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Proposals for a digital industrial policy for Europe

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ABSTRACT

A digital industrial policy should take into account the new opportunities for industrial policy arising from digitalisation for tackling the sluggish economic growth performance in the Europe. The structural problems and potential market failures related to the adoption of digital technologies are identified. Apart from incentives to invest into digital infrastructure, the policy measures should strengthen the intangible asset base along the value added chain of the digital economy, fostering the related R&D activities, along with the skills of researchers and of workers. Public and private sector financing, combined through financial instruments, should focus on furthering entrepreneurship and implementation of innovative business plans.

1. Introduction

Europe's sluggish growth performance and relatively high unemployment rates are a concern for policy makers and economists which has led to extensive debate on causes and remedies (see for instance Caselli, Centeno, & Tavares, 2016). An appropriate policy response is however still awaited. The financial crisis of 2007 and the slow embracing of the digital revolution have deteriorated further economic performance, with productivity growth in the EU slipping behind that in the US and other leading trading partners (Foster et al., 2013). This trend has undermined the ability of European firms to compete, providing skilled jobs and ensuring a high standard of living. It is not a surprise that a debate on industrial policy is returned high on the political agenda. In particular, there is a revival of interest in “re-industrialization” in consideration of the well-proven productivity growth effects manufacturing is able to provide.[1]

The European Commission has appropriately set “industrial revival” as a target (European Commission, 2014). But the nature of “*industry*” as policy target has changed drastically, along with the predominant products that the industry produces. The twentieth century was great for product innovation delivering very well identified items such as cars, aircraft, radio, TV and computers. Moreover, the related production technologies allowed for persistently high labour productivity growth. But in the twenty-first century the prevailing technologies are digital, producing mostly intangible goods or services that are not comparable with the tangible world of the manufacturing industry. Also the production factors change, as they are increasingly of non-tangible nature, in particular knowledge (Haskel & Westlake, 2018). Any meaningful industrial policy measure should acknowledge this fact and identify any market failures arising in the new environment that need to be compensated for.

The future manufacturing environment will be rich with knowledge assets. Several propositions are now advocating re-industrialization through industry-oriented 'integrated' policies, i.e. policies based on furthering skills, innovation, supporting institutions and environmental concerns.[2] But these suggested policy measures need to take more account of the fact that the impact of

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[1] See Mosconi (2015a) for a survey.

[2] The features of such policies are discussed in Aiginger (2014) and Mosconi (2015a,b).

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digital technologies and that their applications are no longer confined to early adopters in key sectors, such as telecommunications, electronics and automation. There is the notion that everything that can be digitalised will be digitalised, and what can be digitalised can be scaled up, with ideally global market reach (Kranz & Picot, 2016). Internet, e-commerce, mobile broadband, social media and big data have started to pervade all sectors. The European policy response by the European Commission (2016a) was the adoption of the Digital Single Market strategy, leading to a number of specific initiatives in the digital domain, including the Digitisation European Industry (DEI) initiative in 2016. However, the propositions need to taken further to specific actions and we will discuss possible options, taking into account also country specific features.

The observed diffusion of digital technologies, such as the DESI indicator used by the European Commission, differs substantially across countries. The ensuing benefits individual countries can therefore enjoy vary substantially, depending on the relative size of the digital sectors and the innovation absorption capacity of the industrial structure of a country. The internet dramatically enlarges the information sphere and allows in principle for an almost immediate match of demand and supply of information. This poses challenges for traditional industrial policy because the addressee of policy action is undergoing a rapid and radical change. Firms are increasingly working on online platforms. These can provide a large variety of real or virtual services to both suppliers and buyers, changing also the way in which transactions are carried out (e.g. consumers inputting data that previously was performed by supplier). Innovative firms on such platforms become able to exploit a position in the middle of a multi-sided market setting and thus shape the conditions under which the markets function. As information is the key production factor, the ensuing low transaction costs for information transmission challenges many of the main tenets of the traditional theory of firm, blurring also the boundaries of producers and consumers.[3]

This structural change in the production and consumption process has important practical implications, leading to very strong multiplier effects for the factor inputs. For instance, it can be observed that the economic value of firms involved in the supply of information services does not depend on observable accounting variables such as actual sales and cash positions, but rather the perceived value and potential of the user base and network. On such indicators an astonishingly rapid growth of market capitalization could be observed for digital firms. US based firms are the undisputed leaders with this respect, apart from some exceptions. European based companies are occupying lower ranks on a world scale of digital entrepreneurship, certainly not in line with the comparatively high level of welfare that Europe is currently commanding on a global scale.[4]

As will be shown, the problem for Europe is that its digital sector is relatively small compared to for instance the digital sector in the US. Europe has been reluctant to adopt digital technologies in the industrial sectors and to adapt their production processes to fully benefit from the network effects that come along with digital technologies. The adoption of digital technologies should become a distinct industrial policy goal. The failure to pick up this challenge could have wide-ranging economic consequences for Europe. In particular, it is most likely to undermine the sustainability of the European model of economic and social welfare and therefore appropriate measures for digital industrial policy become necessary.

The paper is organized as follows. Section 2 illustrates the evolution and role of the manufacturing industry and the reasons for performance decline. Section 3 discusses the impact of digitalisation on the economy and the international positioning of Europe. Section 4 looks at the prevailing market impediments that hamper digitalisation in Europe. Section 5 gives a brief account of policies in place and provides some suggestions for a new approach to industrial policy centred on the efficient adoption of digital technologies and the resources required. Section 6 concludes.

