FOR A TRANSFORMATIVE INDUSTRY & INNOVATION STRATEGY

Key messages

- EU R&D and innovation performance largely depends on industrial specialisation
- The EU needs a long-term strategy to foster industrial competitiveness
- A framework for designing a new transformative industry & innovation policy strategy is proposed

EU corporate R&D & innovation strategic goals

Corporate research and development (R&D) and innovation are expected to play a pivotal role in EU competitiveness and job creation.

Since 2000[1] the objective of "*preparing the transition to a knowledge-based economy and society by better policies for the information society and R&D*"[2] is at the core of the EU socio-economic reform agenda.

Crucial discussions are now underway on the next EU multiannual financial perspectives (post-2020) and the subsequent EU financial support programmes - including the next EU Framework Programme for Research and Innovation (FP9).

In October 2017, the European Commission has adopted a proposal for "A renewed EU Industrial Policy Strategy". The aim is to foster industrial competitiveness, innovation and technological leadership in a fair environment where the potential of digital technologies may be leveraged across all industrial sectors (European Commission, 2017a).

The ultimate objectives are to create more and better jobs, to accompany those regions and workers most affected by industrial development (and globalisation), as well as to facilitate the transition to a low-carbon and circular economy.

In this framework, a strengthened link between innovation and industrial policies should be envisaged. For this purpose, there is a need to better understand how to effectively design an industrial (technology) strategy favouring an increase in innovation and competitiveness. In this policy insight, we will propose an integrated policy framework recognizing the importance of industrial dynamics and structural change.

The relevance of manufacturing for R&D and the technology specialisation of EU

The last decade(s) has been characterised by a progressive retreat of the manufacturing sector both in terms of value added share and job creation.[3] This led the Commission to recognise its importance to foster competitiveness and sustainable growth (European Commission, 2014).

To the extent that manufacturing industries provide a foundation for innovation and productivity growth, the target of manufacturing to represent 20% (by 2020) of a country's value added may result in increased R&D investments.

The positive association between manufacturing and R&D investment, as found in a recent study (Coad and Vezzani, 2017), also suggests that the link between manufacturing and R&D depends on a country's industrial structure (specialisation).

The EU shows higher shares of R&D in medium-tech sectors (Fig.1) as compared to the USA, but still lower than Japan. These sectors still play a key role in shaping the patterns of jobs creation and competitiveness within the EU Indeed, large EU R&D

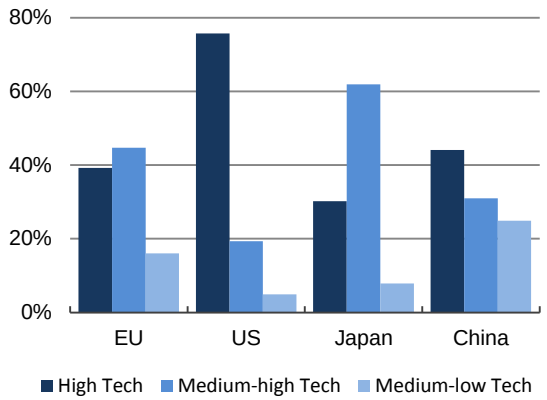
[1] Lisbon European Council: http://www.consilium.europa.eu/en/uedocs/cms_data/docs/pressdata/en/ec/00100-r1.en0.htm.

[2] Another important pillar of the strategy was: "sustaining the healthy economic outlook and favourable growth prospects by applying an appropriate macro-economic policy mix".

[3] Emphasis has been recently given to the importance of service activities in manufacturing (De Backer *et al.*, 2015). However, many service activities of today would not be possible without high-tech manufacturing products.

investors operating in sectors such as 'automobiles and parts' and 'industrial engineering and machinery' show sound capacity to compete (and lead) on a global level (Hernández *et al.*, 2017).

Fig.1: R&D shares by group of technological intensity sectors



Data: Elaboration from the EU R&D Scoreboard (Hernández *et al.*, 2017).

