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Industrial Innovation for Transformation

7th European Conference on Corporate R&D and Innovation
CONCORDi 2019

Background Note

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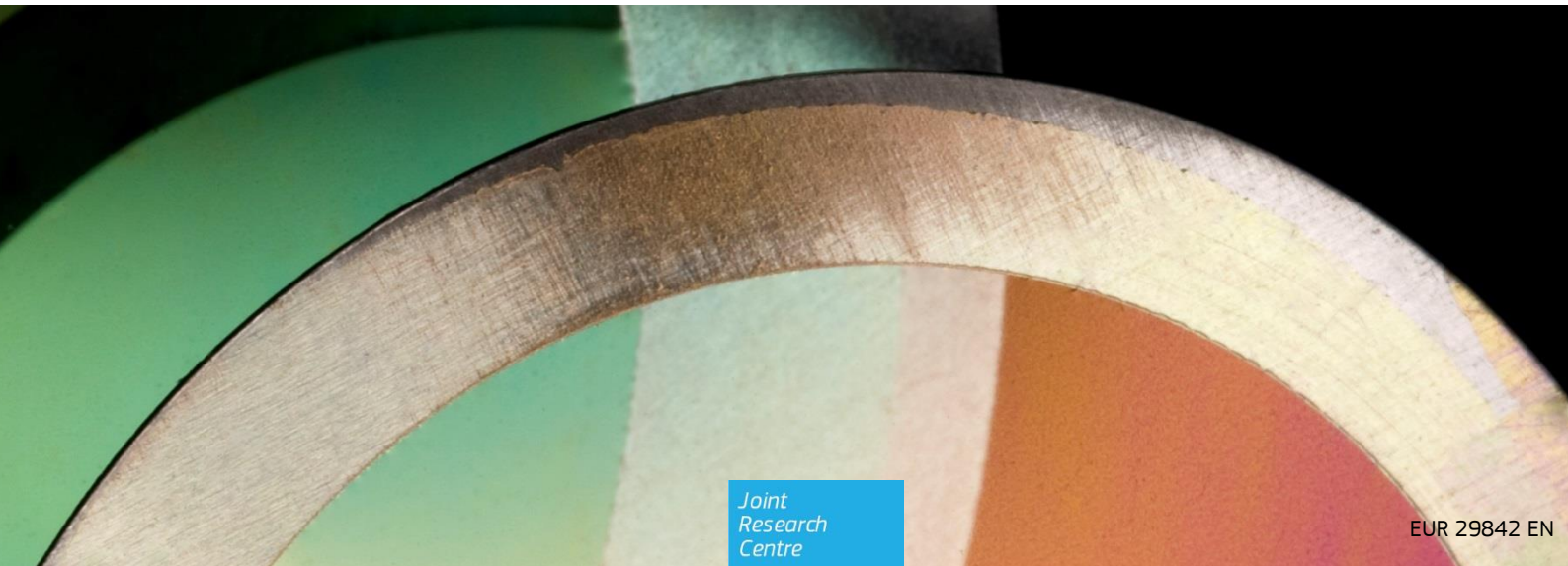

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BETTER POLICIES FOR BETTER LIVES

CONCORDi 2019

7th European Conference on Corporate R&D and Innovation

25-27 September 2019 – Seville (Spain)[1]

INDUSTRIAL INNOVATION FOR TRANSFORMATION

Notes on the Background

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1. Introduction

There is widespread consensus on the key role of manufacturing in competitiveness, innovation, and sustainable growth. However, the last few decades have been characterised by a progressive decline in the EU manufacturing sector's share of both value added and employment.[3] This decline has significant implications for total business R&D investment because manufacturing accounts for most of business' expenditure on R&D and for the livelihood of local innovation systems. In turn, these systems increasingly rely on attracting industrial activities and favouring industrial participation in global value chains and networks.

At the same time, European industry is facing several challenges such as the digital revolution and the ambition to achieve zero emissions and develop a circular economy, which is dramatically changing Europe's industrial landscape. This requires a strong push to sustain industrial transformation, embracing technological change, integrating product and service markets, and developing environmentally and economically sustainable technologies and products that are inclusive and broadly accessible to society.

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[1] CONCORDi 2019 website: http://iri.jrc.ec.europa.eu/concord/2019/index.html.

[2] All authors are from the European Commission, Joint Research Centre.

[3] See "EU losing share in global manufacturing value chains", JRC Science for Policy Brief, June 2018

To benefit from the opportunities and mitigate the risks associated with the current industrial transformation, the EU must modernise its economies and strengthen its resilience. To ensure industrial competitiveness, the EU should strengthen its industrial capacities in key areas that underpin the current industrial transformation while it should also strengthen areas in the competitive advantage it currently enjoys. There is an important structural dimension in the current technological race towards future competitiveness and innovation, with changes worldwide driven by market threats and opportunities as well as regulatory challenges[4].

