



United Nations Conference on Trade and Development

Distr.: General
18 February 2013

Original: English

Trade and Development Board
Investment, Enterprise and Development Commission
Fifth session
Geneva, 29 April–3 May 2013
Item 5 of the provisional agenda
Investment, innovation and technology for development

Investing in innovation for development

Note by the UNCTAD secretariat

Executive summary

Promoting technological learning and innovation is among the most powerful levers that can be used to stimulate structural change, improve firms' competitiveness and create growth and jobs. Public policy has a central role in developing science, technology and innovation (STI) capabilities. The purpose of this note is to provide some background information for a policy dialogue in the Investment, Enterprise and Development Commission about the options available to developing countries in this field as well as some examples of good practice in this area.

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Introduction

1. Innovation is a major driver of economic transformation and development. Enabling and fostering innovation has long been considered a core strategic goal of economic policy in more advanced economies, and is receiving increasing attention in most developing countries.

2. Finance plays a fundamental role in technological change and innovation. The availability of financial capital and the organization of financial markets strongly influence the way new technologies are deployed and new techno-economic paradigms emerge (Pérez C, 2002). Innovation often involves significant capital investments and is an uncertain, risky undertaking, which makes it more difficult to mobilize the necessary resources. For enterprises lack of finance is often a major obstacle to innovation. This is a common finding of the Science, Technology and Innovation Policy Reviews that UNCTAD carries out in developing countries.¹

3. Although innovation materializes most often as an entrepreneurial activity, the public sector plays a critical role in it.² The existence of market failures affecting the production and diffusion of knowledge and technology is a broadly recognized justification for public funding for innovation. As put by Nobel Laureate Kenneth J. Arrow (1962), “we expect a free enterprise system to underinvest in invention and research (as compared with an ideal) because it is risky, because the product can be appropriated only to a limited extent, and because of increasing returns in use.”³ Studies have shown that the social rate of return of public investments in research and development (R&D) can be several times larger than private investments.⁴ However it must be underlined that R&D investments should be linked with, and supportive of, policies addressing a broad range of other obstacles that may impede the emergence of innovation systems. In other words, innovation policy cannot be limited to the funding of R&D.

4. The purpose of this note is to provide some background information for a policy dialogue in the Investment, Enterprise and Development Commission about the options available to developing countries to fund innovation. It also presents some examples of good practice in this area. Section I describes the main vehicles that exist for the funding of innovation. Section II presents some data about levels of investment in innovation in different countries. Section III presents experiences of innovation funding in various contexts. The paper closes with a section of conclusions and suggestions for discussion.

¹ Available at [http://unctad.org/en/pages/publications/Science,-Technology-and-Innovation-Policy-Reviews-\(STIP-Reviews\).aspx](http://unctad.org/en/pages/publications/Science,-Technology-and-Innovation-Policy-Reviews-(STIP-Reviews).aspx).

² See for example United States National Academies of Science (2007). In the information technology sector alone, a 2012 report by the United States of America’s National Research Council calculated that \$500 billion per year of private sector revenue could be traced back to research by public sector agencies. See National Research Council (2012).

³ For a recent overview of the issue, see for example Hall B and Learner J (2010).

⁴ See for example Klette T J, Moen J and Griliches Z (1999).

I. Instruments for financing innovation

A. Financing gaps for innovation by enterprises

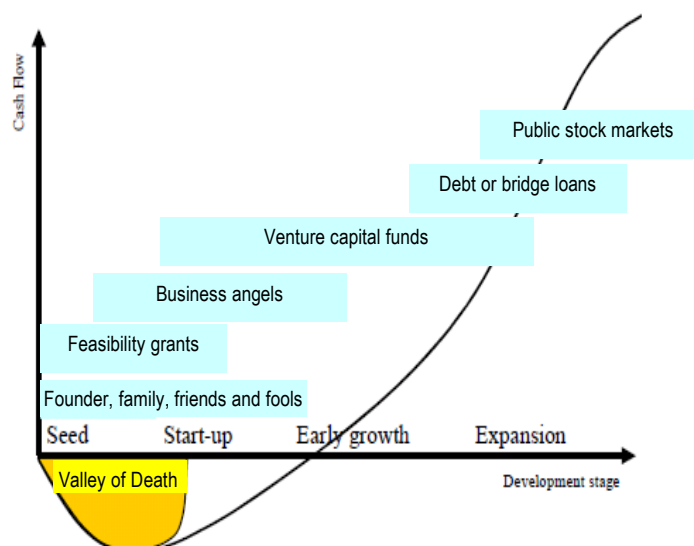
5. Figure 1 presents the stages of development of an innovative new technology-based enterprise and the financing challenges typically faced as the enterprise develops over time. Cash flow is initially negative as the creative idea begins to be developed into a commercially saleable technology or product, which for technology-based ventures will likely require R&D. Cash flow generally remains negative at the start-up stage of the enterprise and directly afterwards, until the business is running and can start growing such that sales revenues from operations lead to a positive cash flow (the early growth stage). The initial period up to the point of successfully developing the technology, product or process to the point of commercial viability is generally the time where financing is least available, and is traditionally known as the “valley of death”. Many innovators at this point are blocked by a lack of financing from further pursuing an innovation process that could lead to commercially successful products.

6. External financing is also often scarce at the early growth stage, where a product has been adequately developed and needs to be scaled up to a commercially viable level. Both the seed capital and early growth stages of innovation typically experience severe bottlenecks in financing in most countries.

7. Some countries have developed instruments to alleviate the seed finance problem for promising innovative activities. Examples include, inter alia, the Small Business Innovation Research programme in the United States of America, the Tuli programme and the Finnish National Fund for Research and Development in Finland, the Scottish Co-investment Fund and the University Challenge Seed Fund in the United Kingdom of Great Britain and Northern Ireland, Commercialization Australia in Australia, and Action Community for Entrepreneurship Start-ups and the Start-up Enterprise Development Scheme in Singapore.⁵ The cash flow position and size of initial financing needs may depend on the activity or industry in question, with some requiring large investments even at the early stages of operations.

⁵ See United Nations Economic Commission for Europe (UNECE) (2009) and Pelly R and Krämer-Eis H (2011).

Figure 1
Cash flow and financing as an enterprise develops over time



Source: United Nations Economic Commission for Europe (2009).

