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Measuring Determinants of Entrepreneurial Activity - The Area of R&D and Technology

Briefing Paper

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1 Measuring the determinant group "R&D and Technology"

Since 2006 the OECD and Eurostat have made great efforts in developing measures of entrepreneurship and entrepreneurial activity. The Entrepreneurship Indicators Programme (EIP)[1] framework for indicators reflects the growing importance of entrepreneurship and seeks to improve our current understanding and measurement of entrepreneurship.

The EIP framework is built around three inter-connected tiers, all of which are important for the formulation, evaluation and adjustment of policy measures of entrepreneurship: **Determinants**, **Performance** and **Impacts**. The Copenhagen workshop is part of the EIP work, and the focus is on one of the key determinants groups of entrepreneurship: R&D and technology.

In general entrepreneurial activity and entrepreneurship are stimulated and influenced by a combination of three factors: Opportunities, skilled people, and resources. Resources are reflected in the determinant group "R&D and technology" (but perhaps not only there). R&D creates new inventions that the entrepreneur and entrepreneurial businesses can turn into new commercial products or processes. R&D in this context should be understood as a resource that can be created or purchased, whether directly or in an embodied or diffused form.

This briefing paper for workshop participants is divided into three parts. Firstly, it describes the current policy areas under the determinant group "R&D and technology". Secondly, a list of indicators related to the area is presented; and thirdly, a method to assess the quality of indicators is outlined. Questions are posed under each part, thus providing the participants with a sound basis for discussion of future measurement needs to be fed into the EIP.

1.1 Policies affecting access to R&D and technology

The determinant group "R&D and technology" is affected by several policy areas. Currently the OECD/Eurostat framework for entrepreneurship indicators places 6 policy areas under R&D and technology. These policy areas will very likely affect other determinants groups of entrepreneurship as well, but are placed under "R&D and technology" since it is presumed that they affect this determinant group the most. The rationale for including the 6 policy areas is outlined below.

1.1.1 R&D investment

Entrepreneurs play an important role in commercialising R&D. Countries with high levels of R&D will produce more possibilities for entrepreneurship compared to countries with low levels of R&D. Moreover, local knowledge created by firms conducting R&D may spill over for application

[1] http://www.entrepreneurship-indicators.net/

by other firms run by entrepreneurs. The R&D can both be privately and publicly funded.

1.1.2 University/industry interface

Effective technology or knowledge transfer regulation opens and speeds up the process of transferring publicly funded research into the business economy, thereby effectively creating new opportunities for potential entrepreneurs. This regulatory framework can be enhanced by policies encouraging universities (and other public institutions engaged in research and development activities) to facilitate the development of ventures, spin-outs, or other forms and manifestations of knowledge and technology transfer based on publicly funded research.

1.1.3 Technological cooperation between firms

Existing firms can play an important role in developing entrepreneurship in new and younger firms either through corporate venturing or by actively working with these firms. The willingness of established firms to use new firms as suppliers or partners also plays a crucial role in the development of their entrepreneurship. For example, the success of Silicon Valley compared to the Boston area in the early 1990s has been explained by the more open attitude towards cooperation in Silicon Valley.

1.1.4 Technology diffusion

It is not only directly acquired or created R&D that benefits entrepreneurs. Many entrepreneurs simply use existing technology in new ways and benefit from the uptake and diffusion of these technologies. For instance, the wider use of the internet is hugely beneficial to entrepreneurial activity.
The borderline or overlap with the next policy area needs too be investigated:

1.1.5 Technology appropriation

To serve as an example, broadband access is included as a separate policy area even though it may also be part of technology diffusion. The provision of broadband capacity gets a lot of policy attention in many countries. For example, the deployment of broadband networks in all regions of the European Community is seen as a prerequisite for the development of the knowledge economy.

1.1.6 Patent system, standards, intellectual property rights (IPRs) in the wider sense

The robustness and use made of countries' intellectual property rights system varies considerably and may be a good indicator to measure the output of R&D geared towards entrepreneurship. Entrepreneurs can buy patents or protect their own products or processes, designs and trademarks through the IPR system. Several studies indicate a positive correlation between patent protection and entrepreneurial activities.

