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EU corporate R&D intensity gap: structural features call for a better understanding of industrial dynamics

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In order to achieve its 3 % target for R&D intensity and boost its competitiveness and job creation, the EU needs to adapt its industrial structure and increase economic activity in the high-R&D-intensive sectors. A focus on fostering the conditions for the creation and growth of 'new-emerging innovative sectors' (NEIS) is recommended.

1. Economic and policy background

Corporate research and development (R&D) and innovation are expected to play a pivotal role in the European Union (EU) competitiveness and jobs creation. For this reason R&D has become a major policy focus of the EU. The 'Investment Plan for Europe' views research and innovation investment as one of the main levers to mobilise investment in the economy to foster job creation, increase competitiveness and meet long-term needs.[1]

Shared competencies and synergies between the policies of the EU and the Member States in this area are envisaged to be implemented in the framework of the Europe 2020 strategy,[2] which takes the form of seven 'flagship initiatives'. One of these initiatives is the Innovation Union, which sets a headline target for intensity of R&D investment in the EU of 3 %.

This target of having R&D expenditures of at least 3 % of gross domestic product (GDP) strongly relies on the private sector, which is expected to account for two-thirds of this target. The focus on the private sector is of particular interest because the private-sector R&D gap between the EU and its closest competitor countries is still large despite more than a decade of efforts.

This brief note summarises the results of recent empirical studies on the causes and trends of the EU private-sector R&D gap and suggests possible implications for the EU policy agenda.

2. Results

This summary is drawn from two recent studies[3] analysing firm-level data from companies listed in the EU Industrial R&D Investment Scoreboard. The data cover the years 2005-2013 and relate to the top R&D investing companies worldwide, which account for, on average, more than 80% of global private R&D expenditure.[4] The following are the key findings.

(i) Stable EU R&D investment growth rates showed resilience despite economic and financial turbulence. Corporate R&D investment growth rates in the EU sample remained steady during the period 2005-2013. Furthermore, in 2009, the adverse effect of the economic and financial crisis on annual growth in R&D investment was greater in the USA than in the EU.

[1] See http://ec.europa.eu/priorities/jobs-growth-and-investment/investment-plan_en

[2] See: http://ec.europa.eu/eu2020/index_en.htm

[3] Based on two papers by Moncada-Paternò-Castello (2016a, 2016b) issued in the context of the IRIMA II project, a joint activity by the European Commission's Joint Research Centre (JRC) and the Directorate General Research and Innovation.

[4] Calculated from European Commission (2014).

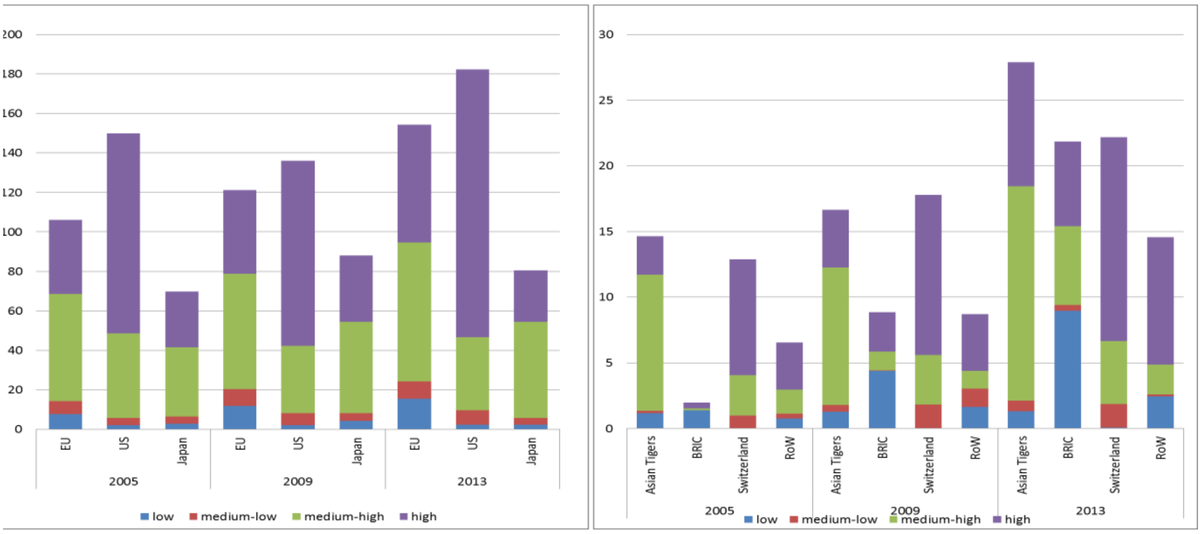
In Japan the recovery to the 2009 annual growth level was still proving difficult in 2013. Despite hard times in the 2009, US companies show the highest R&D investment figures, followed by companies in the EU and Japan. The USA also led R&D investment in the high-tech sector group, while the EU in the low- and medium-tech groups during these years (Figure 1).