Abbreviation: 3Fs, family, friends and fools.

8. As an enterprise matures, financing often becomes less of a bottleneck. The amount of financing needs is likely to grow with the development of the firm, such that initial financing may be relatively small while large amounts may be required during the expansion stage. Established firms already in late expansion or maturity are generally beyond the valley(s) of death, and financing innovation is often less difficult.

9. Access to financing for an innovative activity is likely to be more problematic for innovative start-up firms. Financing for small and middle-sized enterprises (SMEs) and microenterprises is in general more challenging than for large firms in most countries, although the severity of the problem may rise in inverse relation to the level of development or national income. Innovative start-ups face the disadvantages of both lack of an established history (a previous track record, experience and collateral) and small size, in addition to the relatively high risk and uncertainty of undertaking technology development or an innovative activity.

B. Instruments for financing innovation

1. Direct financing

a. Private financing

Personal savings, family and friends

10. In most cases, early stage seed and start-up financing is provided by the entrepreneur's own funds along with financing from family and friends. This can include debt financing through the innovator's personal credit.

Partners' (or employees') personal savings

11. Bringing in partners is a common way to finance part of the expenses. Partners can bring expertise as well as financing. Employees, where they exist, may also provide financing.

Retained earnings

12. For enterprises that have already been established, retained earnings from the profits of previous years are a common source of innovation financing. The generation of a dynamic profit–investment nexus where profits finance additional investment, leading to continued profitability and investment, can be an effective mechanism for building a dynamic industry of growing firms.

Business angel financing

13. Business angel investors are an important source of financing at the seed and early growth stages in many developed countries and some developing countries.⁶ Business angels are wealthy individuals who make early-stage equity investments in new or young ventures. They usually provide significant technical, managerial and business expertise in addition to finance. They are similar to informal, non-institutional venture capital but are likely to operate at a smaller scale and provide financing at an earlier stage than is the case with informal, non-institutional venture capital. They generally operate at the national level (OECD, 2011a). Little information is available on the existence of business angels in least developed countries (LDCs).

14. Business angel networks are being formed globally and national angel associations or federations are being established as trade bodies to represent the industry. Examples of regional associations include Tech Coast Angels and Common Angels in the United States; and of national associations, the Angel Capital Association in the United States, the National Angel Capital Organization in Canada, France Angels in France, the Danish Business Angel Network in Denmark and the China Business Angels Association in China; with the European Business Angel Network a Europe-wide federation, the Business Angel Network Southeast Asia a regional federation in Asia and the Latin American Association of Angel Investors a new regional federation (OECD, 2011a).

Venture capital

15. Venture capital has existed in the United States since the 1940s, becoming a mainstream financing mechanism in the 1970s. Many developing countries (such as Brazil, Chile, China, Taiwan Province of China, India, the Republic of Korea and Singapore) attempted to develop venture capital markets during the 1980s and 1990s. Venture capital is equity financing provided by either venture capitalists or institutional investors, generally at the early growth or expansion stages, aiming to take advantage of high growth potential firms that have already started operations. They increasingly fund at the later expansion rather than early growth stage, and are later stage investors than business angels. Their investments can be relatively long term, up to 10 years in duration. One segment of the venture capital market is relatively informal and non-institutional in nature. The bulk of venture capital is from firms that run venture capital funds that seek outside investors, mainly institutional investors, who provide the bulk of financing. The venture capital firm provides professional managers for venture capital funds. They often operate on a larger

⁶ For a recent overview of the issue, see Organization for Economic Cooperation and Development (OECD) (2011a).

scale than business angels and may not have strong entrepreneurial skills or specific industry expertise. They may or may not provide expertise in addition to finance, but do monitor closely the progress of the firm and intervene to improve management and performance.

16. Venture capital is widely recognized as an important source of equity finance for enterprise innovation. Private equity is often put together with venture capital, although a large part of private equity represents investment in leveraged buyouts, which is very different in nature from traditional venture capital. Both institutional venture capital and private equity tend to invest in larger companies, with a minority of financing allocated to small firms. venture capital funds can be either private or public, but the bulk of them are private sector owned and operated. Venture capital funds are increasingly international in their investments (UNECE, 2009 and OECD, 2011a).

Commercial bank loans

17. Commercial banks are the most traditional, and in most developing countries the largest, source of financing for enterprises. Some developing countries (such as Taiwan Province of China and the Republic of Korea) used Government-owned commercial banks to overcome financing constraints of firms in the 1950s, 1960s and 1970s through directed credit programmes, effectively using them as development banks. SMEs in many developing countries have difficulty in accessing bank loans at affordable interest rates, and the high cost of credit remains a major constraint. Especially in LDCs, this constraint has represented a longstanding bottleneck on enterprise innovation. Commercial banks are in general relatively risk averse and experience has shown that they may not represent the ideal instrument for financing innovation by new enterprises as opposed to established, larger companies.⁷ This has been partly attributed to the relatively high information, transactions and monitoring costs that they face in making small loans to SMEs.

Stock exchanges

18. Stock exchanges allow firms to raise money through equity offerings, but only for already established companies seeking expanded financing; for many stock exchanges, this is only for companies of a minimum-size threshold that excludes most new firms. There exist several well-established exchanges for SMEs in developed countries such as NASDAQ in the United States, the Alternative Investment Market in the United Kingdom, Alternext with French, Dutch and Belgian securities, the Canadian market's TSX Venture, the entry market of the Frankfurt Stock Exchange, First North dealing in Swedish, Finnish and Icelandic securities and Spain's Alternative Stock Market. Secondary exchanges for SMEs also exist in developing countries such as the Growth Enterprise Market of Hong Kong, China, and others in Egypt and India.⁸ Others, such as Kenya and Zimbabwe, are considering the launch of a secondary exchange.⁹ Financing from stock exchanges is generally at later stages, during expansion or maturity. It is particularly relevant in innovation financing as a traditional means for venture capital and angel investors to exit the investments that they make in enterprises. Exiting through initial public offerings on stock exchanges, along with selling their equity stakes to investors operating in the industry (trade sales), represent the two most common avenues through which venture capital investors liquidate their investment positions and release cash for additional venture capital investments.

⁷ See for example Her Majesty's Treasury (2004).