2. Key factors for past industrial performance success and the role of industrial policy

Persistent productivity growth and excellent performance in manufacturing are considered as the key ingredients for the unprecedented economic welfare levels achieved in post-war Europe (Eichengreen, 1996). Most of the national economies were initially little integrated in the world economy and industrial performance was quite responsive to national industrial policies. With the gradual and reciprocal opening up to economies of similar socio-economic structure, a distinct pattern of intra-industry trade with similar products emerged, leading nevertheless to some degree of heterogeneity across countries. Patterns of industrial sector specialisation were emerging. For instance, Germany was specialising in mechanical engineering and Italy in low to medium technology sectors. The international competitiveness of such specialisation is reflected in trade specialisation patterns of individual countries (Guerrieri & Milana, 1990). Last, but not least, limited international constraints were put on targeting industrial policies and state support for “strategic” industries and “national champions”.

Such nationally tailor-made industrial policies were increasingly put under pressure to comply with international organisations and agreements for the advancement of the scope for competitive markets during the 1990s, in particular with the adoption of the EU Treaty of Maastricht and the creation of the World Trade Organisation. To align with these new framework conditions, industrial policies had to become more of the horizontal nature, with the intention to mainly correct for market failures. Examples with this respect are the support to R&D activities, to small and medium sized enterprises (SME), or the pursuit of energy efficiency goals (Aiginger, 2014). In any case, none of these developments could prevent the strong decline of the importance of manufacturing industry's value added as a share of GDP.

Fig. 1 shows the evolution of value added/GDP share for some selected countries. Generally after the turn of the millennium the

[3] Although the boundaries of the firm will change significantly, the concept of firm will stay because the problem of incomplete contracts will persist and the ownership of residual control. See McAfee and Brynjolfsson (2017).

[4] For an evolution of the rankings see Curwen, Sadowski, and Whalley (2015).

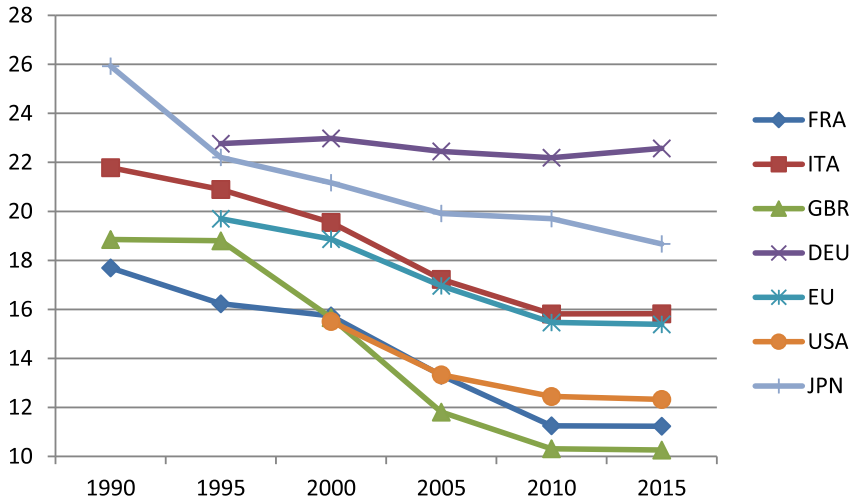

Fig. 1. Manufacturing value added as a percentage share of GDP.
Source: author elaboration on data from World Bank

share has fallen well below 20%. The exception is Germany, where the share is stable above 22% of GDP. It was also the only country that was able to keep during that period its market share in the world trade, while all other advanced countries lost market share, as a result of the integration of China in the world market. This German exception in the role of manufacturing may provide some hints for explaining the good overall economic performance of Germany over the last decade, but it should also give some leads for identifying determinants for keeping up the manufacturing value added share and to what extent there is scope for industrial policy to achieve this result.

One of the explanatory factors is innovation and the resources devoted to R&D. The R&D expenditure of the European business sector, though increasing, is still low. It has only reached 1.6 per cent of industry value added in 2014 (OECD data) and is far below what is considered as appropriate for an advanced economy: firms in the US spend 2.6% of value added on R&D and in Japan 4.0%. To some degree that can be explained by the different mix of industrial sectors; in Europe R&D intensive industries play on average a smaller role than elsewhere. But this average conceals strong national heterogeneity. For instance, in 2014 Germany with the largest industrial sector in Europe has a share of 3.1%, which the second largest Italy has a share of only 1.2%. Moreover, the divergence among European countries around this ratio has actually increased over time.

The technological context in which the manufacturing industry is operating is changing rapidly with digitalisation. Industrial policy needs to grasp well the role of all production factors, in particular those other than labour and fixed capital. With respect to labour, the rapid technological evolution requires a larger degree of flexibility and ability to upgrade skills. Moreover, specific knowledge derived from R&D and innovation activities are crucial in implementing new production modes. Intangible capital deepening therefore tends to become the main source of labour productivity growth (Roth & Thum, 2013). For the production factor capital, soft or intangible assets, such as general knowledge and intellectual property, play an increased role.

Estimates by Corrado, Hulten, and Sichel (2005) have shown that the rate of labour productivity growth is by 10–20 per cent higher when including intangibles both as input and output, in comparison with a framework that ignores intangibles. Economic modelling does already take these into account with the development of endogenous growth models, but this does not yet have trickled fully down in terms of practical implementation of the main propositions for industrial policy (Bianchi & Labory, 2011).

This neglect of intangible assets has practical consequences for policy formulation. The emphasis on business R&D only as the driver of productivity growth is underestimating the actual growth contribution of intangible assets. Intangible assets explain to a large degree the productivity gap between Europe and the US (Corrado, Haskel, Jona-Lasinio, & Iommi, 2013). Intangible assets that constitute knowledge at firm level can be grouped into computerized information, innovative property, and economic competencies. The findings of this line of research lead to the important conclusion that the focus on productivity enhancing policies should also encompass all kind of intangible assets.