(ii) The R&D intensity gap between the EU and its main competitors is mainly due to structural factors. The R&D intensity gap between the EU and the USA, Japan and Switzerland is negative in all years examined (i.e. R&D intensity is lower in the EU).

considering firms' R&D investment effort in their individual sectors (intrinsic effect), and even improved its relative performance over the period examined. However, when the R&D intensities of different sectors are aggregated and the totals compared, the effect of the sector composition (structural effect) of the EU's direct competitors — where high-R&D-intensity sectors account for a higher proportion of the economy than in the EU — outweighs the positive intrinsic performance of the EU compared with all of the other countries or regions considered.

(iv) There are no signs that the EU will appreciably narrow the corporate R&D intensity gap in the coming decade.

Figure 1. R&D investment in 2005, 2009 and 2013 in selected countries/regions by sector group (€m)



"RoW",rest of the world

This is mostly due to the structural[5] composition of the economy (in line with the findings of Moncada-Paternò-Castello *et al.*, 2010, and Cincera and Veugelers, 2013). The gap with the BRIC countries (Brazil, Russia, India and China) and the Asian Tigers (Hong Kong, South Korea, Singapore and Taiwan) is negative, i.e. R&D intensity is higher in the EU.

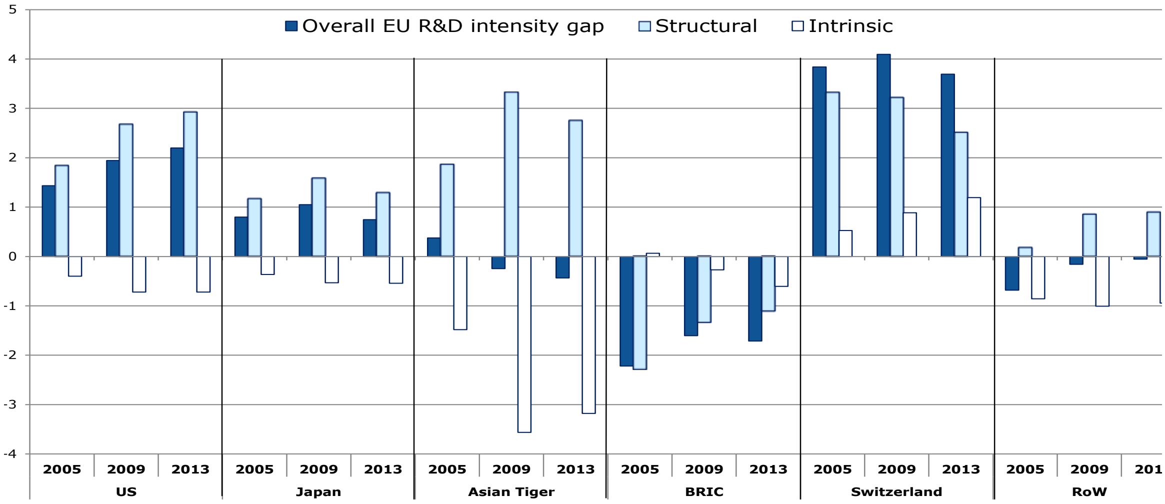
(iii) Within any particular sector, the R&D intensity of individual firms in the EU is superior to that of similar firms in competitor economies. The EU outperforms all other economies examined (except Switzerland) when

More precisely, the negative gap between the EU and the USA has widened over the 9-year period of observation, whereas the gap between the EU and Japan and Switzerland has remained relatively stable, although somewhat decreased in 2009-2013. The positive R&D investment gap between the EU and the BRIC countries has narrowed. The R&D intensity gap between the Asian Tigers and the EU shifted from negative in 2005 to positive in 2009, and by 2013 was even more positive (Table 1).

(v) The shift in R&D investment between sectors was slightly higher in the EU than in the USA during the period 2005-2013. This is even more pronounced when considering the number of firms active in different sectors. However, in both economies the pace of change was slower than in Japan and in the emerging economies.