⁸ See <http://www.world-exchanges.org/>.

⁹ See <http://www.reuters.com/article/2011/08/24/kenya-market-smes-idAFL5E7JO1PS20110824> and <http://www.newsday.co.zw/2012/12/14/zse-pushes-for-sme-listing/>.

Bonds

19. Bond issuance is generally reserved for larger, established companies and is not a source of financing for young firms or small early stage operations. For large firms it can represent a source of financing for innovative activities.

Value chain financing

20. For companies that operate as part of a value chain, there is the possibility of some sources of finance, such as credit to supplier firms in national, regional or global value chains, for the purchase of inputs needed for production. An expansion in this type of financing through global value chains has reportedly taken place since the outbreak of the global financial and economic crisis in 2008 as a measure to reduce the negative shock that some firms experienced from the loss of commercial bank credit after the crisis. This type of financing may be less likely for new firms.

Microcredit

21. Microcredit is small-scale debt financing. In many developing countries microfinance institutions are started by non-governmental organizations or established with Government support. A large part of microcredit has become more institutional in nature in many countries as the schemes have become more widespread and the business has matured. Microcredit is often used by microenterprises for general business operations, including the introduction of innovations. However, recent research has raised concerns about the capacity of microfinance to generate positive outcomes in productive capacity (Bateman M and Chang HJ, 2012).

Crowdfunding

22. Crowdfunding is a recent phenomenon that is emerging in some developed countries as a means of accessing early stage financing. It operates by using the Internet to link entrepreneurs with investors, establishing web-based schemes that match investors with enterprises searching for investment financing. It remains a small phenomenon, but it could grow rapidly if appropriate regulation and mechanisms to ensure trust with Internet-based investment could be developed. Examples include CircleUp and Social Mobile Local Lending, two crowdfunding companies established in the United States in 2012. CircleUp takes equity stakes in companies with revenues of between \$1 million and \$10 million, while Social Mobile Local Lending provides small loans for small businesses looking to expand.¹⁰

b. Public financing*Seed finance*

23. Seed financing is for the initial R&D needed to establish the commercial feasibility of an idea, including both technical feasibility and market potential for the innovation. Financial markets in most countries do not provide financing for this stage of development, and government policies and financing instruments have been designed to address this market failure. Policies include incentives to encourage investors to provide seed financing. Financing instruments include the allocation of public funds to seed funds (grants, loans and investments – including co-investment funds and technology or innovation funds, as

¹⁰ *New York Times* (2013). The crowdfunding crowd is anxious, 5 January. Unless otherwise indicated, all references to dollars (\$) refer to US\$.

discussed below). In most cases government grants represent an important source of seed capital for new firms. They may come in the form of matching grants that seek to match spending by the enterprise, and may be considered co-financing. They may also be straight grants, for example, for a feasibility study.

Co-investment funds

24. Co-investment funds provide public sector co-financing for private seed capital and venture capital financing. Several countries have launched co-investment funds to address the seed/early-stage equity financing gap and to help develop and professionalize the angel investment market. Typically these programmes work by matching public funds with those of private investors (on the same terms) who are approved under the scheme. Examples include the Scottish Co-Investment Fund, the TechnoPartners Seed Facility of the Netherlands, the Seed Co-Investment Fund in New Zealand and the Co-Investment Fund for Business Angels in Portugal (OECD, 2011a).

Innovation or technology funds

25. Innovation or technology funds provide direct financing for enterprise R&D and innovative activities, often at the early stages. They typically provide grants, which are often allocated through competitive applications from entrepreneurs and enterprises seeking funding, but may also be on a non-competitive basis. They exist in some form in many developed countries, and have been established by Governments in a number of developing countries in the past decade. Innovation or technology funds may be supported financially by international donors and development organizations, or by private sector funds. They generally provide relatively small grants, and operate according to specific criteria established for each fund. Their terms of reference and management structure can be tailored to a particular context so that they can respond to different needs and priorities in different countries. As instruments designed specifically to finance technology development and innovation, they can be targeted at specific industries or activities according to national industrial policy priorities.

Development banks

26. Public sector development banks have been established in many countries in order to provide lending for activities considered under industrial policies to be vital for national development, often at concessional (subsidized) terms. They played a major role in financing industrialization efforts and structural change in some developing countries that were relatively successful in industrializing (such as Brazil, China, Taiwan Province of China, India, Malaysia, Mexico, the Republic of Korea and Singapore). Development banks remain significant lenders in some developed and developing countries. They can provide loans for new firms and for innovative activity. Their role in financing innovation though is likely to vary greatly by country, in addition to varying over time in some countries with national financial market development and changes in government development strategies.

Innovation prizes

27. The offer of prizes for anyone who can find a solution to technical problems has been used for hundreds of years to reward technological innovation. Known today as innovation prizes, they can take two different forms. First, a cash reward awarded after the fact as part of a competition for the most useful innovation in a certain field. Second, a cash reward to the person, team or company that solves a specific technical challenge. A number of countries use innovation prizes to incentivize innovation, although it is generally a mechanism that currently is limited in size and significance. However, the tool could be

scaled up, and some academics have even suggested that patents could be replaced with innovation prizes as a means of rewarding innovation.¹¹

International development assistance

28. International aid from donors and development financing institutions can be used for financing innovation, but has generally not been aimed at the direct financing of enterprises. Financial support for STI has not received high priority in international aid programmes.¹² However, support for STI in donor and development institution programmes may be on the rise. There is a case to be made for the increased financing of technology and innovation in developing countries, particularly those at the earliest stages of technological development with weak private sectors and severe financing constraints.

29. The Istanbul Programme of Action for the Least Developed Countries for the Decade 2011–2020 includes a commitment by member States to undertake by 2013 a joint gap and capacity analysis with the aim of establishing a Technology Bank and a science, technology and innovation-supporting mechanism which would help improve LDCs' scientific research and innovation capacities. In this context, Turkey has offered to support LDCs through an economic and technical cooperation package (including a pledge of \$200 million annually) with specific support in the area of technology.¹³

30. The World Bank Group's International Finance Corporation is a notable potential source of innovation finance, similar in nature to venture capital. It provides loans and equity finance to mostly medium and large firms in developing countries.