3. Digital technologies as game changers for competitive advantage

Information and communication technology (ICT) may be considered as a general purpose technology used for digitalisation and thus have the scope of shifting the traditional boundaries of adopting industries (Helpman & Trajtenberg, 1998). As argued by Basu and Fernald (2007), this can be empirically verified: with the lower cost of communication and the ubiquitous scope for connecting devices there is a large increase in flexibility for manufacturing, in mass customisation, in speed of production and in quality. Hence industry observers and policy maker have contemplated new approaches in industrial policy, such as the ideas and concepts floating

around the concept of *Industry 4.0*.[5] The impact of digital technologies and their applications is no longer confined to early adopters in typical ICT sectors, such as telecommunications, electronics and automation. Digital technologies diffuse in a horizontal manner across all sectors of economic activity and transform them. Growth accounting studies demonstrate how investment in digital technologies contribute to economic growth by three channels (Van Ark, O'Mahony, & Timmer, 2008; Van Ark, 2015): first, the productivity growth effect of the ICT producing sector itself, in particular through the innovation benefits deriving from what is known as "Moore's Law", according to which nano-electronic devices, the core components of ICT, double their performance every 18 months; second, the capital deepening effect of ICT investment as a factor of production; third, the ICT induced productivity growth in sectors adopting ICT.

Quantitative estimates found that the first two channels account for the bulk of the effects, however with significant differences across countries. The relatively poor growth performance of Europe can be explained by the fact that the digital sector is relatively small with respect to the following parameters: a) in terms of actual ICT sector's value added share in total manufacturing; b) in terms of ICT sector's prospective innovation capability as given by the relatively low level of business investment in R&D in the ICT sector[6]; c) the lack of widespread access broadband communications infrastructure.[7]

The analysis of the third channel through which ICT affects economic growth is more complex as the propagation of the growth effects in adopting industries is more wide-ranging. This includes factors such as economies of scale and network effects, which are more difficult to disentangle from other elements of change. As data is the raw material for digital technologies, the processing of data requires substantial investment in non-tangible assets such as data acquisition, business practice, organizational re-arrangement and training. As already mentioned above, Europe invests much less in such intangible digital assets than the US, which can explain Europe's poorer growth performance (Van Ark et al., 2008).

A look at Europe's large firms shows that they are mostly present in traditional sectors such as mechanical engineering or process industries, whereas in the US largest firms are now mostly new and digital sector companies. The difference in the innovation and growth capability is particularly striking if this is observed under a dynamic pattern. For instance, Cincera and Veugelers (2014) show that in the US the young firms succeed in realizing significantly higher rates of return to R&D as compared to their older counterparts, including in high-tech sectors. The authors also show that this is not the case for Europe, where firms generally fail to generate significant rates of return, irrespective of sectors and age.

This dynamic pattern shows up in the market structure of the digital sector at a worldwide level when looking at the main corporate actors involved. Digitalisation has a profound impact on the main players in the corporate world. Comparing today's most capitalised companies with those of less than a decade ago illustrates a profound reshuffling of positions (Table 1). In 2017, the top 3 firms were *Apple, Alphabet* (*Google*) and *Microsoft*. Non-digital sector companies such as *ExxonMobil, Petrochina* and *Wal-Mart* led the ranking back in 2009. Many of today's top firms are relatively new firms and possibly did not exist twenty years ago. Moreover, these large firms in the digital sector all originate from the US, while European firms do not play any role in the top ranks. The largest European company is the food firm Nestle on rank 17 and the largest European digital economy firm is the software firm SAP on rank 33. From this comparison emerges not only a striking asymmetry in the relative strength of the sector specialisation and innovation patterns, but illustrates also the overwhelmingly large economic size of US based firms in the digital domain.

The R&D expenditure by sectors may be regarded as lead indicator of future market importance and growth potential. Looking at the world's largest R&D spenders as established by the consultant firm PWC over the last decade (2005–2016) [8] shows a reshuffling of the leading positions: while in 2005 the only one digital firm (Microsoft) ranked among the top five, in 2016 there were four digital firms (Samsung, Amazon, Alphabet, Intel) among the top five. Moreover, digital firms account for 40 per cent of the total R&D expenditure of the sample, followed by healthcare with 22 per cent and automotive with 15 per cent. Within the R&D budgets, there is a pronounced shift away from expenditure from physical products to software and services.

It is clear that this transformation of the structure of R&D expenditures across sectors requires an equivalent rebalancing of the predominant researchers' skills. If Europe wants to match those trends, it needs to create the premises for more specialisation in the digital sector by increasing the R&D skills in that domain. But more in general, the scope for industrial policy aimed at furthering digitalisation of the economy depends to a large degree on its effectiveness in tackling identified market impediments that hinder this evolution.

4. Potential market failures hindering digitalisation

The evidence for the broader economic benefits of digitalisation provided might lead to conclude that furthering digitalisation is in the public interest for preserving overall economic performance whenever market forces do not provide sufficient incentives for investment in digitalisation. Therefore the task would be to identify those areas were market forces are not working spontaneously to achieve such goals of general interest. If investments in digitalisation involve positive economic externalities not entirely captured by the private investor, merely private market incentives lead to a sub-optimum level of investment and hence justify public intervention to maximise social welfare. In that case there would be good reasons for investigating into potential market failures, which manifest

[5] The term was coined by contribution such as Roland Berger (2014) and Schwab (2016), but taken up under different wordings by a number of countries.

[6] OECD (2017), p. 129 shows that Taiwan spends 75% of the business R&D expenditure in the ICT sector, Korea 53% and US 33%. With the exception of Finland and Ireland, all EU countries are generally far below the US level.

[7] Czernich, Falck, Kretschmer, and Woessmann (2011) estimate and show that significant growth opportunities are foregone in many European countries as a result of low broadband penetration.

[8] http://www.strategyand.pwc.com/innovation1000.