The above list of 6 policy areas attempts to be as exhaustive and mutually exclusive as possible, which means that the most important areas related to the determinant should be covered. However, the choice of policy areas

in the EIP framework has been seen as a starting point and revisions are expected as the understanding of entrepreneurship continually expands.

Therefore, the possibility of including other policy areas that might play an important role for R&D and technology has to be considered at the workshop. Furthermore, change of policy focus might lead to a regrouping of existing areas. The possibility of disaggregating some of the policy areas is also a part of the envisaged and desired workshop discussion.

Proposal for discussion

- Should the current list of policy areas be modified?, i.e.:
  Expand the list, aggregate and/or disaggregate some of the policy areas.

1.2 R&D and technology indicators

This section considers the available R&D and technology related indicators. Indicators measure institutional structures, policies and market outcomes. Therefore, some indicators are directly affected by policies like public investments in R&D, whereas others are indirect measures like, for instance, broadband uptake.

Several sources have been checked for possible indicators. This paper deals with indicators that have already been included in the manual *Quality assessment of entrepreneurship indicators*, which is described further in the next part. Moreover, indicator lists ascribed to the policy objectives in the *Lisbon Strategy* for growth and jobs in the European Community[2] and the *European Innovation Scoreboard 2007* have been used as sources[3].

The indicators *University/industry research collaboration* and *IPR* have been used in the quality assessment manual. It is evident that other indicators must be considered for the various policy areas grouped under "R&D and technology". The list outlined below has been composed by using the various sources described above.

A common feature of the indicators is that they are available for most OECD countries, which is a prerequisite for being included in the EIP framework. The list is not exhaustive and will be subject to change given that new indicators might appear and/or that the policy areas are modified as a result of the workshop. The purpose is to provide a basis for discussion of indicators and their quality ending up with a set of harmonized indicators for the EIP. Indicators are grouped into the current

[2] http://europa.eu.int/growthandjobs/
[3] http://www.proinno-europe.eu/admin/uploaded_documents/European_Innovation_Scoreboard_2007.pdf

policy areas where possible. Data sources and reference years can be found in Annex I.

Proposal for discussion

- Does the proposed list capture all the relevant policy areas and demands for quality requirements, i.e.:

  How well do the proposed indicators represent the policy areas?

  Which of the indicators are most relevant?

  What is missing from the current list and what should be developed?

R&D and technology: List of possible indicators

Indicators	**To be selected for the EIP framework (yes/no)**
1. R&D investment	
Total expenditure on R&D (GERD), as % GDP	
Business enterprise expenditure on R&D (BERD), as % of GDP	
Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	
Budget commitments for future investments (GBAORD), as % of GDP	
Public R&D expenditures (GOVERD + HERD), as % of GDP	
Higher education expenditure in R&D (HERD), as % of GDP	
Business enterprise expenditure on R&D (BERD) financed by public sources	
Enterprises receiving public funding for innovation	
Total expenditure on R&D (GERD) financed from abroad, as % of GDP	
R&D expenditure of SMEs as part of total R&D	

Indicators	**To be selected for the EIP framework (yes/no)**
2. University/industry interface	
University/industry research collaboration as measured by cooperation agreements	
% of research in the public sector financed by business	
% of innovative companies cooperating with universities or other public research organizations (PROs)	
Number of patent applications by universities	
Amount of licensing income by universities	
3. Technological cooperation between firms	
% of companies stating co-operation as the source of innovation	
Number of cross-licensing agreements between companies	
Number of technology clusters within a given geographic area	
4. Technology diffusion	
Market penetration speed for given technologies or innovations	
% of enterprises using eGovernment services	
e-commerce as % of total turnover of enterprises	
% enterprises receiving internet orders	
% enterprises purchasing on the internet	
% employees using internet at work	