2. Indirect financing

Tax incentives (tax credits, allowances, deductions)

31. Many countries provide tax incentives for technology development and innovation, such as tax credits and tax deductions on R&D.¹⁴ These incentives aim to encourage R&D by allowing R&D spending to be deducted from tax liabilities, usually up to some maximum percentage of total tax liabilities. Tax incentives can be applied across the board or may be selective, so that they target only R&D in strategic industries or activities. Estimating the impact of tax incentives on actual innovation outcomes is not a straightforward task.¹⁵ An important issue for consideration by policymakers in developing countries is the fiscal cost of such tax incentives. A second key issue is their "additionality", the extent to which they simply subsidize R&D that would have taken place even without the incentive as opposed to incentivizing additional private sector R&D. A third issue is the tendency for tax incentives to be claimed mostly by large firms, meaning that they may be less likely to incentivize R&D by SMEs.

Public loan guarantees

32. Government loan guarantee schemes aim to offset the risk aversion of banks in relation to SME loans. They achieve this by guaranteeing loans for selected SMEs seen as having good potential or those operating in specific industries or activities considered

¹¹ See for example Kremer M and Williams S (2009).

¹² See for example UNCTAD (2007).

¹³ Fourth United Nations Conference on the Least Developed Countries. Istanbul Newsletter, Special Supplement. May 2011.

¹⁴ See Palazzi P (2011) and OECD (2011b).

¹⁵ See <http://www.sitra.fi/en/articles/2007/pekka-yla-anttila-do-innovation-policies-call-tax-incentives> and OECD (2011b).

strategically important for development in the country. They may thereby be used as an industrial policy tool to promote leading industries.

Public R&D spending and business–academic–Government R&D partnerships

33. Most countries undertake publicly funded R&D at public research institutes and universities. Public R&D is particularly important in many developing countries where the private sector has very low levels of R&D. This funding is not generally a direct source of financing for enterprises, but the R&D often provides knowledge that helps firms to solve problems or adapt foreign technologies for efficient local use by firms. Such R&D also provide new knowledge and technologies that can be transferred to firms as the basis for innovative activity. Some Governments also encourage R&D alliances between enterprises, universities and public research institutes. This is a classic tool for strengthening key linkages in national or sectoral innovation systems that support innovation in particular industries.

34. Governments often provide other support measures that are non-financial in nature but encourage enterprise innovation by providing infrastructure, knowledge or a guaranteed market for their products. These measures can include public investment in clusters such as science and technology parks and business incubators; science and technology, and information, communication and technology infrastructure; and public procurement contracts. In some cases, incubators and science and technology parks may also provide financing as well as infrastructure and other indirect support (for example, the Hsinchu Science-based Industrial Park in Taiwan Province of China and the Technological Incubators Programme in Israel).

II. Trends in spending on innovation in developing countries

35. Expenditure on innovation can include elements in addition to R&D but the item for which data generally exist for countries outside the OECD is expenditure on R&D. This section reports data on R&D for several developed and developing countries in order to illustrate their levels of spending and trends in spending on innovation in recent years. Table 1 reports data on gross expenditure on R&D as a percentage of gross domestic product (GDP) for selected countries for which roughly comparable data are available for at least one or two recent years. Expenditure on innovation in most developing countries is clearly at a much lower scale than in developed countries, with several exceptions. These include the notable cases of China, the Republic of Korea and Singapore. In China, gross R&D expenditure has increased rapidly during the 2000s, nearly doubling as a proportion of GDP despite high GDP growth rates. There are also a small number of developing countries that are investing a significant and rising share of their national income in R&D, including Brazil and Tunisia. Most developing countries invest less than 1 per cent of GDP in R&D, and many of them invest less than 0.4 per cent of their national income in innovative activity.

Table 1
Gross domestic R&D expenditure in selected countries
 (Percentage of GDP)

	1996	1998	2000	2002	2004	2005	2006	2007	2008	2009	2010
Developing countries											
Argentina	0.42	0.41	0.44	0.39	0.44	0.46	0.49	0.51	0.52	0.60	
Bolivia (Plurinational State of)	0.33	0.29	0.29	0.28						0.16	
Brazil	0.72		1.02	0.98	0.90	0.97	1.01	1.10	1.11	1.17	1.16
Burkina Faso									0.19	0.20	
Chile								0.31	0.37		
China			0.90	1.07	1.23	1.32	1.39	1.40	1.47	1.70	
China, Hong Kong SAR		0.43	0.47	0.59	0.74	0.79	0.81	0.77	0.73	0.79	
Colombia	0.30	0.21	0.11	0.12	0.14	0.14	0.14	0.15	0.14	0.15	0.16
Costa Rica	0.30	0.26	0.39		0.37		0.43	0.36	0.40	0.54	
Cuba	0.35	0.50	0.48	0.56	0.60	0.55	0.44	0.44	0.50	0.61	0.61
Ecuador	0.09	0.08		0.06			0.14	0.15	0.26		
Egypt ^a	0.21	0.20	0.19		0.27	0.24	0.26	0.26	0.27	0.21	
El Salvador		0.08						0.09	0.11	0.08	
Ethiopia											0.24
Gabon								0.45	0.55	0.64	
Ghana								0.23			
Honduras			0.04	0.04	0.04						
India	0.63	0.69	0.75	0.71	0.74	0.78	0.77	0.76			
Iran (Islamic Republic of)				0.55	0.59	0.73	0.67		0.79		
Jamaica				0.06							
Jordan				0.34							
Malaysia	0.22	0.40	0.47	0.65	0.60		0.63				
Morocco		0.29					0.64				
Mozambique							0.53				
Pakistan						0.44		0.67		0.46	
Panama	0.33	0.29	0.38	0.36	0.24	0.25	0.25	0.20	0.21	0.21	0.19
Paraguay				0.11	0.08	0.09			0.06		
Peru		0.10	0.11	0.10	0.15						
Philippines				0.14		0.11		0.11			