Table 1
The world's largest firms, by market capitalization (31 March 2017).
Source: author on Bloomberg statistics

Rank	Firm name	Sector	Capitalisation $bn 2017	Rank 2009	Capitalisation $bn 2009
1	Apple	Digital	754	33	94
2	Alphabet	Digital	579	22	110
3	Microsoft	Digital	509	6	163
4	Amazon	Digital	423	–	31
5	Berkshire Hathaway	Banking	411	12	134
6	Facebook	Digital	411	–	–
7	Exxon Mobil	Oil & Gas	340	1	337
8	Johnson & Johnson	Health Care	338	8	145
9	JPMorgan Chase & Co	Banking	314	28	100
10	Wells Fargo & Co	Banking	279	55	60

themselves more strongly in Europe than elsewhere. The following is a list of candidates.

4.1. Lack of digital infrastructure

Europe is trailing far behind in ultra high speed broadband telecommunications infrastructure with respect to some important industrial countries. According to OECD data, at the end of 2016 Korea had a fixed line fibre access infrastructure penetration rate of 30% of inhabitants and Japan of 23%. The bulk of the EU countries, especially the larger ones, have a penetration rate below the OECD average of 6.4%. However, the EU average for FTTH is not too dissimilar from that to the US.

Telecommunication services are nowadays provided mostly on competitive market terms. Investment in broadband infrastructure has to take account of the (relatively short) financial return horizons taken by investors. This is often well short of the technical and economic lives of the underlying infrastructure assets, in particular for areas with low population density. Hence the concern that the market forces guided by such incentives may not provide the socially optimum broadband coverage for a country and this concern may justify policy action.

4.2. Lack of digital skills

The reaping of the benefits from the digitalisation of the economy fundamentally depends on the individuals' capabilities to use digital technologies effectively. Berger and Frey (2016) report that digital literacy is lacking on several accounts in Europe: for instance, 25 per cent of workers have none or low digital skills. Digital illiteracy is also unequally distributed over age cohorts, with the problem increasing as moving to older cohorts. Moreover, there is also a regional inequality aspect, with less prosperous regions more affected by digital illiteracy. It is therefore necessary that Europe devote more economic resource to education and training to cope with these challenges. In 2013 the EU spent 5.0% of GDP on education, which is below the OECD average of 5.2% and the US with 6.2% and South Korea with 5.9%. (OECD, 2015). However, there is a substantial heterogeneity across EU countries around this measure, with some countries having a much higher need to spend more than others. But there is not only the need to increase the resources made available for education to increase the skills level for digital technologies but also to provide flexible opportunities to upgrade skills over time.

4.3. Insufficient private investment in digitalisation

Investment in digitalisation requires a substantial amount of investment into intangible assets. These investments affected by asymmetric information problems similar to investments in R&D, leading to market failures in financing.[9] Digital assets are difficult to evaluate on a market basis, as they are frequently new products for which evaluation benchmarks still need to be established. This exacerbates the typical asymmetric information problem for outside investors in making investment decisions.

The pecking order of finance theory (Myers & Majluf, 1984) would suggest that equity is in such cases the preferred mode of finance. But differently from the US, in Europe firms are financed predominantly by bank debt (Langfield & Pagano, 2016). Moreover, satisfactory financial returns of digitalisation may need longer time period to materialise than is justified by the time horizon set by private investors. Also from this point of view debt is an inferior mode of finance, as debt holders have a shorter investment horizon than equity holders. All this leads to limited availability of private funding for digital assets especially in Europe[10] because of the reliance on debt finance for firms. It is also well known that the venture capital sector is less developed in Europe than in the US (Hege, Palomino, & Schwienbacher, 2009). Remedies for this may be incentives to promote cultural changes in risk attitude of European entrepreneurs and investors as well as a higher reliance on equity funding.

[9] For a detailed description of the channels see Hall and Lerner (2010).

[10] There are notable exceptions to this information puzzle, of course mainly in the US, as indicated by the provocative book by Galloway (2017). Large digital firms can manage the information to investors in such a way that traditional parameters of investor prudency are suspended.

4.4. Lack of critical market size

The success of a business model based on intangibles is typically characterized by the reward of being the first to the market - "the winner takes it all" (Shapiro & Varian, 1999). The success of US-based companies, such as Google, is to a large degree dependent on a large culturally homogeneous user population such as the US, compared to a (nationally) fragmented market for internet search engines in Europe, also because of language reasons. European national initiatives have mainly created small search engines, which has enabled Google to achieve eventually a higher market share in Europe than in the US (Haucap & Heimeshoff, 2013). Google and other US based companies have the advantage of a large home market. Once new ideas are tested and successful, they can quickly exploit the large market to generate sufficient cash flow on homogeneous basis to launch then the product on an international basis, which is easily achieved through the digital format of these types of services. This has resulted in a great competitive advantage for US-based internet companies by being able to quickly introduce their proven products in new markets and thus immediately becoming market leaders. Digital technology companies starting out from a smaller home market suffer from an inherent disadvantage with this respect.

4.5. SMEs as innovation laggards

The structure of European industry is to a large degree based on SMEs. Studies such as Icks, Schröder, Brink, Dienes, and Schneck (2017) suggest that SMEs are laggards as concerns the digitalisation of their businesses. There are a number of reasons. First of all, the propensity to digitalise a business depends on the business-model: smaller companies are often more concentrated in industries that are less exposed to the need for rapid digitalisation. Secondly, because of the smaller size of the firm, the management and specialist resources to fully understand the implication of the digital transformation are more limited. Thirdly, SMEs usually adopt a gradual approach to digitalisation – resulting in a piecemeal introduction of digital business processes and products. Last, but not least, investments in digitalisation across all size classes are predominantly financed by internal sources, mostly internal cash flows and hence depend on the financial performance of the firm.

