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Investment in Innovation for European Recovery: a Public Policy Priority

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Investment in innovation for European recovery: a public policy priority

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Abstract

The 2008 crisis had severe consequences in Europe, especially for investment, including investments in R&D and innovation. We argue that there are large scientific and technological opportunities that could pave the way to a new stage of social and economic development, but they need appropriate public policies to be seized. A European recovery can come from developing and exploiting these opportunities, but to do so requires a large governmental programme of *investment* in R&D and innovation that attracts businesses to invest further. The European Union could play a crucial role in this process by pursuing the ambitious goals outlined by the European Council in the Lisbon (2000) and Barcelona (2002) summits, which unfortunately were abandoned as a consequence of the economic crisis and the austerity measures. Powerful instruments, such as the Juncker investment plan, and the proposed 2021-2027 Framework Programme Horizon Europe, can provide the right kind of stimulus. A re-organization of the governance of the European innovation and competence building through a proper Council at the EU level is essential.

Keywords

R&D, European Union, Juncker Plan, EU Framework Programmes for Research and Technological Development, Research policy, Innovation policy

1. Introduction

The European Union (EU) has not yet managed, after more than a decade, to fully recover from the 2008 economic crisis. The European Union is certainly not the only region of the world that was strongly affected by the financial crisis. But the signs of a European recovery continue to be much weaker than in other parts of the world and this is leading to substantial changes in the relative economic strengths and weaknesses of countries and regions. While emerging countries are continuing to catch-up with the Triad, some observable differences are also shaping the economic growth patterns of the United States, Europe and Japan. The United States has so far more successfully managed to increase its GDP and to generate new jobs, while a range of economic indicators show that Europe and Japan are lagging behind.

The lack of economic recovery in the EU is often associated to the weak investment rate of the last decade. Some economic policies, at both the national and EU levels, have therefore tried to foster investment. The European Central Bank (ECB) has kept interest rates at a historical low level. The EU's Juncker Plan has endowed the European Investment Bank (EIB) with an increasing amount of funds accessible at very advantageous rates. These measures have only been partially successful. They prevented a further collapse of production and consumption, but have failed to present sustained signs of revitalization across countries. The reason why there have not been more robust public investment plans is linked to the fact that the dominant concern in Europe has been with the consolidation of public debt. But, many voices have proclaimed that austerity measures deepened, rather than alleviated, our problems, and that a new path should be trotted (see, for example, Blanchard, 2016; Fatás and Summers, 2018). Making the Stability and Growth Pact the landmark of economic policies had the effect of impeding the boost in both business and government investment needed in large parts of the EU.

Investment is a very wide term and any strategy for economic recovery needs to qualify it. First, and foremost, this paper concentrates on *innovation investment*. We would like to explore to what extent a large plan of public innovation investment could contribute to the overall economic recovery and to opening up a new stage of development in the EU. We define innovation investment as composed by intangible resources, such as R&D, and material assets, including equipment, machinery and infrastructures. We consider innovation investment the crucial component of overall investment because it is most likely to lead to new products, processes and services, potentially leading to the creation of new firms, new industries and new jobs and new types of jobs.

The importance of investment in intangibles is growing, while the importance of physical investment is declining (Conceição et al., 2013; Antonelli and Fassio, 2014; Corrado et al., 2016). The EU also needs to boost investment in intangibles, since: 1) the EU investment in intangible is much lower compared to the US; 2) while investment in intangibles has been relatively resilient and recovered fast in the US, it lags behind in the EU; 3) by looking at the sources of economic growth over 2000-2013, tangibles and intangibles accounted for 80% and 20% in the EU while both account for 50% in the US (Corrado et al., 2016). If properly identified, innovation investment is ultimately able to have multiplier effects, in the long run, much higher than the standard Keynesian investment multiplier, in particular because it will mobilize autonomous resources from the business sector, generate new companies and industries and initiate the Schumpeterian swarming. The public sector does play a

crucial role in innovative investment, especially in the fields where risks are higher, but also the expected returns that can be activated in unrelated scientific fields and technological areas are broader.

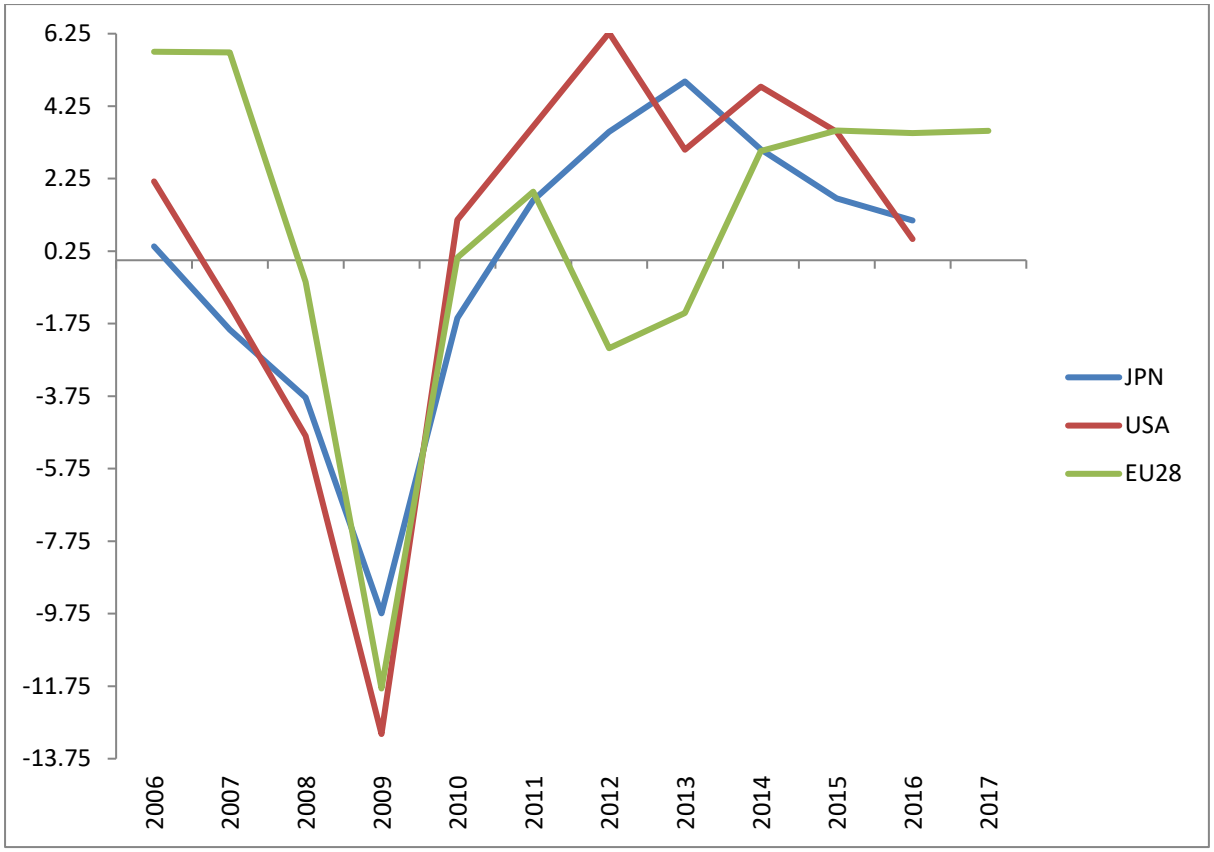
We have discussed these issues, and heard a variety of voices, including policy-makers, businessmen, policy advisers and economists. We report in this paper the outcome of this exploration. The paper is organized around three main issues. The first illustrates the current context, and specifically, whether scientific and technological opportunities can be the backbone of another stage of economic development as they have been over the history of capitalism. The second discusses whether the current economic policies implemented in Europe, including the Juncker Plan, and those planned for the period 2021-2027, are effective instruments to combat the economic slump and to create and disseminate ground-breaking competences. The third outlines how a large scale programme of public innovation investment aimed at enhancing investment in science and technology can sustain a new stage of development, also in the light of the current policies carried out at the EU level, and most notably the various EC Framework Programmes for Research and Technological Development.