	1996	1998	2000	2002	2004	2005	2006	2007	2008	2009	2010
Republic of Korea	2.42	2.34	2.30	2.40	2.68	2.79	3.01	3.21	3.36	3.56	3.74
Seychelles				0.41	0.42	0.30					
Singapore	1.34	1.75	1.85	2.10	2.13	2.19	2.16	2.37	2.84	2.43	
Sri Lanka							0.17		0.11		
South Africa		0.6 ^b			0.85	0.90	0.93	0.92	0.93		
Thailand	0.12		0.25	0.24	0.26	0.23	0.25	0.21			
Trinidad and Tobago	0.10	0.13	0.13	0.13	0.11	0.09	0.06	0.05	0.03	0.05	
Tunisia	0.30	0.39	0.41	0.57	0.90	0.92	0.96	1.00	1.03	1.10	
Turkey	0.45	0.37	0.48	0.53	0.52	0.59	0.58	0.72	0.73	0.85	0.84
Uganda				0.37	0.26	0.22	0.30	0.39	0.33	0.41	
Viet Nam				0.19							
Zambia									0.34		
Developed countries											
Canada	1.65	1.76	1.91	2.04	2.07	2.04	2.00	1.96	1.86	1.92	1.80
Finland	2.53	2.88	3.35	3.36	3.45	3.48	3.48	3.47	3.70	3.93	3.88
France	2.27	2.14	2.15	2.24	2.16	2.11	2.11	2.08	2.12	2.26	2.25
Germany	2.20	2.28	2.47	2.50	2.50	2.51	2.54	2.53	2.69	2.82	2.82
Italy	0.98	1.04	1.04	1.12	1.09	1.09	1.13	1.17	1.21	1.26	1.26
Japan	2.77	2.96	3.00	3.12	3.13	3.31	3.41	3.46	3.47	3.36	
Spain	0.81	0.87	0.91	0.99	1.06	1.12	1.20	1.27	1.35	1.39	1.39
Sweden						3.56	3.68	3.40	3.70	3.60	3.40
Switzerland	2.65		2.53		2.90				2.99		
United Kingdom	1.83	1.76	1.81	1.79	1.68	1.73	1.75	1.78	1.79	1.86	1.76
United States ^c	2.55	2.60	2.71	2.62	2.55	2.59	2.64	2.70	2.84	2.90	

^a Partial data.

^b Data is for 1997.

^c Excludes most or all capital expenditures.

36. Table 2 shows the breakdown of investment in R&D by sector (business enterprises, Government and the higher education system) in countries for which data are readily available.¹⁶ It should be noted that in many firms innovation may be taking place, but innovative effort is informal, not through formal R&D.

¹⁶ Data for higher education system expenditure is provided separately from data for Government expenditure because in many countries public universities and other higher education centres coexist with private equivalent institutions.

37. At least half of total R&D is performed by enterprises in developed countries, where firms are heavily involved in formal innovative activity. In most of them, the Government accounts for less than 15 to 20 per cent of a country's innovative effort, and higher education for less than a third of the total. In developing countries, in contrast, the degree of involvement of enterprises in formal innovation is mixed. In some developing country enterprises are relatively heavily engaged in such activity. These include, for example, China, the Republic of Korea and Singapore. In others, their effort is significant, and they are approaching levels found in some developed countries. In a significant group of developing economies, enterprises are exerting a relatively marginal effort in innovative activity, and the public sector is the major actor with either Government research institutes or the higher education system taking a leading role. For many developing countries data availability is poor. It is likely that a significant number of those countries for which data are not included fall into the group of countries in which enterprises are not active in formal innovative effort (notably LDCs and some small, low- and middle-income countries). For many developing countries, the public sector is an absolutely critical actor in national innovation, and public policies and instruments for financing play a central role in stimulating innovation as well as in the development of functioning innovation systems.

Table 2
Gross expenditure on R&D by sector of performance^a
(Percentage)

	<i>GERD performed by business enterprises</i>				<i>GERD performed by government</i>				<i>GERD performed by higher education system</i>			
	1996	2000	2005	2009	1996	2000	2005	2009	1996	2000	2005	2009
Developing countries												
Argentina	25.9	25.9	32.2	22.3	40.9	38.3	39.7	44.7	31.5	33.5	25.8	31.3
Bolivia (Plurinational State of)	26.0	26.0			24.0	22.0			35.0	46.0		
Brazil	45.5	40.1	40.2		11.0	35.1	21.3		43.5	24.8	38.4	
Chile				40.4				9.7				40.8
China	43.2	60.0	68.3	73.2	42.8	31.5	21.8	18.7	11.8	8.6	9.9	8.1
Colombia	30.0	30.7	21.5	47.2	30.0	5.0	2.6	6.2	35.0	48.5	50.8	47.2
Costa Rica	21.7	23.3		25.7	12.3	19.5		23.5	36.6	36.2		49.0
Ecuador	4.0	13.5		8.5	68.4			89.6	15.5			1.4
Ethiopia				15.5			85.6	42.2			14.3	42.3
Ghana				4.9				92.8				2.3
Guatemala			2.9	2.0			33.7	11.2			63.3	84.7
Hong Kong SAR		18.0	51.5	53.3		1.8	2.0	4.1		80.2	46.6	53.3
India		18.0	30.4	33.9		77.9	65.2	61.7		4.0	4.4	4.4
Indonesia		26.3				69.8				3.9		37.9
Iran (Islamic Republic of)			12.2	10.6			59.4	56.1			28.4	33.3
Kenya				11.7				35.4				29.8