Market forces alone, such as competitive pressure, that accelerate transformation processes in general are therefore unlikely to bring about digitalisation and drive companies to invest more in digital technologies at the desired pace – at least, when it comes to smaller companies. They are often more reluctant to adopt appropriate strategies for cybersecurity.[11]

4.6. Cybersecurity and data protection

Data as a commodity can have significant economic value. Access to data and its use may hence be very sensitive, both for firms and individuals. Data, especially when relating to individuals, has generally a high status of protection in Europe because referring to fundamental human rights and thus is subject to specific regulation. Data on firms is more subject to economic considerations of competitive market interaction and related legitimate enforcement requests of data security. Security of data has the characteristics of both a private and public good (Ashgari, van Eeten, & Bauer, 2016). The intangible nature of data, the limited observability of its use and the huge technological opportunities in combining data provide also several opportunities of misuse. It is however very difficult to disentangle the effects: investment in security may have positive or negative externalities. Data protection may benefit all users if it prevents illegitimate collection and use (e.g. circumventing intellectual property rights, discrimination of individuals). However, data protection may also induce more costs in accessing data if data protection is stricter than actually warranted and thus negative externalities may set in for underuse of data and lack of development of advanced services. The trade-off is particularly challenging with personal data.

Because of the volatile nature of data, there may also be diverging incentives for investment in cybersecurity; the owner of the data may not have the same interest to protect the data as the provider of the data. A typical example is credit card data stored on servers. Investment in cybersecurity will depend on the economic consequences of abuse to the owner of data compared to the provider of the data, and there may not be an alignment of interest, especially when incomplete information on the use of the data is involved. Failure to invest in cybersecurity may lead to breakdown of markets or prevent agents to participate in markets. This does not only refer to data on individual persons. As mentioned above, SMEs seem to be particularly exposed to this problem, as they generally have a much lower awareness of the need for investment in data protection.

5. Building blocks for a digital industrial policy

The European Commission has already put a number of policy initiatives in place for promoting the digital sector, in particular the Digital Agenda for Europe, the Digital Single Market and the Gigabit Society.[12] Moreover, the R&D funding programme Horizon 2020 devotes a considerable share of financial resources to the digital domain, on top the financing from the Connecting Europe Facility. Although the digital sector has definitively received increased attention over the last years, these measures may not be enough, also because the digital sector is still neglected in the European policy debate with respect to formulating a specific industrial policy. The European industrial policy approach traditionally aims to be rather broad based and cut across sectors to further international

[11] OECD (2017), p. 12 reports that SMEs in particular need to introduce or improve digital security risk management practices.

[12] See European Commission (2016b) and related staff working documents.

competitiveness of the European industry. The beneficial effects of such transversal policies would then trickle down in due course to the firms able to embrace the opportunities. Such “integrated approaches” however need to be developed further. In the European policy context this is broached within a “green” and “sustainability” focussed argumentation (e.g. Aghion, Boulanger, & Cohen, 2011), i.e. very much about the energy intensity and emission standards of the manufacturing sector. The manufacturing sector's resilience with respect to climate change objectives is promoted by Europe in the global context. A similar approach could be adopted for digitalisation. In the following some areas for policy actions in the digital domain are discussed to address part of market failures mentioned above.

5.1. Digital infrastructure

Digital infrastructure such as ultra high speed broadband networks will be the backbone infrastructure along with datacentres for the investment challenge for the next decade. Gruber, Hätönen, and Koutroumpis (2014) show that under a relatively broad range of assumptions on benefits and cost, the increased roll-out of broadband infrastructure pays off economically. But because of the generally very long payback periods and low financial return to private investors a major part (about two thirds) of this investment located in medium to low population density areas is financially not feasible from pure market funding sources and hence requires additional public support. The financing gap consists of the investment requirements exceeding the maximum capital expenditure that can be matched by expected revenues, that is, the investment volume up to which FTTH deployment is financially viable, i.e. the revenues raised from operation are able to raise sufficient resources to pay for the capex. This is mainly a function of population density. Generally only the urban areas can be financed by the market, while the others require some form of subsidy. Uniform access to broadband services is essential for the development of digital services and uniform patterns of diffusion. The European Commission launched the Digital Agenda for Europe as a policy initiative to provide Europe with broadband coverage targets and provided some very limited funding through the Connecting Europe Faciliy. But the amounts required to the meet the objective of the Digital Agenda and even more so the follow up Gigabit Society initiative are much higher than anticiped in the budget of the European Commission (Analysys Mason, 2016).

But the financial support to infrastructure role out needs also be complemented by greater policy coordination. The deployment of 5th generation (5G) mobile generation infrastructure is a central part of the European Commission's “Connectivity for a European Gigabit Society”, developing further the broadband infrastructure deployment objectives of the Digital Agenda for Europe. In particular, 5G access should be available in at least one major city in each Member Country by 2020 at the latest, and by 2025 there should be uninterrupted 5G coverage for all urban areas and major terrestrial transport paths. Such technological innovation needs a high degree of coordination by the policy maker, which currently is not happening because countries are late in providing the necessary radio spectrum.

For mobile generation, the first introduction of 5G networks risks to occur outside Europe. Europe still has spectrum issues to sort out that will delay introduction well beyond 2020, while the plans in the US are much more advanced with 5G trials under way in 2018. Early introduction of mobile generation is important for the supply industry as it allows to preempt the setting of standards and get first mover advantages in equipment supply (Lemstra, 2018).

Europe was actually worldwide leading in the development adoption of second generantion mobile telecommunications in the early 1990s (Gruber, 2005), thanks to the ability of Europe in negotiating international technology standards. The European Commission (2016b) strategy on Connectivity for a European Gigabit Society sets a vision of Europe where availability and take-up of very high capacity networks enable the widespread use of products, services and applications in the Digital Single Market.