We argue that relaunching the Lisbon strategy is not only necessary for ensuring a *sustainable long-term* pattern of economic growth, but it is also necessary as a *short-term strategy* for economic recovery. This strategy has to be based on a big public science and innovation investment plan that opens up new technological opportunities and crowds-in the business sector to be promoted at the EU level. This would help re-launching the Lisbon strategy and the Member States to reach the 3% objective in terms of R&D/GDP intensity. We base this argument on an illustration of the current landscape after the Great Recession of 2008 and on an analysis of the presence of potential opportunities for public investment in research and innovation, as well as on how the EU has responded so far and how she is aiming to respond in the post-2020 agenda. Our policy prescriptions strongly support the current effort towards an increase in science-related investment for the post-2020 EU agenda.

2. The fall of public and private investment since the beginning of the economic crisis in Europe

In this section we discuss the macro-economic landscape with a focus on investment and expenditures on research and development (R&D). In steady development patterns, fixed investment grows in a steady and predictable way along with GDP, suggesting that investment would have picked up after Europe reached the bottom of the crisis. A study carried out by the European Commission (2013) shows that this stable, long-term relationship between investment and economic activity broke in 2008 (see also EIB, 2016 and ECB, 2016). Figure 1 reports the average growth rate of investment (gross fixed capital formation) for the EU, the US and Japan. It shows a huge drop in annual growth rates of investment in the years 2008-2009, followed by another slump in the case of the EU, a moderate double dip for the US and Japan.

Figure 1. Gross fixed capital formation average rate of growth, 2006-2017

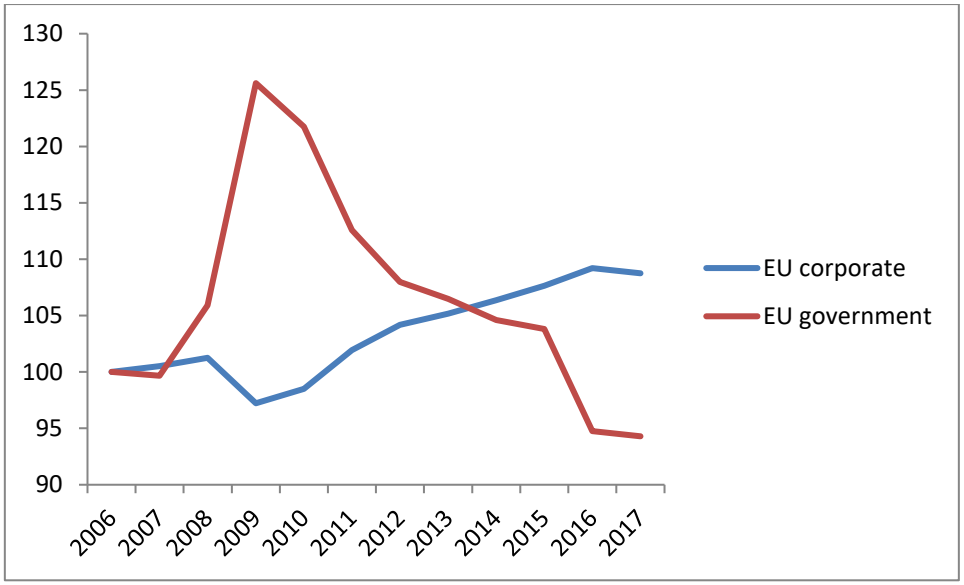


Source: OECD statistics

In Figure 2 we split investment into *business and public investment* for the EU (2006=100). Business investment, after a sizable drop following on the crisis in 2009, increased steadily. Public investment shows a continuous relative decline, following a very sizeable jump in 2009/10. This drop in public investment is linked to the fiscal adjustment programmes undertaken in several countries in the EU (Bosch 2013, Truger and Paetz 2013; Wren-Lewis, 2015).

The share of the public investment in total investment was equal to 14.2% in 2006, reached a maximum of 17.3% in 2010, and then declined to 13.4% in 2017. By contrast, the business sector increased its share from 56.7% in 2006 to 61.7% in 2017. These figures show that the government has not matched the growth rates of the business sector in the years after the crisis in the EU economies.