[5] A common approach distinguishes 'intrinsic factors', which reflect the R&D investment of firms within a particular sector, and 'structural factors', which reflect the size of the R&D-intensive sectors in relation to other sectors within an economy. Low aggregate R&D intensity can reflect the absence or small size of R&D-intensive sectors rather than any general firm-level failure of R&D performance.

Table 1. Differences in total corporate R&D intensity (R&D investment to sales ratio (%), vertical axis) between the EU (sample used for comparison) and selected countries/regions in 2005, 2009 and 2013, and their decomposition into *structural* and *intrinsic* effects



There are no signs that the USA showed greater capacity than the EU to change its industrial R&D structure over the period 2005-2013 (although this may be the case for the years previous to 2005). However, the USA experienced a strong shift towards the software and computer sectors. The greatest change in R&D sectorial composition was in China, accompanied by increased presence of Chinese firms among the top R&D investors.

(vi) In the EU, R&D specialisation covers a wider range of sectors. The EU is specialised in 19 out of the 35 sectors analysed, compared with 13 in Japan and 11 in the USA. In the USA, specialisation is focused on the ICT-related sectors and on biotechnology, while in the EU in medium-tech sectors. Overall, the changes in sector specialisation from 2005 to 2013 in the so-called Triad economies (EU–Japan–US) have favoured the EU. The EU has increased its R&D comparative advantage in 12 sectors, while Japan showed an increase in 11 sectors and the USA in only two (details are given in Table A1, in the annex).

(vii) The average age of firms varies greatly across countries and sectors, and is associated with sectorial dynamics.

Japanese and EU companies are the oldest (71 and 66 years old respectively) firms in the sample, Chinese companies are, by far, the youngest of the sample (6 years old on average); this is mainly due to the privatisations that took place in the late 1990s and early 2000s, when public companies were 'reborn' as private ones. Most firms in the USA and other world regions are aged in the range 40-50 years.

Even more interesting are the results of the econometric analysis of variance, which show substantial differences in the average age of firms in different sectors. In fact, such differences are even greater than the differences between countries, i.e. age differences are associated more by sector specificities than by country specificities.

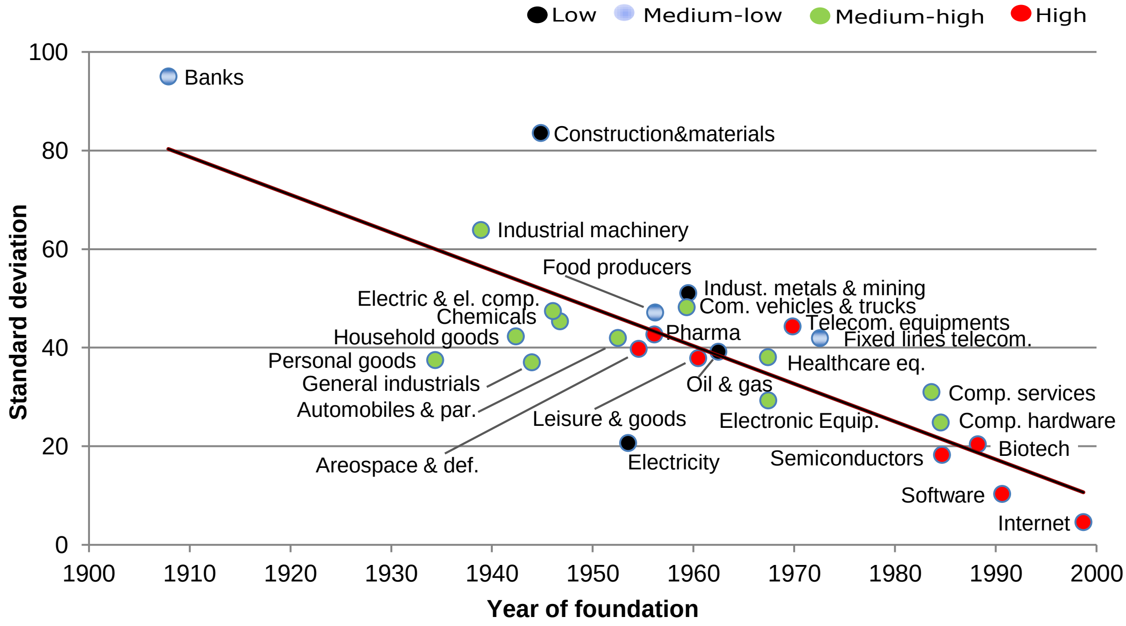
Figure 2 shows the age differences between different industrial sectors. Three observations stand out: (i) in sectors with lower average age than most of other sectors in the sample, R&D intensity is 4 % or higher (> 5 % in the case of the high-R&D-intensity group); (ii) these are ICT-related sectors, except 'healthcare equipment' and 'biotechnology' sectors; and (iii) the four youngest sectors are all highly R&D intensive, which suggest that the knowledge and technology frontier of competing firms has moved forwards, requiring more intensive investment in R&D.