	<i>GERD performed by business enterprises</i>				<i>GERD performed by government</i>				<i>GERD performed by higher education system</i>			
	<i>1996</i>	<i>2000</i>	<i>2005</i>	<i>2009</i>	<i>1996</i>	<i>2000</i>	<i>2005</i>	<i>2009</i>	<i>1996</i>	<i>2000</i>	<i>2005</i>	<i>2009</i>
Malaysia		57.9	84.9			25.0	5.2			17.1	9.9	
Mexico	22.4	29.8	46.9	44.2	36.4		23.2	24.6	37.9	28.3	28.7	28.4
Mongolia			1.6	6.9			73.0	80.9			25.4	12.2
Morocco			22.0				25.6				52.4	
Pakistan						80.4	67.6	75.0		19.6	32.4	25.0
Panama	1.6			0.2	41.5	62.2	37.1	45.7	8.6	7.1	8.6	8.4
Peru		10.0	29.2			37.0	25.6			41.9		
Philippines			58.6	56.9			18.6	17.7			21.3	23.3
Republic of Korea	73.2	70.8	68.0	74.3	16.2	13.3	11.9	13.0	9.4	11.3	9.9	11.1
Saint Lucia		6.3				58.1						
Saint Vincent and the Grenadines		80.0				20.0						
Singapore	63.2	62.0	66.2	61.6	9.3	14.1	9.7	11.3	27.4	23.9	24.2	27.1
South Africa			58.3	58.6			20.8	20.3			19.3	19.9
Sri Lanka	1.7	7.5		18.3	55.5	56.0		56.9	25.4	19.0		24.8
Thailand	22.5	34.8	43.6	45.0	49.0		17.2	18.5	22.1		38.3	32.5
Trinidad and Tobago	23.7	11.1	29.5	2.3	56.1	69.1	45.1	59.6	20.2	19.8	25.4	38.2
Tunisia		5.7	14.5	20.0		55.3	50.8	80.0		35.7	34.8	
Turkey	26.0	33.4	33.8	40.0	11.9	6.2	11.6	12.6	62.2	60.4	54.6	47.4
Uruguay	30.4	39.3		34.8	28.7	25.0		27.4	40.9	35.7		35.0
Viet Nam		14.5				66.4				17.9		
Zambia				2.0				19.3				78.2
Developed countries												
Canada	57.9	60.3	55.8	51.7	14.7	11.2	9.7	10.1	26.8	28.2	34.0	37.6
Finland	66.2	70.9	70.8	71.4	15.8	10.6	9.6	9.1	18.1	17.8	19.0	18.9
France	61.5	62.5	62.1	61.7	20.3	17.3	17.8	16.4	16.8	18.8	18.8	20.7
Germany	66.1	70.3	69.3	67.6	15.3	13.6	14.1	14.8	18.6	16.1	16.5	17.6
Italy	53.5	50.1	50.4	53.3	20.0	18.9	17.3	13.1	26.5	31.0	30.2	30.3
Japan	71.1	71.0	76.4	75.8	9.4	9.9	8.3	9.2	14.8	14.5	13.4	13.4
Spain	48.3	53.7	53.8	51.9	18.3	15.8	17.0	20.1	32.3	29.6	29.0	27.8
Sweden			72.7	70.4			5.0	4.4			22.0	25.1

	<i>GERD performed by business enterprises</i>				<i>GERD performed by government</i>				<i>GERD performed by higher education system</i>			
	<i>1996</i>	<i>2000</i>	<i>2005</i>	<i>2009</i>	<i>1996</i>	<i>2000</i>	<i>2005</i>	<i>2009</i>	<i>1996</i>	<i>2000</i>	<i>2005</i>	<i>2009</i>
Switzerland	70.7	73.9		73.5	2.5	1.3		0.7	24.3	22.9		24.2
United Kingdom	64.9	65.0	61.4	60.4	14.4	12.6	10.6	9.2	19.5	20.6	25.7	27.9
United States	72.0	74.6	69.4	70.3	12.9	10.3	12.4	11.7	12.0	11.4	13.9	13.5

Source: United Nations Educational, Scientific and Cultural Organization, Institute for Statistics (database accessed 29 January 2013).

Abbreviation: GERD, gross domestic expenditure on research and development.

^a All data are for the year indicated or the nearest available year.

III. Selected experiences with instruments for financing innovation in developing countries

A. Promoting angel investors

38. Experience with business angels in developing countries has been limited. Efforts are usually concentrated on the more general promotion of an entrepreneurial culture and the establishment of grants and tax incentives for start-ups, such as the Start-Up programme in Chile. This programme seeks to attract promising entrepreneurs to establish their start-ups in Chile and promote an entrepreneurial culture. Established in 2010, it provides local and foreign entrepreneurs with \$40,000 of equity-free seed capital and a one year visa to develop their projects for six months, along with assistance in accessing human and financial capital networks. Over 600 start-ups have been involved in the programme (<http://startupchile.org/>).

39. Measures to promote angel investment may include tax incentives, the establishment of co-investment funds and supporting the development of business angel networks. Co-investment funds – where public funds leverage private ones – can help finance a larger number of projects than private investments or public funds alone. Matching public funds with those of private investors on the same terms and leaving management to vetted business angels and venture capital firms provide opportunities for innovative start-ups to quickly evolve from direct public financing towards private financing and the management of their incubation and early stages. This investment vehicle may be particularly interesting for policymakers looking to increase private sector involvement in the funding of seed and early growth stages.

40. Providing training for angel investors and promoting an entrepreneurial culture can be supported as a matter of innovation policy. For example, the Ewing Marion Kauffman Foundation has developed a programme which aims to improve the interaction between novice and more experienced angel investors and thus contributes to the professionalization of the angel investment market.¹⁷ The New Zealand Venture Investment Fund Limited, a New Zealand Government-supported fund manager, plays an active role in bringing together venture capital and angel investors (OECD, 2011a).

¹⁷ The Kauffman Foundation is a non-profit organization based in the United States. See www.kauffman.org.

B. Venture capital

41. Venture capital has mostly developed in countries which experienced fast growth in their high-tech sectors in the 1990s, enjoy strong research–industry linkages and have well-established small business innovation programmes (OECD, 2003).

42. Government programmes that take a stake in new firms have been used to leverage private financing for innovation. For example, the Yozma fund in Israel has been credited with successfully promoting a vibrant entrepreneurial ecosystem for technology firms, including a developed venture capital market. Two policy elements shaped the nature of the fund. First, the Government shared the risk but offered all the rewards to the investors. Secondly, the Government exited from the programme once it had served its purpose, with the result of boosting venture capital activity in Israel.

43. A survey conducted for a recent UNCTAD report discussing the obstacles for the development of a highly innovative sector such as software in developing countries also found that access to limited venture capital was the most quoted obstacle in all regions, particularly in developing regions.¹⁸ In Asia the venture capital market, while growing rapidly in the region's relatively more advanced economies, remains largely underdeveloped (Park C, 2011). According to domestic and international private equity investors currently investing in Latin America, the key challenges for venture capital in the region are the regulatory and tax environments, the strength of the financial market to take up spin-offs after venture capital has reached a mature phase, and the small number of established venture capital fund managers that can join as partners in a particular venture.¹⁹ Without public policy support, the availability of venture capital to support the development of high-tech sectors is lacking as the strong preference is for investment in the consumer goods and retail sectors.