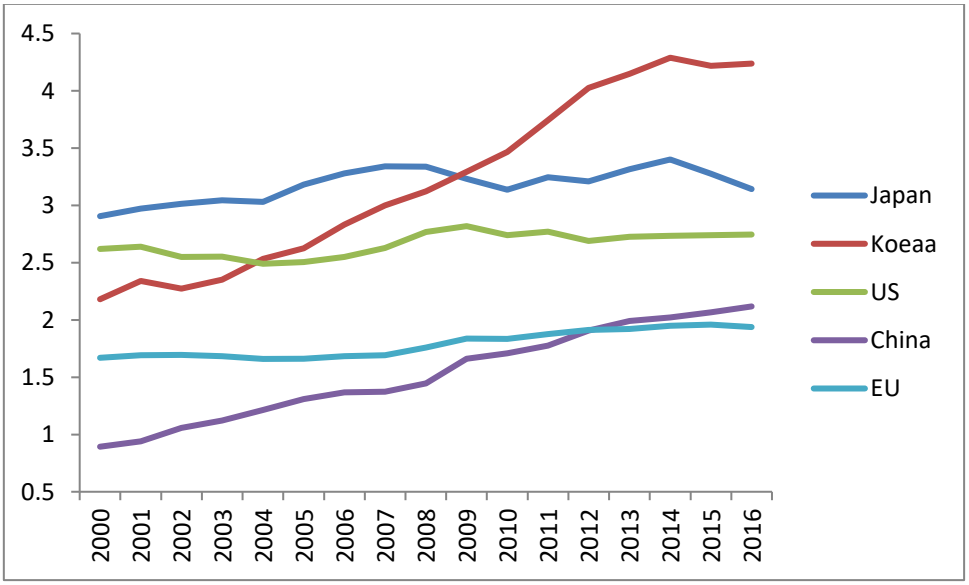
Figure 2. Gross fixed capital formation by sector2006-2017 (2006=100)



Source: OECD statistics

A major concern for Europe's growth potential is *investment in innovation*. There is plenty of evidence that the business sector cut innovation related investments during the crisis (Archibugi et al., 2013; Filippetti and Archibugi, 2011). Using R&D as a proxy for innovation investment, Figure 3 shows that the EU is still far from the investment levels of the US and Japan. Figure 3 further shows that emerging technological leaders, such as South Korea and China, are challenging Europe's position. Further, the data show that, also as a consequence of the 2008 economic crisis, gross domestic spending on R&D in proportion to the GDP in the EU has not grown at all.

Figure 3 - Gross domestic expenditure on R&D as a percentage of GDP (GERD,) 2000–2016



Source: OECD statistics

In which countries has the public sector sustained the overall R&D expenditure while the business sector downsized? There is also evidence that this is not the case in several EU nations. Most

European governments have acted pro-cyclically with investments in R&D: the Czech Republic, Estonia, Greece, Hungary, Italy, Lithuania, Poland, Portugal, and Spain substantially cut public budgets for R&D during the recession (Makkonene, 2013; Veugelers, 2016; Pellens et al., 2018). But the Europe innovation leaders followed a counter-cyclical strategy. According to Pellens et al. (2018, 2), "we have observed an increasing innovation gap between innovation leaders and moderate innovators in Europe due to the most recent 2008 crisis". If protracted over time, a reduction in investment, both fixed capital investment and R&D investment, will have long-term negative effects on economic growth and productivity. Table 1 reports the percentage of total gross domestic expenditure on R&D financed by the government and by the business sector.

Table 1 - Gross domestic expenditure on R&D (GERD) financed by the business sector and by the public sector, as a percentage of GDP

			Business sector				
	2000	*2008*	*2013*	*2014*	*2015*	2000-2015 difference	2008-2015 difference
Japan	2.10	2.61	2.50	2.63	2.56	0.45	-0.05
Korea	1.58	2.28	3.14	3.23	3.14	1.57	0.87
US	1.81	1.76	1.67	1.70	1.71	-0.10	-0.05
China	0.51	1.23	1.54	1.61		1.10	0.38
EU	0.92	0.95	1.05	1.06	1.07	0.15	0.12
			Public sector				
	2000	*2008*	*2013*	*2014*	*2015*	2000-2015 difference	2008-2015 difference
Japan	0.57	0.52	0.57	0.54	0.51	-0.06	-0.02
Korea	0.52	0.79	0.95	0.98	1.00	0.48	0.20
US	0.69	0.84	0.75	0.71	0.70	0.01	-0.14
China	0.30	0.41	0.44	0.42		0.13	0.01
EU	0.59	0.61	0.64	0.63	0.62	0.03	0.01

Source: OECD statistics

Table 1 shows that from 2000 the business sector has increased R&D expenditure in all countries with the exception of the US. The EU shows a moderate increase both compared to 2000 as well as compared to 2008. Turning to the public sector, while both Japan and the US exhibit a moderate decline, the EU reports stable figures over time. The figure shows that: 1) the business sector in the EU demonstrates resilience in its R&D expenditures, as confirmed by firm level analysis (Archibugi and Filippetti, 2011; Filippetti and Archibugi, 2011); 2) the public sector also maintained investment; although the level of public R&D investment in the EU is lower compared to the other countries (with the exception of Japan, which traditionally has had a relatively more important role of the business sector in driving R&D).

A final point, not visible in the figures and table we presented above, is that these patterns are stronger in the European peripheries (Veugelers, 2016; Dosi et al., 2017; Pellens et al., 2018). The

disparities between the stronger core countries of Europe and those at the periphery widened, potentially as a result of different rates in investment, in particular in innovation and R&D, both by the public and business sector (Archibugi and Filippetti 2011b; Izsak and Radošević, 2017). This is jeopardizing economic convergence across Europe, and ultimately puts cohesion at risk.

This evidence points to the following:

a) The investment needed for growth is lacking. If anything, the governments have placed the recovery on the shoulders of the business sector, as opposed to fiscal stimuli.
b) The investment in R&D needed for growth is lacking. While the business sector shows some progress, R&D investment financed by the public sector has not changed much over the period 2000-2015.
c) There are substantial, and increasing, asymmetries across European countries, with peripheral countries worse affected. These differences are putting cohesion in Europe at risk.

On the ground of these facts we raise the issues discussed below.