Indicators	**To be selected for the EIP framework (yes/no)**
5. Technology appropriation	
ICT expenditure - IT - Expenditure on Information Technology as a percentage of GDP	
ICT expenditure - Telecommunications - Expenditure on Telecommunications Technology as a percentage of GDP	
% of enterprises with broadband access	
Broadband penetration (as % of population) (COCOM)	
Broadband penetration rate (number of broadband lines per 100 population)	
6. Patent system, standards	
IPR system robustness	
Number of EPO patents per capita	
EPO patents per million population	
USPTO patents per million population	
Triad patents per million population	
Number of new community trademarks per million population	
Number of new community designs per million population	

Indicators	**To be selected for the EIP framework (yes/no)**
Other	
Science and technology graduates (tertiary graduates in science and technology per 1000 of 20-29 years population)	
Researchers (FTE) per 1000 labor force	
Population with tertiary education per 100 population aged 25-64	
Highly qualified scientific and technical workers, as % labor force	
Highly qualified scientific and technical workers, as % of total S&T human resources with tertiary education	
Hours worked by high-skilled persons engaged (share in total hours worked)	
Participation in life-long learning per 100 population aged 25-64	
Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	
Innovative SMEs (% of all SMEs)	
SMEs innovating in-house (% of SMEs)	
Innovative SMEs co-operating with others (% of SMEs)	
Innovation expenditures (% of turnover)	
Sectoral specialisation in terms of technology intensity (sum of high and medium-high)	
Employment in medium-high and high-tech manufacturing (% of total workforce)	
Employment in high-tech services (% of total workforce)	
Exports of high technology products as a share of total exports	
Sales of new-to-market products (% of turnover)	
Sales of new-to-firm products (% of turnover)	

1.3 Quality framework of entrepreneurship indicators

In light of the policy areas ascribed to R&D and technology and the proposed indicators another goal of the Copenhagen workshop is to discuss quality assessment. It is evident that indicators differ, for example in terms of data collection method and how well they describe a given policy area. Therefore, a quality framework ranking the various indicators can help users to get an overview of their usefulness.

A starting point is the ICE (International Consortium for Entrepreneurship) manual *Quality assessment of entrepreneurship indicators*. The manual describes and quality assesses a comprehensive list of entrepreneurship indicators. Quality assessment is based on experience from the OECD, Eurostat and the US Key Indicator Project[4].

The focus in the manual is on performance and business environment indicators for entrepreneurship. In the current version 4 performance indicators and 66 business environment indicators are included. In the following, the manual's quality assessment framework is addressed to provide the participants at the Copenhagen workshop the opportunity to comment on the applied method.

1.3.1 Quality assessment of indicators

Quality is defined as "fitness for use" in terms of user needs (OECD, 2003[4]). This definition is broader than has been customarily used in the past when quality was equated with accuracy. It is now generally recognized that there are other important dimensions. Even if data is accurate it cannot be said to be of good quality if it is produced too late to be useful, or cannot be easily accessed, is not widely available, or appears to conflict with other data. Thus, quality is viewed as a multi-faceted concept.

The most important quality characteristics depend on user perspectives, needs and priorities, which vary across groups of users. It is important to note that each indicator must be evaluated in its context; in this case it would be in creating or facilitating the creation of technology, knowledge, innovation and research and development. Consequently, an indicator used in this quality assessment may be applied and assessed differently in other studies focusing on other issues (for instance, on human resources, etc.). Thus, the quality measure for an indicator is meant to guide the policy maker rather than the statistician.

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[4] OECD (2003), Quality framework and guidelines for OECD statistical activities, version 2003/1, Organisation for Economic Co-operation and Development, Statistics Directorate, STD/QFS 2003 1.
Munoz, P. D., (2004). Indicators for EU Policy making – The example of structural indicators, Eurostat. From www.oecd.org/oecdworldforum.
Wallman, K. & K., Prewitt, and S. Schechter (2004). *Developing key national indicators for the United States*, from www.oecd.org/oecdworldforum.