The related 5G Action Plan also proposes a venture financing facility to stimulate 5G innovation and take-up with the participation of the industry and public funding. Lemstra, Cave, and Bourreau (2017) elaborate on the policy requirements that would allow Europe to reclaim leadership for fifth generation (5G) mobile telecommunications infrastructure.

Sector regulation would require substantial rethinking. European sector regulation, putting emphasis on inducing service competition and low retail prices, stifles the opportunties for private sector investment in infrastructure and further sector development (Gruber, 2012). As a result, broadband infrastructure is being built at a much lower rate in less densely populated areas and hence substantial public support for the roll-out of high speed broadband infrastructure is needed. Such areas typically suffer from an imbalance between high up-front investment costs and, in comparison, limited cash flows from a lower number of consumers. Because of this lack of commercial viability, projects in these so-called “grey” and “white areas” are often held back by private investors, resulting in a rapid deepening of the “digital divide” with respect to urban areas. Taking into account the positive externalities deriving from high speed broadband infrastructure over a long time horizon, the public support to such projects might be economically fully justified. Therefore the deployment of digital infrastructure needs considerable investment support, in particular in rural areas (Gruber et al., 2014). New funding vehicles, such as dedicate equity funds developed by the European Investment Bank blending various source of public funds with private sector resources, should be embraced more forcefully.

The European Commission is already supporting strategic infrastructures through subsidies from regional development funds as well as from the Connecting Europe Facility. What needs to be avoided is that incumbent operators are able to cherry pick investment opportunities in the “grey” areas. The remaining unserved areas would otherwise be even more difficult to cover with the subsidies available and deter for new entrants. Attention towards the appropriate design of regulatory provisions that shift investment risks to those best placed to shoulder can be equivalent to monetary public support. The new European Communication Code currently under discussion needs to find a balance between the diverging interests of legacy infrastructure owners and potential new entrants.

5.2. Education and skills

Education is a domain that is exclusively dealt with at the level of the Member State of the EU. Hence European level policies have mostly a role of coordination and benchmarking. Moreover, there have been put increased efforts on making the job market more flexible, by increasing the employment opportunities through exchange programs such as Erasmus+.

Digitalisation is posing a considerable challenge for job markets as the change in production technologies changes the skills mix of workers needed. To compensate for the risk of technological unemployment, efforts are required in making the workforce more resilient. Policies have generally focused on raising qualification levels across the EU, either by raising the standard education curriculum or by instituting lifelong learning cycles. Both skills utilization and organizational innovation performance are associated with the quality of managerial practices and how work is organized. In firms characterized by narrow job functions and low levels of autonomy there is a big risk that the workforce over time will lose its initial skills base. Hence, skills-enabled growth in European industry will not only depend upon the quality of graduates and doctoral candidates, but also upon how these skills are put to use and further developed in manufacturing companies in Europe. Although skills mismatches are to some extent part of a dynamic economy, it becomes even more necessary to implement accelerated apprentice routes for particularly the unskilled part of the workforce who lost their jobs in manufacturing during the crisis. These routes should focus on up-skilling for advanced manufacturing based on new automation and digital technologies.

Digital technologies themselves are also creating new opportunities for skills development.[13] These can include internet based applications such as massive open online courses (so called MOOC) that provide complete courses on line to a large number of students, thereby extending the time and places where learning can take place. Lifelong learning has been identified as a priority for the future since it is the key to maintaining the employability of people and, thereby, their ability to participate fully in an ageing society.

5.3. Public sector acting as digital lead innovator

Public procurement can have an important role in innovation in the digital sector by providing a first mover advantage as the state may contribute in setting standards in the procurement of new technology. Substantial opportunities may emerge in the field of digital applications, as Edquist and Zabala (2015) illustrate with the cases of gesture-based communication systems. In their view pre-commercial procurement is less a demand side but rather a supply-side policy instrument in relation to innovation.

There are at least two reasons for public support of private investment in digitalisation. First, the public sector has the possibility to act as pioneer for digitalisation of services, in particular through pre-competitive procurement policies. Not by chance, a number of fundamental innovations were made by public sector or related entities in the digital domain (e.g. transistor, internet, MP3). Second, the public sector can act as investor to compensate for the limited risk appetite of private investors. In fact, there may be an intrinsically cultural difficulty for raising risk capital for investment in an innovative firms linked to the digital sector. Investors in Europe have generally a greater risk aversion than investors in the US. Veugelers et al. (2015) show that this risk aversion poses a problem in particular to innovative SMEs trying to enter new markets relevant for innovative technologies. The largest portion of the European Commission's Horizon 2020 budget, almost 40 per cent, is dedicated to exploring and creating approaches and technologies with which to tackle the grand challenges. But it is unclear what is the role of digital technologies therein. A strong public commitment to digital technologies would help to dispel doubts whether it is worthwhile to devote attention to digital technologies in Europe. The public sector may then also act as “strategic investor” in digital projects and/or companies, although this may occasionally clash with notions of efficiency. Clearly, all these public sector engagements require an appropriate design of financial instruments and efficient public investment decisions.

A commitment by the public sector also helps to overcome the minimum critical market size problem. This market size may be necessary to amortize the set up cost for (mostly intangible) digital capital. The support may be necessary for entering a market, though it by no means will ensure success. For instance, the challenge in the market for internet search engines is particularly daring given the huge first mover advantage of incumbent firms such as Google accumulated on data processing capacity and the depth of the search index. The Franco-German joint venture Qwant aims to establish itself as an alternative to the dominant search engine Google, with the intent to overcome the national fragmentation of this market in Europe and tailored to meet the local needs of European end users and ad placers, complying also with the European privacy legislation concerning the “right to forget” of individuals’ web activity (Simonnot, 2016). To mitigate the market size problem in front of the sheer market power of Google (Lewandowski, 2015), the French government has decided to install Qwant as default search engine in computers used by the public sector in education.[14] Although individually not necessarily successful, public support to such initiatives of European interest in the digital domain should be tried more often.