44. Among noteworthy public initiatives to promote venture capital is the Inova Brasil project presented in box 1.

Box 1. Inova Brasil

In 2000, Brazil's Studies and Projects Finance Organization (FINEP) and the Multilateral Investment Fund of the Inter-American Development Bank (IDB) launched Inova Brasil, a programme aimed at stimulating the development of a domestic venture capital and seed capital industry. At the time, it was at an embryonic stage of development and was not growing. Phase I of the programme was devoted to developing venture capital, and phase II, to early-stage financing through angels and early-stage venture capital. Phase I provided for training of investors in venture capital funds and of entrepreneurs, and matching the latter with venture capital investors. After several years it led to significant growth in the domestic venture capital market in later-stage finance. Phase II stimulated the provision of early-stage financing for a significant number of companies.

Overall the programme has been a major success and is being replicated in other developing countries in the region. A number of key factors contributed to Inova Brasil's success. First, it addressed a wide range of elements to create an efficient indigenous venture capital ecosystem, including developing the technical and knowledge capacity of local venture capital fund managers and the readiness of local firms and entrepreneurs to engage with venture capital. Second, adapting the regulatory and legal framework and

¹⁸ The UNCTAD/World Information Technology and Services Alliance Survey of Information Technology/Software Associations. See UNCTAD (2012).

¹⁹ Coller Capital/Latin American Private Equity and Venture Capital Association (2012).

broadening the inflow of capital were crucial. Finally, building strong partnerships with credible local and international partners, including regional banks, pension funds, and national private firms and development organizations, helped broaden the financial base.

Source: Leamon A and Lerner J (2012).

C. Innovation funds

45. Many developing countries lack specific instruments to finance innovation. However, the experiences of a few countries suggest that these can be successfully implemented in a relatively short time frame. An evaluation of four Latin American innovation funds concluded that their effectiveness depended on the financing mechanism used, the presence of non-financial constraints, the quality and level of interaction between firms and academic institutions and the characteristics of the target beneficiaries (Hall BH and Maffioli A 2008).

46. In Mexico, for example, the incentives programme for innovation, managed by the National Council of Science and Technology, has disbursed over \$600 million since 2009 to support 2,281 innovation projects in the private sector. The programme, through a competitive process, provides finance for innovation activities of SMEs, larger firms and collaborative projects with research institutions. It covers a percentage of the innovation costs incurred by enterprises and research institutions in accordance with the type of enterprise and the nature of its collaboration with research institutions. In 2009, the programme generated 3,163 new jobs, including 1,098 jobs requiring high qualifications, and 180 patent filings and 87 other intellectual property rights, including trade secrets and industrial designs. In 2010, for every dollar of funding, the programme generated \$12 in sales and \$1.79 in profits.

47. In Peru, the Science and Technology Programme has enhanced the innovation culture among Peruvian firms and promoted greater interaction between firms and research institutions (box 2).

Box 2. Peru's Science and Technology Programme

In 2007, the Government of Peru established the Science and Technology Programme, known by its Spanish acronym FINCyT, with a \$25 million IDB loan and an \$11 million contribution from the Peruvian Treasury. Its objective was to finance projects that would help boost levels of enterprise competitiveness. FINCyT financed a variety of innovation projects including:

- (a) Technological innovation projects in companies;
- (b) Technological research and innovation projects in universities and research centres;
- (c) Fellowships and internships;
- (d) Projects to strengthen and coordinate the national system of innovation.

In a four-year period, the Programme supported 117 enterprise innovation projects and 76 university research projects, putting special emphasis on developing collaborative networks among enterprises, universities and research centres. As a result, more firms were carrying out product innovation and collaborating with academic centres. For example, in the five years before FINCyT's inception, Peruvian universities filed 11 application patents, compared with 33 between 2007 and 2011, 14 of which stemmed

directly from projects funded by FINCyT.

A number of factors contributed to these positive results. First, the design of the programme was based on existing good practices and lessons learned from other experiences in the region. Second, in a country with a relatively burdensome bureaucracy, the independent structure of the programme allowed for shorter time frames that are more adequate for the promotion of innovation activities. Moreover, continued support has been provided to encourage and facilitate the participation of firms in the programme. For example, a short project design and project management training programme for potential candidates was introduced to address the low quality of project proposals being submitted and to enhance the success rate of projects.

Following the success of the programme, the Innovation for Competitiveness Project was approved in 2012, funded by an IDB loan of \$35 million and \$65 million from the Peruvian Treasury.

Source: UNCTAD (2011) and presentation by Mr. Alejandro Afuso, Executive Director of FINCyT, 20 September 2012 (<http://vimeo.com/49923490>).

