ± 3%	13.5 ± 2.7%	P<0.01
Administrative	8.5 ± 1.5%	5.2 ± 1.5%	P<0.01

STI¹: Science, Technology and Innovation.

Source: OCyT [2010, 2012].

Table 5. RD¹ (GDP² percentage) expenditure by country, from 2002 to 2010.

	2002	2003	2004	2005	2006	2007	2008	2009	2010
United States	2.62%	2.61%	2.55%	2.59%	2.64%	2.70%	2.84%	2.90%	
Brazil	0.98%	0.96%	0.90%	0.97%	1.01%	1.10%	1.11%	1.17%	1.16%
Argentina	0.39%	0.41%	0.44%	0.46%	0.49%	0.51%	0.52%	0.60%	
Mexico	0.44%	0.40%	0.40%	0.41%	0.39%	0.37%	0.35%	0.40%	
Colombia	0.12%	0.14%	0.14%	0.14%	0.14%	0.15%	0.14%	0.15%	0.16%

RD¹: Research and Development.

GDP²: Gross domestic product.

Source: World Development Indicators, The World Bank.