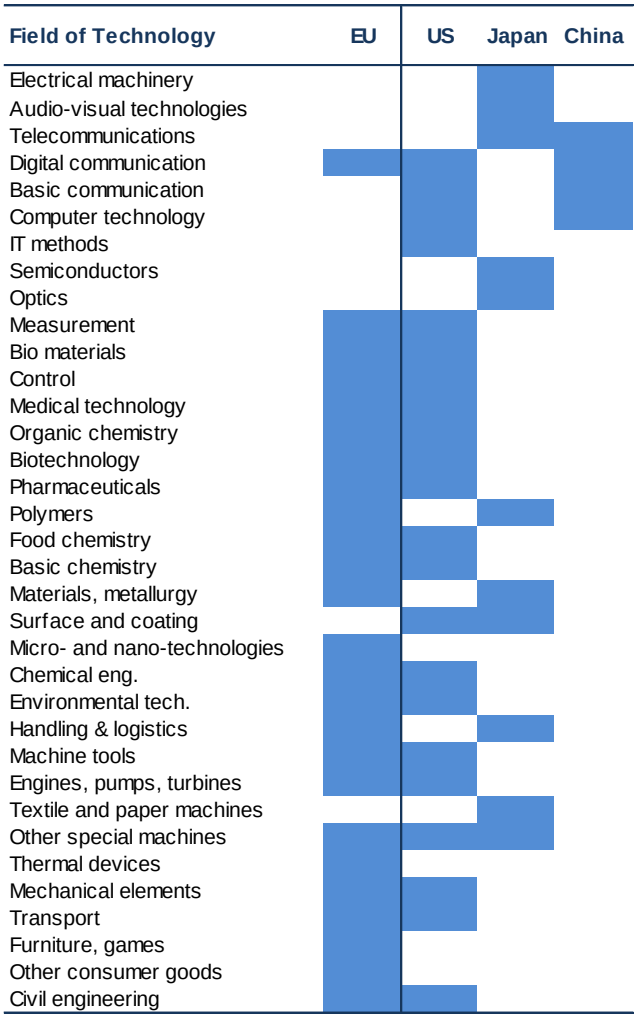
In the last decade(s) the EU has been criticised for its slow dynamics towards high-tech sectors. However, while this is reflected in a relative low specialisation in new high tech sectors, this resulted also in a broader technological specialisation compared to the other main world economies (Fig. 2). This broader specialisation possibly reflects a wider range of competences that represent a base to grasp the benefits deriving from new technological opportunities.

Importantly, European and US appear to be the only ones specialised in a number of technologies that are fundamental to address grand challenges as health, aging and the environment. They both appear specialised in fields such as Medical technology, Pharmaceuticals, Food chemistry, Biotechnology and Environmental technologies.

Industrial specialisation shapes countries' R&D and innovation performance

When considering the sector in which firms operate, EU firms do not invest less intensively in R&D than their USA or Japanese counterparts. At a country scale accounting for the industrial structure leads to substantial differences in the traditional R&D intensity country rankings, suggesting that high levels of aggregate R&D intensity is due to a high weight of R&D-intensive industries in the economy rather than a macroeconomic environment particularly favourable to R&D (Mathieu and van Pottelsberghe de la Potterie, 2010; Moncada-Paternò-Castello *et al.*, 2010; OECD, 2015). R&D intensity is mainly the result of the industrial specialisation (structure).

Fig.2: Technological specialisation



Note: Cells highlighted in blue = strongest comparative specialisation.
Data: Adapted from Dernis *et al.* (2015).

Aiming at a radical change of the EU industrial structure?

EU firms in medium- and low–tech sectors continually increase their R&D investments and at the same time play an important role in absorbing technological developments from R&D intensive firms (e.g. through embedded ICT components) and from smaller, specialised, innovative firms (e.g. through dedicated solutions). For this reason, some EU firms operating in low- and medium-tech sectors might play a key role in modernizing the industrial base by adopting the next generation technologies. Increasing R&D in these sectors can help in improving their global competitiveness, but we should not forget that for a number of industries the acquisition of innovations from external parties and scale economies (still) play a determinant role (Pavitt, 1984).