The framework focuses on three quality dimensions: relevance, accuracy and availability. Each indicator is evaluated by grading it for each dimension and by an overall assessment. If considered useful, further qualitative information may be taken into account in the evaluation of the indicator. This implies that scope exist to describe other characteristics which may lead to restricting or increasing the use of a given indicator, relating for example to the complexity of an indicator, to a lack of an unambiguous scientific basis or to the lack of coherence with other existing indicators, etc.

(i) Relevance

The relevance of an indicator is a qualitative assessment of the value contributed by the indicator. That is, the evaluation depends on the proximity between what the indicator measures and the framework condition it is supposed to measure. It is desirable for the indicator to be as close as possible to the framework condition it is intended to measure (Table 1.1).

Table 1.1

The Indicator's Proximity to the Framework Condition it is Supposed to Measure	Direct Measure	Proxy Measure
Mark	A	B

However, relevance has one more dimension: If an indicator is applied as a measure for a specific policy, it is useful to know whether a policy initiative has a direct or indirect impact on the indicator (Table 1.2).

Table 1.2

Policy Initiatives' Impact on Indicator	Direct Measure	Proxy Measure
Mark	A	B

(ii) Accuracy

The accuracy of an indicator is the degree to which the indicator correctly estimates or describes the quantities or characteristics it is designed to measure. Accuracy has two dimensions: data collection method and degree of cross-country standardisation.

a) Data Collection Method

The data collection method is sound if data correctly estimates or describes the quantities or characteristics that it is designed to measure. Thus, accuracy based on data collection method refers to the closeness between the values provided and the (unknown) true value.

Major sources of error in data collection include coverage, sampling, non-response, response processing, and problems in dissemination.

Addressing these problems is standard practice for national statistical offices and international governmental institutions. Data from these sources should not suffer, in general, from these problems, whereas data from other sources should be evaluated on a case-by-case basis.

The appraisal of accuracy is based on the method used in collecting the data. Almost all indicators are based on surveys (also including polls and censuses). This framework distinguishes among three types: fact-based, action-based and opinion-based surveys.

Fact-based surveys relate to easy quantifiable aspects, in which different people will give the same response to a question. The OECD Regulatory Database is an example of this type as respondents are asked about whether or not a country has a given regulation.

Action-based surveys concern issues where respondents are asked if they have performed a given action within a given time period or not. The European Community Innovation Survey is an example of this type of survey. In this survey, firms are asked whether they have introduced new or technologically improved products or processes on the market during the last year.

Opinion-based surveys deal with questions asking for a subjective evaluation of a given aspect of the economy. The World Economic Forum's Executive Survey is an example of this type of survey. It asks executives about their opinion of the functioning and the quality of various aspects of the economy.

The accuracy of data collection methods can be evaluated as very good, good or acceptable (Table 1.3).

Table 1.3

Data Collection Method	National statistical offices/fact-based surveys	Action-based surveys	Opinion-based surveys
Mark	A	B	C

These scores can be clarified as follows:

• Very good: the indicator originates from national statistical offices or international government institutions, or the indicator stems from a fact-based survey.

• Good: the indicator comes from an action-based survey.

• Acceptable: the indicator comes from an opinion-based survey.

b) Cross-country Comparability

Whether an indicator is comparable across countries requires consideration as to the method of data collection in the concerned countries. For example, an indicator is comparable if the same question is asked in all the countries in the same way and by the same means. It is desirable to have the highest degree of comparability across countries.

Table 1.4

The Indicator is Cross-country Comparable	Fully Comparable	Comparable to some extent
Mark	A	B

(iii) Availability

The concept of availability relates to the accessibility of a given indicator in various countries and for a given time frame. It is desirable to have data from as many countries as possible (Table 1.5). In addition, an indicator available beyond the initial benchmark year is better than one that is only available beyond for one year (Table 1.6).

Table 1.5

The Share of OECD Countries for which the Indicator is Available	100-76%	75-50%
Mark	A	B

Table 1.6

The Number of Years the Indicator is Available for	Beyond the initial benchmark year	The initial benchmark year
Mark	A	B

(iv) Overall Quality Assessment

The overall quality assessment is divided into three categories: good, acceptable and questionable (Table 1.7).