D. Tax incentives

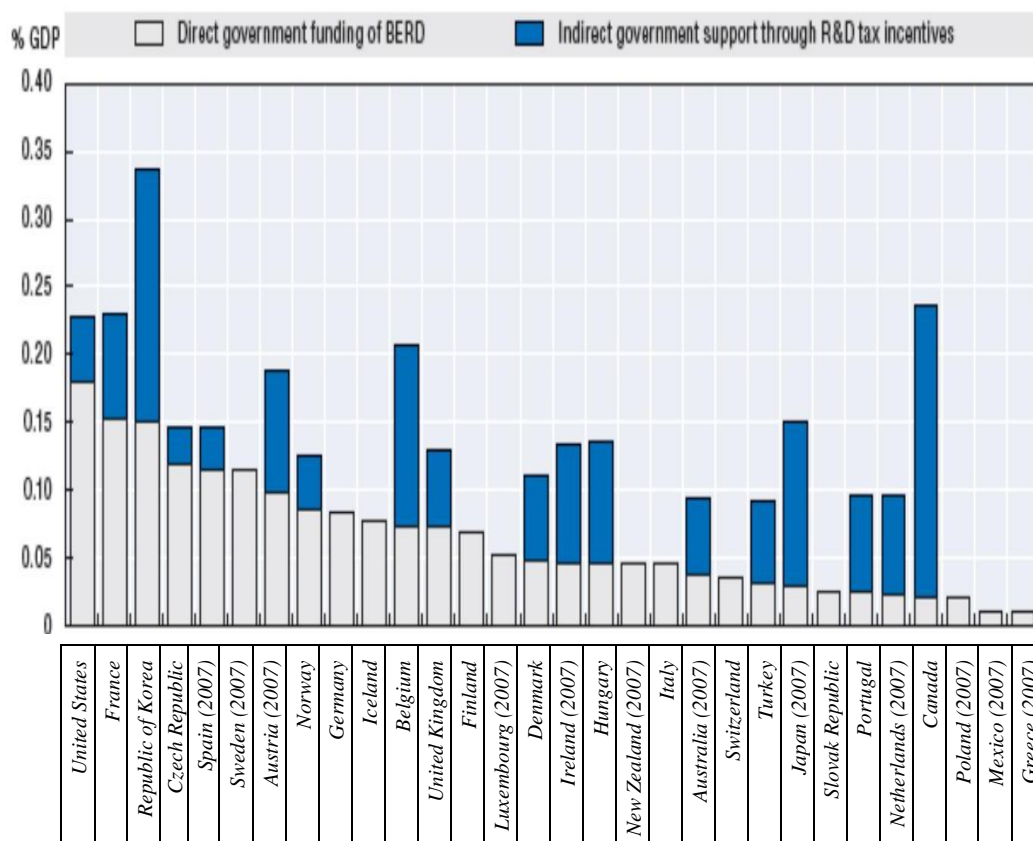
48. Tax incentives are among the most widely used STI policy instruments. Most developed countries use them to stimulate R&D investment (see figure 2). For example, in Australia, the R&D Tax Incentive, which replaced a less generous R&D Tax Concession in 2011, is available to businesses that want to offset some of their R&D costs. The R&D Tax Incentive programme aims to help firms increase their R&D activities and innovate. It is open to firms of all sizes in all sectors conducting eligible R&D. The main policy components are a 45 per cent refundable tax offset for smaller firms with an aggregated yearly turnover of less than \$A20 million and a non-refundable 40 per cent tax offset for all other eligible firms.

49. Tax incentive programmes can also provide tax relief on investment, capital gains and losses to individuals that invest in SMEs or innovative or technology-heavy start-ups. For example, the United Kingdom's recently approved Seed Enterprise Investment Scheme offers individual income tax relief of 50 per cent of the amount invested (up to a maximum of £100,000 per tax year). To qualify, a firm must have fewer than 25 employees, be no more than two years old and have assets of less than £200,000.

50. Other developed countries, including France, Ireland, Israel, Italy and Portugal, have also introduced national tax incentives to individuals that invest in start-ups. Their introduction has not been exempt from debate, as tax incentives can be difficult to target and may attract financial investors that do not provide the valuable expertise and contacts that angel investors offer. Robust data, careful design and continued monitoring and revision are required to fine-tune tax incentive programmes.

51. More recently countries such as Brazil, China, Hong Kong (China), Taiwan Province of China, India, Indonesia, Malaysia, the Philippines, the Republic of Korea, South Africa, Singapore, Thailand and Viet Nam implemented various R&D incentives for innovation (Deloitte, 2011 and Ernst and Young, 2011).

Figure 2
Direct and indirect government funding of business R&D and tax incentives for R&D, 2008



Source: OECD Science, Technology and Industry Outlook 2010.
 Abbreviation: BERD, business expenditure on research and development.

52. Malaysia offers a wide range of tax incentives to help foster innovation and industrial technology through its Income Tax Act 1967 and the Promotion of Investments Act 1986. In addition, currently there is a broad pallet of R&D tax incentives focused on STI activities. These include tax incentives for conducting R&D and commercializing outcomes, funding incentives and incentives targeted at specific industries such as information, communication and technologies and biotechnology. Despite abundant incentives, a recent report suggests however that the take-up rate has not met expectations. A way to increase the rate could be to broaden the definition of R&D which currently leaves out innovation activities in quality control processes, research in the social sciences, data management, efficiency surveying and management and other soft technologies such as market research (PricewaterhouseCoopers Taxation Services Sdn Bhd, 2011).

53. Since 2006, South Africa offers a tax relief for expenditure related to R&D. The amended Scientific and Technological Research and Development Tax Incentive (effective from 1 October 2012) offers companies undertaking R&D in South Africa a 150 per cent tax deduction of their operational R&D expenditure. This incentive is available to businesses of all sizes in all sectors of the economy. All eligible R&D expenditure qualifies for an automatic 100 per cent tax deduction. An additional 50 per cent uplift applies to expenditures on R&D activities approved by the Minister of Science and Technology. Only

two years after the introduction of tax incentives, research and development expenditure in South Africa increased by 12.7 per cent to \$18.6 billion (Deloitte, 2011).

V. Some conclusions and suggestions for discussion

54. Successful innovation funding programmes tend to target clearly identified financing gaps. This calls for a good understanding of the needs and capabilities of different types of firms at different stages of development and operating in various socioeconomic contexts. Innovation funding programmes should be articulated so that firms can access progressively more sophisticated support mechanisms as they develop their technological capabilities. This requires capacity-building efforts both among the managers of innovation funding programmes and among their beneficiaries (for example, to develop project assessment and project formulation skills).

55. Agreement on key indicators indicating progress in programmes to fund innovation is needed. Developing simple but meaningful indicators that can demonstrate the linkage between innovation outcomes and the goals of innovation funding programmes require an understanding of firm and institutional dynamics in the national innovation system.

56. The relationship between national development policies and funding for innovation needs to be considered and the relevant linkages strengthened. Since access to finance is only one of many bottlenecks for innovation, funding programmes need to be planned in conjunction with other support measures. This relates in particular to issues such as collaborative networking, coordination and the overall promotion of an entrepreneurial culture.

57. From these general observations some questions emerge that the Commission may wish to address.

58. The first observation concerns strategies to maximize the impact of available funds for innovation support programmes and how to improve resource mobilization at the domestic and international levels. How can the visibility of innovation support in national and international development agendas be improved? How can critical financing gaps be better identified? How synergies between investment in innovation and in other critical development priorities be strengthened?

59. The second observation concerns an exchange of experiences about the design and management of innovation funding programmes. What can be learned from the experience of developing countries that have put in place general and/or specialized innovation funding programmes? What are the key capabilities and skills that are critical for sustainable programme impact?

60. Finally, how can Governments better involve all STI stakeholders in designing, implementing and assessing investments in STI? What role can international development cooperation play in this area?

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