Policymakers are strongly committed to developing new policy narratives for EU industrial transformation in this framework and to going beyond "digital technologies only", which also implies a need for new business models and actors. [5]

In addition to industrial dynamics and structural change, it is important to understand how technology might disrupt the reallocation of resources. This not only concerns changes in the production and innovation value chains, but also the nature and future of jobs. More than ever, the creativity and skills of people are the key to innovation. Firms must invest in their workforce if they want to thrive and remain competitive. A range of new skills will be needed for individuals and organisations. This calls for a more integrated approach to industrial innovation and to policies at different territorial dimensions that trigger successful industrial transformation.[6]

Since its first edition in 2007, the biennial CONCORDi[7] has established itself as a forum where researchers working on themes related to corporate R&D and innovation present recent developments in the field and meet policymakers to exchange views and discuss possible implications for EU policy.

The focus of this year's CONCORDi is Innovation for Industrial Transformation[8]. The following key questions will be addressed during the Conference: how to manage a timely, inclusive, and sustainable industrial transformation, establishing European firms as globally competitive; how to advise industrial and innovation policy on how to take into account specific territorial needs to guarantee fair and sustainable competitiveness and job creation across the whole EU; what are the main challenges (and opportunities) caused by innovation that EU industry transformation will have to overcome?

Addressing these compelling topics is not easy and requires the joint effort of academic, policy, and industrial analysts.

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[4] See https://iri.jrc.ec.europa.eu/scoreboard18.html

[5] See "Innovation and Industry: Policy for the next decade", JRC Policy Insights – Industrial R&I, December 2017, Innovation and Industry.

[6] See "For a Transformative Industry & Innovation Strategy", JRC Policy Insights – Industrial R&I, February 2018, Innovation and Industry

[7] CONCORDi website: http://iri.jrc.ec.europa.eu/concord/

[8] The Conference is part of the Technological & Innovation Challenges for Industry 2030 project (*TIC 2030*, and the related work-package *TIC 2030 Strategy*) of JRC Directorate B (Growth and Innovation), Unit B3 (Territorial Development), which provides policy-relevant techno-economic analyses on industrial innovation based on a cross-disciplinary approach (see https://iri.jrc.ec.europa.eu/).

2. Research and policy challenges

To achieve a successful industrial transformation where innovation plays a significant role, a number of challenges need to be met. The following sections propose several key research and policy challenges[9] that CONCORDi 2019 needs to take into consideration.

2.1 Macro-challenges

There are a great many factors driving industrial transformation. Digitalisation, major industrial transitions in energy and transport, and historic shifts in social and demographic patterns call for the transformation of European industry, and increased awareness of the need to become (more) sustainable. Many EU firms are world leaders in these new areas of opportunity, but large swathes of European industry may struggle to find their position in the newly emerging or newly contestable global value chains. Appropriate responses from policymakers may well require the deployment of bolder industrial policies that combine the strength of traditional instruments of innovation (such as support for business R&D) with massive public investment in network infrastructure (information, transport, waste, energy distribution) and public service provision (education, skills, health, security) as well as fiscal, regulatory, and even macroeconomic interventions. This will inevitably require direct attention to the demand-side of innovation as well as the use of innovative public procurement. However, this poses significant challenges for implementation and little is known about the conditions under which these approaches can be successful. It is also extremely important to identify the missing framework conditions that not only enable the scaling up of successful technology-driven start-ups, but also the achievement of economies of scale in strategically important enabling technologies (e.g. batteries). Examples of questions that need to be addressed are:

- What are the shortcomings of current theoretical and analytical frameworks in providing evidence for industrial research and innovation's role in industrial transformation?
- How do EU firms compare with world-wide competitors, in general and in specific sectors, in terms of their capacity to take the opportunities of the current industrial transformation?
- What evidence is there for the impact of R&D subsidies on firms' performance, in terms of both innovation inputs and outputs and in terms of competitiveness?