3. Conclusions and policy implications

The analysis of the evolution of corporate R&D intensity confirms that the EU R&D investment gap relative to the USA, Japan and Switzerland is of a structural nature. Moreover, the analysis reveals no signs that the changes necessary to achieve the EU R&D policy target for 2020 are taking place. Therefore, there is a need to identify specific policies actions that could improve the situation.

Previous studies, for example by Mowery (2009), Mathieu and Pottelsberghe (2010), Foray and Lhuillery (2010) and Duchêne *et al.* (2011), suggest that, in the two decades preceding the timespan we investigated, the USA experienced more dynamic changes in the structure of its economy than did the EU. They indicate that these changes favoured the higher-R&D-intensity sectors (e.g. biotech, software and internet) and as a result many new firms were *created* in the USA during this period.

Figure 2. Average year of foundation of top R&D firms and their variation by sector



Note: The standard deviation expresses by how much the age of firms in a sector differ from the mean age for that sector.

The results of our investigation suggest that the average age of firms and the sectorial dynamics are strained by the sector typology (as well as country specificities). Moreover, the EU is specialised in a large number of sectors, more numerous in low and medium-R&D-intensive ones.

This result should be viewed alongside the findings of Cincera and Veugelers (2013), who claim that younger US companies are more numerous present — and show a greater capacity to grow[6] — in high-R&D-intensity sectors than similar EU companies.

A different sector mix towards more R&D-intensive sectors may help the EU to reduce its R&D intensity gap. Therefore, policy-making should target the conditions favouring the emergence of 'new-emerging innovative sectors' (NEIS). This can complement the traditional focus on (young) innovative firms independently from the sector in which they operate.

NEIS can be novel (e.g. software and internet in the early 1990s) or existing sectors and value chains that are evolving into new industries with great economic and social potential (e.g. in the late 1980s biotech for health emerged out of the pharma sector while, in the future, environmental technology-based sub-sectors are expected to emerge).[7] Therefore, NEIS well fit with the concept of 'emerging industries'[8] and highlight the crucial role played by the "Future and Emerging Technologies"[9] of the European Commission.

Finally, policy strategies should also consider the comparative R&D advantage of the EU companies in the low and medium -tech sectors as well as the role that these sectors play in the economy.

In fact, larger European companies in sectors such as 'automobiles and parts' and 'industrial engineering and machinery' show good capacity to compete (and lead) on a global level. These sectors continue to increase the level of R&D investments and at the same time play an important role in absorbing technological developments from high-R&D-intensive firms (e.g. through embedded ICT components) and from smaller innovative firms.

For this reason, some EU companies in these low and medium-tech sectors might be equipped to be key players in modernize their own industrial sector and, at the same time, in the development process of the next technological generations and the creation of the future knowledge-intensive industries[10].

[6] Targeting high-growth firms is tricky because of the difficulty in predicting which firms are going to grow, as Coad *et al.* (2014) have observed.

[7] Top global R&D investors target countries with comparative advantages in emerging technologies, thus with an environment conducive to the creation and development of new ideas with a high potential long-term growth impact (Dosso & Vezzani, 2015).

[8] 'These are industrial sectors based on new products, services, technologies or ideas, which are in early stage development and are characterised by high growth rates and market potential'. Their development is 'often driven by cross-cutting technologies, creativity and service innovation, and societal challenges' (European Commission, 2016).

[9] An action of the Horizon 2020 Programme http://ec.europa.eu/programmes/horizon2020/en.

[10] In line to several policy initiatives of the European Commission and some EU Member States, such us "Industrial renaissance", "Industry 4.0", and "Industrial modernisation" see https://ec.europa.eu/

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ANNEX

Table A1. R&D sector specialisation by country/regions in 2005 and in 2013 – Results of the *R&D Revealed Comparative Advantage index* (the highlighted values of the index indicate comparative specialisation).