3. Is the engine of creative destruction grinding to a halt?

Since Schumpeter's writings, we are well aware that the rate of innovation is a main driver of fluctuations in income. What are the mechanisms that link innovation and growth in the current economic situation? Over the last years, we have heard, at least, three different views about the role that technological change could play to foster future economic development (for a critical appraisal of the Schumpeterian legacy on development, see Evangelista, 2018). Let see these views in turn.

1) The first view is a revival of the old, secular stagnation hypothesis of Alvin Hansen and others and today supported by Larry Summers (2013) and Robert Gordon (2016). According to Summers, the industrialized world suffers from an imbalance resulting from an increased propensity to save and a decreased propensity to invest. Excessive saving acts as a drag on demand, reducing growth and inflation. According to this view, recent technological change has had an adverse impact on investment in certain sectors. As Summers explains "think about Airbnb's impact on hotel construction, Uber's impact on automobile demand, Amazon's impact on the construction of malls, or the more general impact of information technology on the demand for copiers, printers, and office space. And in a period of rapid technological change, it can make sense to defer investment lest new technology soon make the old obsolete".

In *The Rise and Fall of American Growth*, Robert Gordon (2016) argues that the IT revolution is a minor diversion compared with the inventions that occurred during second industrial revolution—electricity, motor cars and aeroplanes—that changed lives profoundly. He suggests that the IT revolution is altering a narrower range of activities. This view is shared by Tyler Cowen (2011) who argues that in the early 20th century there were many "low hanging fruits" for the world economy to collect, such as antibiotics, electricity-powered factories, radio, TV, planes and automobiles. But these have all been exploited. As we run out of low hanging fruits, we run out of technological

opportunities and growth slows down. In brief, according to the pessimists “the creative destruction described by Joseph Schumpeter is kaput” (The Economist, 2016).

2) A second view is more likely to see the economic slowdown as a consequence of slow or under-use of current technological opportunities. The knowledge diffusion nexus is broken in Europe, whereas there is a broader gap between firms that generate and use technologies at the frontier, and a rising number of low-productivity firms that are unable to benefit from new technologies (Soete, 2018). A different use of the already available technologies in the economic and social fabric is all that is required to increase employment, income and well-being (Lundvall, 2017). This view suggests that major efforts should be devoted to the diffusion of innovations in order to make them accessible to a larger number of sectors. To achieve it, radical social changes will be needed: the fruits of technological change could allow the progressive reduction of working hours, the delivery of improved public services and to increasing facilities in education, health and entertainment. All targets that can be achieved simply through an appropriate adoption and diffusion of the already existing scientific and technological knowledge.

3) According to a third, and more optimistic view, the fundamental mechanism of creative destruction described by Schumpeter and his followers are still working in contemporary economies. Fresh resources should be employed to unleash the power of the existing technological opportunities and enhance new ones. This view makes the assumption that technological opportunities are there, that they can guarantee new jobs, new prospects and growth, provided the economic and social systems allow for their exploitation and diffusion (Perez, 2010; Archibugi, 2017). Compared to the standard Schumpeterian assumptions, however, this view argues that a crucial role in shaping scientific and technological opportunities is also played by the public sector (Mazzucato, 2013), and that the next technological revolution will be driven by investment in intangible assets, rather than by investment in customary investment in tangible assets (Antonelli and Fassio, 2014). What is needed to achieve long-term economic recovery, therefore, is to invest more in the related sciences and the technologies in order to offer to the business sector more near market solutions that can be turned into a new generation of products, processes and services.

We believe that the current situation in the EU corresponds to the third view described here, and the consultation we carried out managed to provide some policy responses to these issues.

The first is that when new scientific and technological projects are planned and carried out, the economic horizons of business and public players is very different. Public players have obviously a much longer time horizon to carry out their projects: take the case of cold fusion, a research target that has been carried out for several decades through public funding and that has not (yet?) achieved its main aim. Nonetheless, the research carried out has generated substantial scientific outcomes and many of them have been applied in different areas. As a result, the learning generated is already a satisfactory return for the money invested. The business sector has a much different economic horizon: while some firms manage to invest massively in basic research in the hope that they can exploit the outcome in at least one of their product lines, many of them have to face the “valley of death” (Auerswald and Branscomb, 2003; Linton, 2018). Without proper up-stream knowledge development through public sources, and sufficient financial guarantees, much of potential new openings are unlikely to be funded.

The second is that major changes could be facilitated by pushing for different social and economic organizations. In core sectors, ranging from transport to energy, public regulations could play a crucial role in forcing the adoption and diffusion of emerging technologies. Governments could enhance scientific and technological change by creating standards and regulations, which, in turn, will impose the business sector to comply and invest in creating better products and processes. The good practices include "mature" products such as automobiles, fridges and washing machines, all which had to improve their quality to meet environmental standards.

The third is that the economic crisis is also dramatically changing the geography of innovation, and this applies especially for the emerging countries. To preserve a dominant position in a field requires to upgrade existing capabilities. The United States, for example, continue to lead in core industries, also because it invests massively in emerging areas, and it is still in pole position in a wide range of new industries. Some emerging countries are more and more catching up also in areas presenting fresh opportunities and they may become the leaders of tomorrow. We have already seen above that the R&D intensity of China is now at the same level of that of the EU, but in selected areas, including Artificial Intelligence, China is currently investing more than the EU (McKinsey Global Institute, 2017).

In spite of their fragmentation, the recognition of the policy discussion, and the responses we gathered, point in a clear direction: the idea that we will face a secular stagnation, due to the lack of scientific and technological opportunities, is not substantiated by actual data and even less by foresights. There is instead a complex and vital coming scientific revolution which is composed of both new applications of already existing devices and fresh technological, social and organizational innovations. In this context, Europe as a whole is very much in a dangerous situation: on the one hand, Europe is not any longer catching up with the United States; on the other hand, Europe is also challenged by emerging economies, which are becoming more active in what seems to be the emerging areas.

4. The response from the European Union so far

We have shown above that the economic crisis has brought about a sharp drop in investment across Europe and that this drop has affected investments in infrastructure and in science, technology and innovation. Since the economic recession has begun, conditions have negatively affected R&D expenditures (Pellens et al., 2018; Kapetaniou, 2018). The gap between the innovation leading countries and the innovation lagging countries is growing (Veugelers, 2016).