5.4. Common initiatives for data protection and cybersecurity

Europe benefits from an important strength when it is considered as the most trusted area in the world when it comes to ensuring

[13] See for instance OECD (2017), p. 160 ff.

[14] As announced on the education ministry's website eduscol.education.fr on 24.01.2015. http://eduscol.education.fr/numerique/dossier/competences/rechercher/outils/moteurs/qwant-junior.

high-level of data security and privacy, also thanks to the recent General Data Protection Regulation (GDPR).[15] This competitive advantage needs to be maintained and built upon. To further support Europe's ambitions, Europe must also endow itself with cybersecurity solutions that meet the needs of emerging digital markets. While cybersecurity used to be the responsibility of each nation member, the main action should be undertaken at the EU level. The European digital market still suffers from excessive fragmentation, while at the same time threats have become global. In September 2017 the European Commission has presented a package of initiatives related to cybersecurity.[16] This includes, among other, a proposal for a EU cybersecurity agency to assist Member States in dealing with cyber-attacks, as well as a new European certification scheme that will ensure that products and services in the digital world are safe to use. The European Cybersecurity Organisation (ECSO), a non-for-profit organisation established in June 2016, represents the industry-led contractual counterpart to the European Commission for the implementation of the Cybersecurity contractual Public-Private Partnership (cPPP). ECSO members include a wide variety of stakeholders such as large companies, SMEs and Start-ups. For the European Commission to be able to support this partnership, under its research and innovation program Horizon 2020, firms have to generate an ecosystem of local suppliers for cybersecurity solutions as otherwise non-European companies may be the main beneficiaries. In that case also the public sector as a main customer has a key role to play. The public procurement policies should be adapted to the greatest extent to achieve the goals of innovation by exploiting the EU Common Market.

5.5. Update competition policy principles

The conventional instruments of enforcement of competition, such as merger control and state aid, are to ensure static efficiency, based on traditional models of general market equilibrium.[17] These instruments often prove inappropriate when dealing with digital markets where deviations from traditional static competitive settings are endemic: with digital markets competition is not *within* markets, but rather *for* markets where the winner takes all (Shapiro & Varian, 1999). Indeed, the diffusion of digital technologies has strongly affected the mode of competition and innovation. In the analogue/mechanical world, firms were competing inside industries in a silo-fashion. In the digital world, firms are competing across industries rather than within them, blurring the boundaries.

Recent examples of structural business reshuffling are *Amazon* for book retailing, *Uber* for taxi and *AirBnB* for accommodation services. All of them have shaken up the traditional markets and changed the way services are provided, involving much more the customer in the production process and in gathering information about preferences. As a result of this, a digital industrial policy needs a different approach to competition policy by taking a fresh look at the main elements of market failure pointed out above. Failure to adapt competition policy accordingly may lead to missed opportunities for creating digital markets in Europe; innovators would rather move to other jurisdictions with competition policies that are more appropriate to the business models in the digital economy. With this respect, Autor, Dorn, Katz, Patterson, and Van Reenen (2017) have coined the interesting concept of “superstar firm”, which in the digital domain could derive from new competitive internet search platforms, the proliferation of digital content products that have high fixed and low marginal costs, or increasing competition due to the rising international integration of product markets facilitated by digital services.

In the fast living digital world product cycles unfold much quicker and the traditional notions of competition policy hence must be revised. Broadly speaking, market entry into new digital markets tends to be much easier; market dominance can be achieved and challenged much quicker, as can exit. Abuse of market power can also occur in these industries. To effectively deal with it, the parameters of competition policy in assessing unfair competition need to be revised for the digital domain, in particular taking in to account considerations of market dynamics and contestability.[18]

5.6. Public support to industrialization of R&D outcomes

The European Commission decides the predominant part of public funding for pre-competitive R&D to be undertaken by the private sector, using matching grants through a multi-annual program (e.g. Horizon 2020). This setting ensures efficient funding of precompetitive R&D and it is delivering good results. However, there remains the problem of timely absorption of the R&D results through product and process innovation by the European industry. European companies are slow in transforming R&D breakthroughs into commercial successes in order to ensure firm growth. Aguiar and Gagnepain (2017) show that firms participation in European research programs increased very strongly their labour productivity, but only marginally profitability. European initiatives should be undertaken to allow public sector funding in the digital domain also for supporting innovation closer to the market.

The eligible digital technologies should be defined on the basis of a broad political consensus about their transversal importance to society, with a wide scope for product applications such as developing low carbon energy technologies, improving energy and resource efficiency, promoting social innovation and substantial positive economic externalities. For such key enabling technologies, support can extend up to first manufacturing. The challenge is to define appropriate technology domains in the digital sector that could benefit from such provisions.

The US have been very successful at transforming R&D outcomes into commercial success thanks to a flourishing venture capital

[15] Regulation (EU) 2016/679, which entered into force in May 2018.
[16] JOIN (2017) 450 final.
[17] See for instance Motta (2004).
[18] For a discussion of digital market competition see also Krämer and Wohlfarth (2018).

industry, particularly designed for supporting innovators in early stages of setting up activity. Most of the firms that have developed into market leaders have relied initially on such funding sources. For such financing an environment characterized by trust and risk taking is essential (Bottazzi, Da Rin, & Hellmann, 2016). In this sense, substantial public sector intervention is still needed for nurturing a venture capital industry in Europe, also to overcome the still quite fragmented market across national lines and the risk of double taxation. As there is not yet an integrated European venture capital market, but rather an aggregation of several markets, measures to improve the situation by developing a fully functioning Capital Markets Union (CMU) are essential (Kraemer-Eis, Signore, & Prencipe, 2016).