	2005	2013	2005	2013	2005	2013	2013	2013	2013
	EU		USA		Japan		Asian Tigers	China	Rest of the World
Aerospace defence	1.9	1.7	1.0	1.0	0.0	0.0	0.0	0.0	1.6
Alt energy	0.0	2.6	0.0	0.5	0.0	0.0	0.0	0.0	0.0
Automobiles parts	1.4	1.6	0.6	0.4	1.5	1.8	0.5	0.6	0.2
Banks	3.2	2.6	0.0	0.0	0.0	0.0	0.0	1.4	1.9
Beverages	0.0	0.8	0.0	1.1	4.9	2.3	0.0	0.0	0.0
Chemicals	1.3	0.9	0.7	0.8	1.3	1.9	0.1	0.0	1.5
Construction materials	1.1	0.6	0.3	0.2	2.2	0.6	0.0	18.2	0.3
Electricity	1.5	2.2	0.0	0.0	1.9	0.6	3.8	0.0	0.0
Electronic	1.0	0.7	0.2	0.3	1.5	1.8	6.7	0.3	0.2
Finance insurance	2.4	1.7	0.7	0.6	0.0	0.7	0.0	0.0	2.0
Fixed line telecom	1.7	1.7	0.0	0.4	1.8	1.4	1.3	1.2	0.2
Food producers	1.4	1.3	0.2	0.5	0.6	0.6	0.2	0.0	3.6
Food retailers	1.7	3.2	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Forestry paper	1.4	2.3	0.7	0.0	1.4	1.7	0.0	0.0	0.0
General industrials	0.3	0.8	1.6	1.1	0.9	2.0	0.1	0.9	0.3
General retailers	0.0	0.7	2.2	2.2	0.7	0.0	0.0	0.0	0.0
Health care eq	0.7	0.8	1.9	1.8	0.1	0.5	0.0	0.0	0.4
Household goods	0.7	1.2	1.7	1.7	0.4	0.1	0.0	0.0	0.0
Industrial engineer	1.5	1.4	0.7	0.7	0.8	0.7	0.2	2.5	1.3
Industrial metals	1.2	1.1	0.3	0.1	1.6	2.0	2.5	3.2	0.7
Industrial transport	1.7	2.3	0.0	0.0	1.2	0.0	0.0	8.6	0.0
Leisure goods	0.5	0.0	0.4	0.2	3.4	4.2	3.7	0.0	0.4
Media	2.2	2.3	0.3	0.3	0.9	1.1	0.0	0.0	0.0
Mining	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	8.7
Mobile telecom	1.2	1.9	0.0	0.6	0.0	0.0	0.0	0.0	2.3
Oil equipment	0.0	0.4	2.6	1.8	0.0	0.0	1.3	1.0	1.4
Oil gas producers	1.4	0.9	0.6	0.4	0.1	0.2	0.5	7.9	2.9
Personal goods	0.9	1.4	1.0	0.5	0.9	1.4	0.9	0.0	1.2
Pharma biotech	0.9	1.0	1.3	1.2	0.3	0.6	0.0	0.0	2.3
Software computer	0.4	0.4	2.2	2.1	0.1	0.3	0.0	0.0	0.7
Support services	0.5	1.2	1.6	1.1	0.3	0.4	0.0	0.0	2.2
Technology haware	0.6	0.6	1.3	1.6	1.0	0.4	1.4	1.9	0.6
Tobacco	0.2	1.0	1.7	1.0	1.3	2.1	0.0	0.0	0.0
Travel leisure	1.0	0.3	1.2	0.2	0.7	4.1	0.0	2.7	1.3
Utilities	1.7	2.7	0.2	0.2	1.0	0.6	0.0	0.0	0.0

Note: The *R&D Revealed Comparative Advantage index* is the share of R&D investment in a particular industrial sector relative to the share of the global R&D investment in all sectors in different countries/regions. Above 1 country *i* is comparatively specialised for R&D investment in sector *j*.

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Abstract
Corporate Research and Development (R&D) is a driver for innovation, competitiveness and job creation. In order to achieve its 3 % target for R&D intensity and boost its competitiveness and job creation, the EU needs to adapt its industrial structure and increase economic activity in the high-R&D-intensive sectors. A focus on fostering the conditions for firm creation and growth in 'new-emerging innovative sectors' (NEIS) is recommended.

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