A new set of economic policy proposals have been developed advocating to abandon austerity measures and to increase public expenditure. A fiscal stimulus by means of public investment directed towards funding infrastructure projects is the quintessential *Keynesian* response to a major recession and a lack of demand from the private sector (Abiad et al., 2016; Dosi et al., 2017). For a recent re-statement of the theory and some estimations of the impact in Europe, see Boitani and Perdichizzi, 2018). In Germany, the trade union confederation DGB proposed ''A Marshall Plan for Europe", envisaging a public investment plan of the magnitude of 2% of Europe's GDP per year over 10 years. An authoritative report of a High-Level Task Force chaired by Romano Prodi and Christian

Sautter reiterates what should be suggested by common sense, namely that long term investments, and above all, public investments, should be carried out when interest rates are low and when the economy is in depression (Fransen et al., 2017). The same report also notes that Europe is very much in need of major investments supporting its social infrastructure, to further accommodate a declining and ageing population, to mitigate the consequences of climate change, and to improve urban transport infrastructures. A recent study from the IMF also demonstrates the positive impact on economic growth of investment in infrastructure projects (2014, in particular chapter 3). A wider scope for a European industrial policy has been advocated by several scholars (see the symposium of *Intereconomics*, 2015, including Mazzucato et al., 2015; Pianta, 2015.[1] See also Pianta and Zanfei, 2016). Unfortunately, most of these bold proposals are yet to be implemented.

In November 2014 the EU announced its flagship venture, the Infrastructure Investment Plan (the Juncker Plan). In 2015 the European Fund for Strategic Investments (EFSI) in partnership with the European Investment Bank (EIB) was implemented to tackle the growing concerns over the lack of investment. The aim of this fund is to see a higher risk-taking capacity and to mobilise at least 315 billion euros of additional finance for investment over its first three years (2015-2017). In December 2017, the European Parliament enhanced EFSI, extending its time frame from mid-2018 to the end of 2020. A total of 33.5 billion euros in guarantees are aimed at attracting at least 500 billion euros in additional private investment.[2] The philosophy of the Plan was to augment the guarantee fund of the EIB allowing the Bank to increase its borrowing capability and therefore to provide resources at very low interest rates for long-term projects. EFSI is guaranteed by EU budgets for 16 billion euros (increased to 26 billion euros after its extension) and by a further contribution of the EIB of 5 billion (increased to 7.5 billion euros after its extension). This would allow, according to the EIB, a substantial multiplier (1x15) thanks to the resources that the EIB could collect on the market.

Building on the mechanism of the ESFI multiplier, for the next long-term EU budget 2021-2027, the European Commission proposes to create the *InvestEU Programme*, to bring together under one roof the multitude of EU financial instruments currently available to support investment in the EU. *InvestEU* would run between 2021 and 2027 with a total guarantee of 47.5 billion and is expected to mobilise up to 650 billion euro in additional public and private investment, starting from an endowment of 15.5 billion (European Commission, 2018a).

In this context, European economic players, both private and public organisations, would be able to acquire from the EIB financial resources to support their investment plans. The EFSI made special provisions for particular innovative and riskier projects and, therefore, it made it possible to fund some long-term R&D and innovation projects, with a particular focus on Europe's SMEs. There is a good record of SMEs using the EFSI for their R&D and innovative projects.[3]

It should, however, be noted that to establish the EU guarantee fund, a total of 8 billion euro has been reallocated from the EU budget: 5 billion euros from existing EU funding programmes (€2.2 billion from Horizon 2020 – which represents only 2.9% of the Horizon 2020 financial envelope for

[1] See "Which Industrial Policy Does Europe Need?", see http://archive.intereconomics.eu/year/2015/3/which-industrial-policy-does-europe-need/

[2] See here: http://www.eib.org/efsi/; and here: https://ec.europa.eu/priorities/jobs-growth-and-investment/investment-plan_en. More daring proposals presented in the European Parliament wanted to empower a EFSI 2.0 with up to 1,000 billion euros. See Gualtieri and Mazzocchi, 2016.

3 See here: http://www.eib.org/en/projects/priorities/sme/index.htm.

2014 to 2020 - and 2.8 billion euros from the Connecting Europe Facility) and €3 billion from the margins of the EU budget. The programmes instruments have shifted much more towards loans and there has been a reduction in available grants. Potentially, therefore, we have to compare the effect of 315 billion euros *loans* potential against the 5 billion euros that could have been provided in grants.

Has the Juncker Plan been effective? It has been criticised on several grounds. The first is about its actual use, namely the total size of the investments carried out. The resources actually mobilized have been lower than expected: of the 315 billion euros that should have been invested in the 2015-2017 period, 294.2 billion euros have actually been invested (as of June 2018).[4] A significant figure compared to the amount of resources subtracted form Horizon 2020 and ERC (for a preliminary assessment, see Camisão and Vila Maior, 2017), that can be considered satisfactory, especially in light of the original scepticism with which the Plan was received.

The second is about the "additionality" of the investments activated through the fund. A preliminary study by the Bruegel think tank (Clayes and Leandro, 2016) claims that most of the projects financed are not additional, that is, they would have been funded all the same by other sources. If this is so, the Plan is not fulfilling its main aim, i.e. addressing failure in business sector investment.

The third is about the "imbalance between private and public interests: private investors aim at guaranteed returns in relatively low-risk activities, but public-interest projects – which are socially the priority – may entail higher risks and lower private returns" (Dosi et al., 2017, p. 9). This is an important point on which we are going back later in discussing our proposal.

The fourth critical remark argues that the Juncker Plan is only a modest, second best. The optimal choice would have been that of setting in motion a massive European public investment plan either through the European Investment Bank (Dosi et al., 2017) or through the member states (with, for instance, the help of an improved investment clause to exempt public investment from fiscal rules). A differently oriented European Stability Mechanism, or another institution created for the occasion could have served this purpose (for early proposals, see IMF, 2014; Quadrio Curzio, 2014. For the policy debate at the European level, see the considerations of Gualtieri and Mazzocchi, 2016). In 2017 the European Trade Union Confederation proposed a plan for a European Public Treasury; this followed the so-called Five Presidents' Report of June 2015[5], to insure a minimum level of public investment - removed from public deficits of the Members States – by pooling future public investment in Europe, and funding it by European treasury securities. However, plans that involve some form of mutualisation of the public debt at the EU level are unfeasible in the current political environment, while the *InvestEU* programme is a much more realistic option at this stage.