Table 1.7

Name of Indicator	Good	Acceptable	Questionable
Indicator A	A	B	C

Clarifications of the three indicator score categories are as follows:

- Good (A): at least 5 A's and no C's
- Acceptable (B): at least 3 A's and no C's
- Questionable (C): less than 3 A's or one or more C's.

As an example, the quality assessment of the indicator *University/industry research collaboration* is outlined in Annex II.

Proposal for discussion

- Do you agree with the current quality framework scheme?
- What should future assessment focus on?

Annex I:

R&D and technology indicators: Data sources and reference years

Indicators	**Data sources**	**Ref. year**
1. R&D investment		
Total expenditure on R&D (GERD), as % GDP	Eurostat, S.I., Innovation and Research	2006
Business enterprise expenditure on R&D (BERD), as % of GDP	DG RTD Regional Key Figures Database	2006
Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	European Innovation Scoreboard 2007	2004
Budget commitments for future investments (GBAORD), as % of GDP	DG RTD Regional Key Figures Database	2006
Public R&D expenditures (GOVERD + HERD), as % of GDP	European Innovation Scoreboard 2007	2005
Higher education expenditure in R&D (HERD), as % of GDP	DG RTD Regional Key Figures Database	2006
Business enterprise expenditure on R&D (BERD) financed by public sources	DG RTD Regional Key Figures Database	2004
Enterprises receiving public funding for innovation	European Innovation Scoreboard 2007	2004
Total expenditure on R&D (GERD) financed from abroad, as % of GDP	DG RTD Regional Key Figures Database	2004
R&D expenditure of SMEs as part of total R&D	Eurostat - Theme 9: Science & Technology - R&D	2005
2. University/industry interface		
University/industry research collaboration as measured by cooperation agreements	World Economic Forum – Global Competitiveness Report 2007-08	2008
% of research in the public sector financed by business	DG RTD Regional Key Figures Database	2004
% of innovative companies cooperating with universities or other public research organizations (PROs)	Eurostat – Theme 9: Science & Technology - CIS-4	2004

Indicators	**Data sources**	**Ref. year**
Number of patent applications by universities		
Amount of licensing income by universities		
3. Technological cooperation between firms		
% of companies stating co-operation as the source of innovation	DG RTD Regional Key Figures Database	2004
Number of cross-licensing agreements between companies		
Number of technology clusters within a given geographic area		
4. Technology diffusion		
Market penetration speed for given technologies or innovations		
% of enterprises using eGovernment services	Eurostat - Theme 9: Science & Technology – Inf. Soc.	2007
e-commerce as % of total turnover of enterprises	Eurostat - Theme 9: Science & Technology – Inf. Soc.	2007
% enterprises receiving internet orders	Eurostat - Theme 9: Science & Technology – Inf. Soc.	2007
% enterprises purchasing on the internet	Eurostat - Theme 9: Science & Technology – Inf. Soc.	2007
% employees using internet at work	Eurostat - Theme 9: Science & Technology – Inf. Soc.	2007
5. Technology appropriation		
ICT expenditure - IT - Expenditure on Information Technology as a percentage of GDP	Eurostat, S.I., Innovation & Research – EITO	2006
ICT expenditure - Telecommunications - Expenditure on Telecommunications Technology as a percentage of GDP	Eurostat, S.I., Innovation & Research – EITO	2006