Sustaining investment and technological uptake represents a valid complement to R&D centred policies by unlocking the potential of these industries and sustaining the demand for new technologies. However, modernizing and improving the competitiveness of these sectors is not enough.

The EU also needs to increase the weight of high-tech sectors in the economy to stay at the technological frontier.

As the industrial structure matters, policy should take it into account

In an EU where industrial specialisation differs substantially across countries (van Pottelsberghe de la Potterie, 2008) a sensible policy strategy should also take into account the industrial specificities, seeking to encourage specific patterns of specialisation. The concept of Smart Specialisation recognizes the importance of structural change and the convenience of building industrial and innovation strategies on idiosyncratic strengths and opportunities (Foray *et al.*, 2009). In particular, Foray and Goenaga (2013) describe four patterns of related diversification that closely resemble patterns of structural change.

In a nutshell, there is a need to integrate horizontal industrial and innovation policies with sector/technology specific ones. The aim should be to promote the industrial transformation towards the knowledge economy by reinforcing the presence of high-tech sectors (and *pushing forward* the technological frontier) and simultaneously fostering the modernization of low- and medium-tech sectors (*moving towards* the technological frontier).

A new paradigm for industrial & innovation transformation ...

In an evolutionary perspective, different patterns of structural change can be associated to specific technological dimensions:

① radical foundation of a domain exploiting opportunities not related with any existing productive assets → **new technologies/sectors**;

② narrow diversification, potential synergies (economies of scope, spillovers) between an existing activity and a new one → ***technological fusion***;

③ transition to new domain emerging from existing industrial commons (R&D, engineering, and manufacturing capabilities) → ***technological redeployment***;

④ modernization through the adoption (co-development) of specific applications with impact on efficiency and/or quality → ***technological adoption.***

This concept is of particular interest when considering that countries (and regions) differ in their technological base and in their capacity of grasping new industrial and technological opportunities.

Also within leading R&D investing economies huge differences in R&D intensity – mainly related to their industrial base – subsist. For example, the differences in R&D intensity among USA states are even more marked than between EU countries (van Pottelsberghe de la Potterie, 2008). Indeed, this suggests that economic areas have different industrial and innovation features, because they are different in terms of industrial specialisation, firm-size structures, average education (policy might seek to reduce these particular differences to guarantee equal opportunities), labour markets, as well as different stages of economic development more generally. Hyper-accelerated changes in R&D are unlikely to result in profitable innovative outputs, and may divert resources from other types of investments. On the other hand, countries strongly specialised in high-tech industries would require higher R&D investments coupled with other intangibles investments.

An appropriate growth policy depends on the distance to the technological frontier (Aghion and Howitt, 2006), and therefore R&D and innovation policies should take this into account, together with industry specificities and the country industry structure. Some policies work better for some sectors favouring specific patterns of structural change, and countries benefit from them according to their relative industrial mix. In Box 1 we sort the four patterns of structural change described above. For each pattern, we associate a specific technological dimension, its intrinsic radicalness and associated uncertainty. In the last column, we provide examples of policy instruments which could best fit the type of structural change identified.

Box 1: Sorting transformative industrial and innovation policies

	Type of structural change	Technological dimension	Radicalness (uncertainty)	Examples of appropriate policy instruments
Strategic/Industrial setting	Radical foundation of a domain	New technologies/sectors	High	• Large-scale mission oriented projects • Invest in and support to basic research • Intellectual property protection • Access to risk capital • Support to nascent industries
	Narrow diversification through synergies	Technological fusion	Medium-High	• Industrial cross-fertilization • Economies of scope • Skill broadening • Support R&D and other intangibles
	Transition to new domain from existing commons	Technological redeployment	Medium	• Economies of scale and scope • Skill upgrading • Support R&D and other intangibles • Support capital investment
	Modernization	Technological adoption	Low	• Economies of scale • Skill updating • Support capital investment (new processes)

The box evidences specificities that produce a tension among different objectives. The choice of policy instruments may lead to differentiated impacts across economies, depending on their sector mix. Therefore, industrial and innovation policies should take into account specific territorial needs to guarantee competitiveness and job creation across the whole EU.[4]

... in the framework of a new industrial and innovation long-term strategy ...