To these general critical observations about the impact of the Juncker Plan, that are going to hold also for the *InvestEU* programme, we add the argument specific to this paper, namely to what extent EFSI, and the next *InvestEU* programme, are the best tools to foster investment in R&D and innovation. The use of *loans*, rather than of *grants*, is suited for cases in which the distribution of risk is known (including general infrastructures) but less in cases when the distribution of risk is

[4] See here: https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan/investment-plan-results_en.
[5] See here: http://europa.eu/rapid/press-release_IP-15-5240_en.htm.

unknown, such as the case of long-term innovation projects.[6] Fundamental R&D and innovative projects involve a great level of uncertainty, not risk. As a consequence, usually innovation and R&D are funded through cash flows, rather than through loans. Only a few firms can actually afford to finance and to carry out blue-sky scientific and technological projects. These companies are generally of very large size and have a diversified output, which allows them to exploit potential discoveries in at least some of their product lines (Nelson, 1959; Rosenberg, 1990). Other companies are reluctant to carry out these projects and cannot carry out long-term and risky projects. In this sense, EFSI could complement greater schemes designed to finance, promote and carry out long-term R&D and innovative projects but not substitute them.

Innovative ground-breaking projects based on a vast knowledge base are on the other hand possible either because they are directly linked to the activities of universities and public research centres or because they receive a substantial share of funds from the public sector. As we will discuss in the next section, there is a strong connection between the opening of scientific and technological opportunities carried out by basic research and fundamental science on the one hand, and business investment on the other hand. The knowledge and the discoveries generated by universities and other public research centres often pave the way for business investment and even the generation of brand new industries (Mazzucato, 2013; Archibugi and Filippetti, 2018). Public resources could generate opportunities that the business sector will then exploit and develop with their own money.

The example of the Hellenic Foundation for Research and Innovation. There are, however, cases in which the EFSI has been able to mobilize important resources directed to fund R&D and innovation. A very significant case comes from the new Hellenic Foundation for Research and Innovation (ELIDEK), funded by the European Investment Bank with a loan of 180 million Euros[7] (plus 60 million from the Greek Public Investment Programme) which represent about 15% of the total public research investment carried out in Greece. Most of the beneficiaries of the funds of the ELIDEK (including doctorate and post-doctoral grants, research equipment and funding of specific research projects) are not really expecting to repay the initial loan. In fact, the EIB loan is guaranteed by the Greek government which, in turn, could use these resources to provide grants to Universities, scholars, students and innovative firms. Therefore, it is ultimately the national government that provides grants for research and innovative activities thanks to the loan received by the EIB.

This shows that, even if the Juncker Plan provides loans and not grants, nations that cannot expand their public expenditure because of budgetary constraints could use the EU Infrastructure Investment Plan as a way to finance research and innovative activities. A solution that, not surprisingly, has been carried out in a country like Greece that has strict budget constraints and which has faced serious problems to adequately fund its academic sector.

The need to close the investment gap is still a major objective of the EC. The EFSI is expected to mobilise 500 billion euros by 2020, and the *InvestEU* is expected to mobilize additional 650 billion euros: are these resources enough to close the investment gap? Or, in other words, can the EU budget and policies manage to compensate the lack of investment in the 28 member countries? The

[6] Already Knight (1921) differentiated between *measurable risk*, when the probability distribution is known, and *unmeasurable uncertainty*, when the probability distribution is unknown.
[7] See *European backing to create new Hellenic Foundation for Research and Innovation to strengthen research across Greece*, European Investment Bank Press Release 2016-178-EN, 15 July 2016.

downfall of investments in the whole EU's member countries after the 2008 crisis has been remarkable: it passed from a share of investment equal to 22.4% of GDP in 2008 down to 20.1% in 2017. In absolute figures (as measured by volumes (2010), million units of national currency), the annual investment spending is still below the level of 2008; most of the Member States are expected to have recovered their pre-crisis GDP level by 2021 only (European Commission 2018b).

What is the cumulated loss of investment since the burst of the crisis in 2008? A simple way to estimate this is to keep the amount of investment constant for the period 2009-2017 at the level of 2008, as if there was no drop. By subtracting to this hypothetical level of investment the actual level of investment in the same period, we have calculated that there was a gross loss in the capital stock of about 2,438.4 billion euros in the period 2009-2017 (calculated as the sum of the lower investment flows in the same period). The total 294 billion euros mobilised by the ESFI from 2015 to 2018 account for a 12% of the loss in the capital stock since 2008. By adding the expected impact of the ESFI extensions to 2020, this would add up to 32.6%. Hence, it is quite evident that the EU alone cannot fill the investment gap.

5. Filling the investment gap in Europe: the crucial role of public policy (and a strategy for investment in innovation)

We have argued above that: 1) there is no evidence that the potential for growth through new scientific and technological opportunities is declining, and 2) that the policy response to face the economic crisis has been unsatisfactory. The latter is particularly evident in the case of investment actions: while they should have been supported through standard anti-cyclical public policies, most governments have deepened the problem by reducing their own expenditures. In this context we have focused on a specific nature of investments, namely those devoted to promote the creation of new knowledge and innovation. What can therefore be done in Europe to achieve an innovation-based, long-term development?

This is a renewed challenge for the EU, especially since scientific and technological developments applied to industrial production have been one of the distinctive historical components of European industrialization (Landes, 1969). Paradoxically, the continent which firstly based its economic and social development on the use of knowledge is now underfunding its R&D and innovation system, while emerging regions are investing massively in knowledge creation.

The policy concern about increasing the resources devoted to science and technology in the EU is not new: the European Council took a solemn commitment of making the Old continent "the largest knowledge economy of the world" already at the Lisbon Summit of 2000, and quantified it also with the aim of reaching an R&D intensity equal to 3 per cent of the GDP at Barcelona Summit of 2002. These targets were considered not realistic from the very beginning (see, for example, Archibugi and Coco, 2005) and they ended to be as one of the several political declarations unmatched by specific policy instruments (for a significant review of the declared science and technology politicians' targets and the reality of what is actually achieved, see Carvalho, 2018).