5.7. Promote digitalisation with SMEs

The predominance of SMEs in the structure of the European industry leads to a sluggish adoption of innovation on the demand side. Hence providing SMEs with incentives for digitalisation can significantly accelerate the pace of innovation and has the scope of attracting additional knowledge resources to an SME. One of the well-known weaknesses of SMEs is that they often lack strategic vision. SMEs are focused primarily on digitalising internal processes, websites and e-commerce solutions. Their approach to digitalisation is gradual. Indeed, for them modifying their existing set-up on an ongoing basis is easier than radically disrupting their business model. For this reason, their efforts still rarely take into account the actual needs of the customer.

Because SMEs are in many countries the main employers, especially when it comes to less developed regions or regions with high levels of (youth) unemployment and because of these difficulties to swiftly embrace digital technologies with related business models and processes, there is public interest in facilitating SMEs in the access to knowledge on digitalisation. In fact, SMEs investing in digitalisation typically employ young people as they are more accustomed with digital technologies. Last but not least, SMEs' access to digital technologies must also be backed up by sufficient levels of cybersecurity, an in principle public good where SMEs are reportedly underinvesting. OECD (2017) reports, that nearly all countries surveyed have adopted national digital security strategies, but SME required special attention. The most frequently mentioned measures are raising SMEs' digital security risk awareness, building capacity in education and skills as well as international co-operation. In general, measures include promoting privacy awareness, developing skills, and empowerment.

5.8. Public support to large digital projects of European interest and fine tuning of financial instruments

The Treaty of the European Union foresees that possibility of targeted industrial policy, in particular in the context of "Important Project of Common European Interest" (IPCEI) and when firms outside the EU get similar support.[19] If a project is considered in line with IPCEI, traditional state aid rules may be suspended. To qualify, "the project must contribute in a concrete, clear and identifiable manner to one or more Union objectives and must have a significant impact on competitiveness of the Union, sustainable growth, addressing societal challenges or value creation across the Union."[20] Moreover, partners from at least two Member States must take part in the project. There is only one successful example for an IPCEI: Airbus, for commercial passenger airplanes. The digital economy sector could be a valid candidate for which this instrument, which has been only recently reviewed and updated in the qualifying principles. There are two digital economy projects under preparation: nanoelectronics and high performance computing.[21]

If for such projects traditional state aid rules can be suspended a broad range of financial instruments becomes possible. In such projects it is feasible to raise substantial resources in the private sector through commercial provision of goods and services.

Financial instruments have the potential to significantly leverage public funding for public interest purposes, involving private financing. Such instruments have a double feature: they can on one hand provide the breathing space to firms for the long term view because of the public sector support that does not require market based remuneration; on the other hand they impose financial discipline on performance because of private sector interest in yielding return on its investment.

6. Conclusions

The proposals lined out aim to contribute to the discussion concerning the future orientation of an updated industrial policy in the European Union that takes into account the radical changes induced by digitalisation. Digitalisation has become a key determinant for wealth creation of nations and a main driver of international competitiveness in manufacturing. Economic growth and prosperity in Europe will depend on its ability in leveraging digital technologies, in particular related infrastructure and services to further refining skills and expanding knowledge with the aim of increasing factor productivity. Other countries and regions have shown how this can be achieved and Europe needs to close the investment gap with this respect. An increasing share of intangible assets of the digital economy will characterise the factors of production necessary for new products and services. While Europe still has one of the best science and research systems in the world, its manufacturing position, in particular in digital sector, is losing out on a global scale. For more than a decade, Europe has fallen behind other economies in the innovation performance for leading-edge digital products and services. Likewise Europe is lacking innovative companies in the digital domain.

This decline of Europe could be contrasted adopting an appropriate digital industrial policy that massively directs resources in an

[19] See Neven (2014).
[20] COM (2014/C 188/02).
[21] For further information, see Enderlein, Dittrich, and Rinaldi (2017).

efficient way towards the digital economy. A digital industrial policy should focus on accelerating the building of ultra high speed broadband networks and related infrastructure to stimulate the creation and adoption of productivity enhancing digital services. Other measures should help to build up intangible assets along the value added chain of the digital economy, fostering the R&D relevant for digital sectors and the improvement of digital skills of researchers and of workers. Investment incentives for cybersecurity and data protection should receive much more attention as these measures have an important role in securing the benefits to those that have made the investment in innovation and that they have continued interest in proceeding along the path of innovation. SMEs are particularly challenged in this domain and therefore particular efforts by policy makers should be made to address them to ensure that they get sufficient access to appropriate financing sources.

The public sector needs to exploit its important role in the public procurement for digital innovation and the setting of digital standards. Examples are the support to high performance computing infrastructure, along with appropriate initiatives for data protection. Financial support for the digital sector should be used with particular emphasis on the efficient leverage effects that can be achieved by combining public and private sector funds through new financial instruments, including dedicated equity funds. Policy measures such as competition policy need to be adapted to deal with the special features of the digital sector. The digital sector provides also ample opportunities to use the measures for state aid provided by the regulations such as those for IPCEI. Entrepreneurship and abilities in designing innovative business plans are essential to meet the challenges and opportunities with digital technologies. A digital industrial policy may become particularly important for the multiannual financial framework for the financing period 2021-27 of the European Union, where digitalisation is expected to play an important role.[22] It would provide the opportunity to absorb efficiently the increased resources provided.

Disclaimer

The opinions expressed are of the author and need not necessarily reflect those of the EIB.

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Appendix A. Supplementary data

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[22] See press release from European Commission of 2 May 2018 http://europa.eu/rapid/press-release_IP-18-3570_en.htm.

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