Indicators	**Data sources**	**Ref. year**
% of enterprises with broadband access	Eurostat - Theme 9: Science & Technology – Inf. Soc.	2007
Broadband penetration (as % of population) (COCOM)	ECTA Broadband scorecard/COCOM	End sep. 2007
Broadband penetration rate (number of broadband lines per 100 population)	European Innovation Scoreboard 2007	2006
6. Patent system, standards		
IPR system robustness	World Economic Forum – Global Competitiveness Report 2007-08	2008
Number of EPO patents per capita	Eurostat, S.I., Innovation & Research	2004
EPO patents per million population	European Innovation Scoreboard 2007	2003
USPTO patents per million population	European Innovation Scoreboard 2007	2003
Triad patents per million population	European Innovation Scoreboard 2007	2005
Number of new community trademarks per million population	European Innovation Scoreboard 2007	2006
Number of new community designs per million population	European Innovation Scoreboard 2007	2006
Other		
Science and technology graduates (tertiary graduates in science and technology per 1000 of 20-29 years population)	Eurostat, S.I., Innovation & Research	2005
Researchers (FTE) per 1000 labor force	DG RTD Regional Key Figures Database	2004
Population with tertiary education per 100 population aged 25-64	European Innovation Scoreboard 2007	2006
Highly qualified scientific and technical workers, as % labor force	Eurostat - Theme 3: Population & Social Conditions: Theme 9: Science & Technology	2006

Indicators	Data sources	Ref. year
Highly qualified scientific and technical workers as % of total S&T human resources with tertiary education	Eurostat - Theme 3: Population & Social Conditions: Theme 9: Science & Technology	2006
Hours worked by high-skilled persons engaged (share in total hours worked)	www.euklems.net	2005
Participation in life-long learning per 100 population aged 25-64	European Innovation Scoreboard 2007	2006
Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	European Innovation Scoreboard 2007	2006
Innovative SMEs (% of all SMEs)	Eurostat – Theme 9: Science & Technology – CIS-4	2004
SMEs innovating in-house (% of SMEs)	European Innovation Scoreboard 2007	2004
Innovative SMEs co-operating with others (% of SMEs)	European Innovation Scoreboard 2007	2004
Innovation expenditures (% of turnover)	European Innovation Scoreboard 2007	2004
Sectoral specialisation in terms of technology intensity (sum of high and medium-high)	Eurostat - Theme 9: Science & Technology – High-tech industry	2005
Employment in medium-high and high-tech manufacturing (% of total workforce)	European Innovation Scoreboard 2007	2006
Employment in high-tech services (% of total workforce)	European Innovation Scoreboard 2007	2006
Exports of high technology products as a share of total exports	European Innovation Scoreboard 2007	2006
Sales of new-to-market products (% of turnover)	European Innovation Scoreboard 2007	2004
Sales of new-to-firm products (% of turnover)	European Innovation Scoreboard 2007	2004

Annex II:

1. University/industry research collaboration

Definition: *"This indicator is an average of responses to a survey of senior business executives, conducted by the World Economic Forum, seeking opinions on the level of collaboration between business and universities in R&D. The responses range from 1 (minimal or nonexistent) to 7 (intensive and ongoing)."*

Assessment		**Grade**
Overall		**C**
1. Relevance	*a) Assessment of Relevance* The indicator is a qualitative assessment of availability but a direct one.	A
	b) Assessment of the Type of Policy Indicator Improved collaboration between universities and businesses is an important outcome of an efficient knowledge transfer regulation and so in principle not necessarily a direct outcome, however, credits or grants given to businesses to collaborate with universities (as practised by the some governments, typically, for SMEs) could have a direct impact. However the indicator is opinion based and policy measures can only have an indirect impact on these opinions.	B
2. Accuracy	*a) Data Collection Method* The data is opinion-based and originates from the World Economic Forum, as part of its annual Global Competiveness Report.	C
	b) Cross Country Comparability In principle the comparability should be high. However given the fact that it is an opinion-based survey there remain some uncertainties about comparability in practice. Moreover respondents from companies with less than 100 employees and less than $10,000 US dollars are excluded which could further distort comparability, particularly between richer/poorer and large/small countries.	B
3. Availability	*a) Availability across OECD Countries* Data is available for all OECD countries	A
	b) Availability over Time The Indicator is available on an annual basis.	A
Source	World Economic Forum – Global Competitiveness Report 2007-08	

Source: International Consortium for Entrepreneurship (ICE), Quality Assessment of Entrepreneurship Indicators (2008)