The fact that emerging economies are nurturing their development also through massive investment in R&D is a message that should be taken seriously by EU policy-makers: other non-European fast-

growing nations have taken the commitments of the European Council more seriously and are betting on the fact that their long-term growth needs to be grounded in scientific and technological openings. If Europe is not able to match that pace, its place in the world economy may become marginalized to traditional productions, and European's population will see lower levels of well-being. Even if the objective of the European Council was exaggerated, it pointed out in the right direction; the last fifteen years have, unfortunately, seen neither the achievement nor any getting closer to the target. A new stage of economic development in the EU will require going back to these targets, and seriously. In Lisbon 2000 and in Barcelona 2002 the responsibility to make of the EU the largest knowledge-based region of the world was mostly put on the shoulders of the business sector (AND INDIVIDUAL NATIONAL ECONOMIES), and this was a rather convenient way by politicians to ask to others to fulfil their own desires. This is one of the reasons why the targets remained wishful thinking.

We argue, on the contrary, that the primary responsibility to start a renovated strategy for research and innovation should be taken by governments, expanding the resources of the public sector or through public procurement (for an analysis of innovation related public procurement, see Edquist, 2017).

Public investment in infrastructure projects can certainly contribute to the recovery, especially if they are directed to the opening up of new scientific and technological opportunities which have long-term and complementary effects, but they are not enough, and their importance has been overstated (Antonelli and Fassio, 2014; Crescenzi et al., 2016). State-led, public investment policies have, in the past, demonstrated to be a key generator of major technological breakthroughs and that once unlock their value they encourage and attract future private businesses. This is the case of the ICT sector: over the last decades, new corporations have emerged and they have become very large and able to give jobs to hundreds of thousands of employees. Many of them were born and grew exploiting new scientific and technological opportunities, often originally developed in public institutions and with public money (Mazzucato, 2013). Microsoft, Oracle, Google, Apple, Facebook, Uber, Airbnb are some of the corporations that managed to capture the imagination of people by being economically successful through innovations. None of them is European; in fact, Europe is home to 7% of the world's leading technological companies only (European Commission, 2018b).

Today there are still new openings in a large number of areas, including green technologies (Tylecote, 2015); Artificial Intelligence (Berger, 2018; European Commission, 2018c), Bio-Medicine (Consoli et al., 2015). Who will take the lead? The available evidence shows that social returns from public R&D varies according to the capacity of countries to reap the benefits from research, but social returns are higher than private returns (David et al., 2000) - the social returns from R&D investment are estimated to be two to three times higher than the private returns (European Commission 2018b). Applied macro models support the role of investment in R&D and intangibles, other than human capital, as necessary conditions to maintain long-term economic growth in Europe (Veugelers, 2016). Recent evidence shows that investment in hi-tech has boosted economic growth (Evangelista et al., 2018) and jobs creation in European regions (Goos et al., 2018). Historical accounts of the role of publicly-funded research have shown that this type of policy brings about major technological change both directly and indirectly. Directly, by encouraging crowding in of public investment in research and by the creation of new markets and by tacking major social challenges through investment in innovation (Mazzucato, 2013). Indirectly, through carrying ourT

basic research (Giunta et al., 2017) as well as processes such as serendipity where casual scientific discoveries have led to the introduction of radically new technologies (Gillies, 2015).

Our suggestion about a programme of public investment in innovation should be also complemented to the agenda on Industrial Policy in Europe, that has recently revamped in Europe around the "re-industrializing" debate. It has been rightly argued that it is fundamental to ask what type of industrialization the EU is aiming for, given that in today's economy this can no longer rely on funding champions in manufacturing, like the automotive sector, but it has to be considered both the 'servitization' of the manufacturing industry as well as the crucial role of knowledge-intensive services (Savona, 2018). It is therefore fundamental that industrial policy will identify "the technological and economic opportunities for structural transformation of the economies" (Savona, 2018, p. 14) and to avoid public spending that support closely related activities where opportunities might get saturated (Frenken, 2016) and the multiplier effect is much lower. The programme of investment in innovation should instead aim to identify the nature and direction of scientific and technological advances in unrelated areas where new technological opportunities might arise with prospective higher multiplier, and where associated risk reduces the probability that the private sector alone would engage without public support. To this extent, the coordination with a European plan of industrial policy is crucial.

An example of appropriate counter-cyclical public spending in research is the American Recovery & Reinvestment Act of 2009 (ARRA) put in place by the Obama administration. The recent ARRA legislation provides an unprecedented level of funding ($8.2 billion in extramural funding) to the National Institutes of Health (NIH) to help stimulate the US economy through the support and advancement of scientific research.[8] According to a report from the Executive Office of the President Council of Advisers[9] the Recovery Act was successful both in terms of job creation (estimated at about 6 million job-years) as well as in terms of economic growth (estimated at between 2 and 3 per cent from late 2009 through mid-2011).

The EU programme for R&D will play a crucial role in fostering innovation investment both at the EU and at the national level, because EU-funded R&I activities have demonstrated 1) to induce the private sector to invest more their own funds; 2) most of the projects are additional, i.e. they would not have been realized without the EU support; 3) support national policies for innovation (EC, 2017). It is precisely for these reasons that the High Level Group on EU R&I chaired by Pascal Lamy has required to double the budget of the post-2020 EU R&I programme.

The next EC Framework Programme 2021-2027 Horizon Europe announced by Commissioner Carlos Moedas is an excellent opportunity for a new start and the EC strategy to focus on mission-oriented projects move very much in this direction, and with larger resources. The EC proposal to allocate about 100 billion euros to research and innovation should by fully endorsed by national governments and, if possible, the resources should be further increased. The EC has already identified key areas for mission-oriented research and some of them correspond to fields where the

[8] Note that Horizon 2020 in 2016 is more than 8 billion of euros. See https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/h2020_threeyearson_a4_horizontal_2018_web.pdf

[9] The Report can be found here: https://www.whitehouse.gov/sites/default/files/docs/cea_arra_report.pdf.

opportunities generated could address social problems, lead to the creation of new companies and open up new industries.