"Much of the progress that seemed impossible 60 years ago in Europe is now taken for granted. [...] Change in all things may be inevitable, but what we want from our lives and the European values that we hold dear remain the same" (European Commission, 2017b).

Innovation and industrial policies to foster European competitiveness should be guided by the ultimate objective of a sustainable economic growth and an improvement of citizens' living standards.[5]

We should aim at designing policies tailored on the European specificities and needs. This can be achieved through recognizing that a targeted active public role is a key determinant shaping the direction of technical change: we should "rethink the state rather than downsize it" (Mazzucato, 2017). Indeed, countries and regions that experienced a sustained innovation-led growth have often benefited from long-term visionary mission-oriented policies (Mazzucato, 2013) – as the quest for the Higgs boson at CERN – to give birth to new breakthrough technologies, which then spur to the business sector creating new industries. At the same time, countries recently capable of moving upstream in value chains have particularly benefited from targeted technology policies and an increase in the scientific quality in their universities (Soete, 2012).

In this context, it is central to understand and target the specific conditions favouring the rise of 'new-emerging innovative sectors' (NEIS). 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 from the pharmaceutical sector, while new environmental technology-based sub-sectors are expected to emerge) (Moncada-Paternò-Castello, 2016). Although Europe has largely missed the first ICT revolution, it should position itself carefully to fully grasp the benefits from the next industrial and technological waves. This means favouring a new technological transition leveraging present industrial and research strengths and be ready to bear the risks and rewards associated with the new challenges. Such targeted policy would complement the traditional horizontal approach with the aim of enhancing long-term development.

[4] In this framework a Smart Specialisation approach can be functional to industrial and innovation policies, considering that sectoral policy works better when more decentralised (Aghion *et al.*, 2011).

[5] GDP per capita is a good indicator of welfare across a broad range of countries, but for any given country the difference between the two measures can be important (Jones and Klenow, 2016). In particular, "European countries have welfare measures 22 percent higher than their incomes. The remaining countries, in contrast, have welfare levels that are typically 25 to 50 percent below their incomes" (ibid. pp. 2239-2240).

..... which encompasses key complementary investments

At the same time, it is also crucial to identify complementary investments associated with the emerging technologies and specialisations, as for example education and training. However, often in Europe there is a weak correlation between R&D and training specialisation and the structure of economic activities; which opens the room for targeted policy measures (Foray *et al.*, 2009). The reductions of public knowledge investments in higher education and research and innovation due to short-term perspectives are curtailing the long-term EU growth and welfare potential (Archibugi and Filippetti, 2016; OECD, 2016). Moreover, the quality and availability of researchers are factors that companies rank among the highest to the attractiveness of a location for R&D (Potters *et al.*., 2017). It appears of utmost importance to guarantee the provision of adequate human capital to fulfil the new knowledge needs.

In summary, in this short note we make the case for the need of defining long-term scientific and industrial research objectives as part of an integrated EU industrial & innovation agenda. This should be organized around few objectives coupled with targeted industrial (technology) policies in a coherent strategic framework where countries and regions can choose the instruments more suitable for their idiosyncrasies.

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Contact information for this document

Pietro Moncada-Paternò-Castello

European Commission, Directorate General Joint Research Centre - Directorate Growth & Innovation, Territorial Development Unit

pietro.moncada-paterno-castello@ec.europa.eu

Edificio Expo - C/ Inca Garcilaso 3 - E-41092 Seville

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