The EC rightly reminds that the next Horizon Europe is probably the largest scientific and technological programme ever attempted[10] and a very substantial increase compared to Horizon 2020, (which had a total budget of about 80 billion euros). But not even such an ambitious Framework Programme could alone achieve the aim of making the EU the largest knowledge-based economy of the world. The total expenditure for R&D in Europe is about 302 billion euros a year, while the average annual contribution of the 2021-2027 Horizon Europe will be, on average, around 14 billion euros a year, with an increase of about 3 billion euros a year compared to Horizon 2020. This is certainly substantial, but not enough to a get closer to the targets indicated by the European Councils in Lisbon 2000 and Barcelona 2002, which will require to reach a total estimated R&D expenditure of at least 450 billion euros a year.[11] To summarize.

1) As part of a long-term strategy in line of the Lisbon-Barcelona strategy, the EU should launch a programme of investment in science, technology and innovation relying on the European budget. In this perspective, Horizon Europe becomes a core priority. This could be a very important stimulus to national governments to increase their own funding and to reach the Lisbon target in R&D expenditure.
2) A *public* push is needed for the following reasons: *1)* it can set out to explore new and unrelated technological areas where the risks and expected returns are higher; *2)* it can be coordinated with other EU policy, namely the re-industrialization plan; *3)* it can encourage the business sector to exploit the new technological opportunities, by reducing their risks of failures, thus promoting a EU boost in the emerging technological sectors.
3) In turn, a massive public investment will become very attractive for the business sector, that may be interested to locate their R&D and knowledge-intensive centres in Europe rather than elsewhere. Complementary policies already widely diffused across European countries, such as fiscal incentives, policies for training and skills, and regulations could be generalized across the EU. If applied in individual countries, they may simply increase the competition across European countries; if applied uniformly across the European Research Area, they may become powerful instruments to make the EU a more attractive location for R&D and innovation centres vis-à-vis other regions of the world.
4) The EIB is already contributing, as discussed above, to financing innovative programmes. Their activities should however have been matched by similar initiatives carried out also by national authorities through public investment banks. In other words, this will help to create a systemic approach in which both loans and grants are used to enhance the European innovation system.
5) An impressive programme of knowledge creation cannot be improvised. It requires long-term planning, especially in terms of creating the human resources that will be able to ultimately

[10] As a comparison, the estimated cost afforded by NASA for the landing of the moon from 1961 to 1969 was of 25.4 billion US dollars, which could grossly correspond to 150 billion 2018 US dollars.

[11] It has often been noted that it is somehow a paradox that, while global governance in several areas is increasing, in the area science and technology the priorities are still selected by national governments, even when the benefits associated to major scientific and technological openings are likely to become in the medium term some public goods (Smith, 2017). In fact, the EU is the largest international organization in terms of scientific and technological resources.

carry out the task also through appropriate governance structure. In light of the ambitious targets of the European Council, Lundvall (2001) suggested to create, within the EU, a Council for Innovation and Competence Building which should have the same political weight as the EU Economic and Financial Affairs Council. This proposal should be retrieved to make the aims of the Council credible and showing that EU priorities are shifting from budget constrains to the long-term creation of knowledge and competences.

6. Conclusions: a U-turn in European policy priorities

The world is changing fast, and the European Union is not keeping its pace. It is not a problem of eurosclerosis as identified by Herbert Giersch and others. The old continent has abundant scientific and technological capabilities, and its social system is one of its strengths rather than its weaknesses (Rifkin, 2004). The European problem is that there has been a prolonged under-investment in resources, mostly justified with the need to meet budgetary constraints and to respect the rules of the stability and growth pact. The consequences, greatly exacerbated by the 2008 crisis, have been very bad for the EU: on the one hand, the search for financial stability has generated an increasing political instability in several EU countries, including centrifugal forces from the EU itself. On the other hand, the expected higher rates of economic growth have not been delivered. Moreover, austerity policies have further increased the differences among the strong and dynamic regions of the EU and the laggard parts. The cohesion polices, which should be a strong component of any regional integrations, have grossly failed, even more in terms of scientific and technological competences (Filippetti and Peyrache, 2013).

On the ground of our expertise in the field of science, technology and innovation policy, and of the consultation we had with selected colleagues, policy-makers and policy advisers, we have outlined here some suggestions for a strong call for an extensive programme of *investments* in science and innovation that would make a U-turn in European economic policies priorities. We have argued that:

- It is crucial to go back to what nearly 20 years ago was agreed at the European Councils of Lisbon (2000) and Barcelona (2002). To make of Europe the most dynamic knowledge economy of the world is possible and needed, not only for long-term sustainable growth but also to boost short-term economic recovery.
- This requires that the responsibility to augment the resources devoted to science and technology cannot be devolved principally to the business sector (as predicted by the past European Councils). The need to generate scientific and technological knowledge and expertise is principally a responsibility of the public sector.
- Actions undertaken at the EU level can have a dramatic impact (VEDI SOPRA…), especially in shaping and creating the conditions for bolder policy actions at the national level. We therefore support the view that a major European investment strategy is needed (Gualtieri and Mazzocchi, 2016).
- The Juncker Plan is certainly moving in the right direction, but it could not manage alone to single-handedly boost investment, and even less so innovation investment, in Europe. It needs to be complemented with more active investment policies, in particular innovation investments, to be carried out at the national level and with national resources. In order to make these

resources available, investments funded through public expenditure, in particular those with a strong R&D and innovative component, should be taken out by the parameters of the stability and growth pact.

- We also welcome the recent announcement of the Horizon Europe Framework Programme 2021-2027. The selection of some mission-oriented scientific and technological priorities is certainly good news for a prosperous European future. But, again, the resources that the EU can mobilize are not sufficient to reach the scale needed for a new stage of social and economic development. Still, they can play a crucial role in inducing national governments to contribute to mission-oriented goals by progressively increasing the resources they devote to science, technology and innovation.
- A U-turn in EU priorities also requires an evolution of R&I policies towards more openness (open science and open innovation) (Soete, 2018) and appropriate governance. We have retrieved a proposal by Lundvall (2001) to create at the EU level a Council for Innovation and Competence Building with a political weight at least equal to the EcoFin. This body should supervise and facilitate the tasks of moving into the direction of making Europe, eventually, the most dynamic knowledge economy of the world.

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