2.2 The Challenge of Industrial Transformation and Sustainability

The effect of innovation on sustainable development is not neutral. In times of major social, environmental, and economic challenges, the goals of innovation policy are questioned. Questions are raised because undirected technological change has been associated with environmentally and socially unsustainable modes of production and consumption. Evidence of labour-substituting automation has raised concerns about the future of dignified, fulfilling, and well-remunerated work. The transformation of EU industry also requires profit, investment, and employment motives to be reconciled with environmental and social

[9] Most of these research and policy challenges are reflected in chapter 3 concerning the contribution to CONCORDi 2019 made by researchers, keynote speakers and policy-makers. This information is complemented by Appendix 1 ('Content of the Conference's scientific papers') and Appendix 2 ('Innovation for industrial transformation: the challenges for the EU policy agenda – some examples').

imperatives. The emerging literature (Burget *et al.*, 2017) on Responsible Research and Innovation (RRI) and transformative innovation policy offers interesting pathways for the development of actionable responses. Examples of questions that need addressing are:

- To what extent can evidence inform policy about the impact of innovation on employment in different sectors and in different regions?
- What impact does industrial transformation and innovation in one region have on the environmental and social sustainability world-wide, for example through value chains, and how might this potential externality affect industrial and foreign policy in Europe?
- Are environmental and social sustainability complementary or opposing concepts? From an empirical and theoretical point of view, can environmental sustainability be an opportunity for the creation of high quality jobs? What implementation challenges are there at company level?

2.3 Human Resource Challenges

High quality human resources underpin all thriving innovation systems. Yet education, skill provision, and skill training systems (including within industry) are not always aligned with the needs of industrial innovation and the move towards sustainability. Public research is a fundamental pillar of global leadership in technological innovation, not least through its contribution to the development of cutting-edge research. Europe's global position in science is helping shift industrial frontiers, and, combined with vibrant business investments in knowledge, can position EU industry at the cutting edge of technological development. On the one hand, there is a pressing need to improve how well the changing dynamics of science relevant to industry, its direction, performance, and division of labour are understood. On the other hand, this calls for a better coordination and experimentation with policies supporting innovation. Examples of questions to be addressed are:

- How is the ongoing industrial transformation going to change the skills required in different sectors?
- What is the impact of policies aimed at increasing the hiring of very highly skilled employees on firms' absorptive capacities?
- How do public policies and firms' strategies for transformation take into account firms' capacity to innovate and to collaborate with public research centres?

2.4 Territorial Challenges

Industrial innovation has a strong territorial dimension (Malmberg and Maskell, 2018). Leading firms organise their knowledge–intensive activities globally. Our collective understanding of them is patchy and incomplete, with progress hindered by the limited availability of data on R&D and other intangible investments and knowledge-intensive business activities, especially at regional and subregional levels. Knowledge-intensive business activities tend to grow in places with thriving local innovation systems and are characterised by strong positive feedback, where virtuous cycles of high performance, high investment leading to divergence between leading and lagging actors (Duschl, 2015). Decades of innovation studies emphasise the capability of the innovation accumulation processes. Europe is making massive investments in knowledge and innovation which foster broad capability accumulation and convergence. Of principal importance is the extent to which capability accumulation takes place within firms. Evidence from micro-data is increasingly important in understanding industrial innovation dynamics, particularly the secular trends of

divergence in intangible investment and productivity between leading and lagging firms (Coad *et al*., 2019). Examples of questions to be addressed are:

- To what extent can quantitative evidence be provided about the territorial level or levels at which innovation policies for industrial transformation can usefully be designed and implemented?
- Is there tension between the needs to consider regional specificities and to achieve EU-level economies of scale in specific markets? How does this affect industrial innovation in transformation policy design and implementation?
- What are useful indicators of regional capabilities with respect to the capacity of the regional innovation systems to adapt during the current transformation?

2.5 The Challenge of Complexity in Innovation for Industrial Transformation

Innovation systems are complex, characterized by different layers of interaction between agents in different domains: science, technology, government, production. Not only analyses at firm or regional level, but also the interactions between different firms, countries, and regions, and their capabilities, both indirectly (e.g. in value chains) and directly (e.g. in different forms of collaborations) play a central role in understanding the system. This creates a serious scientific challenge if traditional approaches commonly used in economic analysis are used to try and understand these systems. These traditional approaches were developed for more specific and less dynamic concepts, often incorporating predefined underlying assumptions which come under serious stress when applied to complex systems. On the one hand, a complex network approach can help understand signals from the innovation system and complement other analyses to inform policy of the specific needs and potential of different regions (Balland *et al.* 2018). On the other hand, the methods of complex system analysis can be used to capture the impact of the non-linear interactions between hierarchical actors that are common in the innovation system. This can help understanding causal implications at a less aggregated level (Dosi *et al.* 2010) and the co-evolution of the different aspects, e.g., innovation, production, scientific activities, and geographical scales, e.g., countries, regions, cities (Pugliese and Tübke, 2019). Examples of questions to be addressed are:

- Different innovation collaborations and linkages have different geographical patterns and diffusion properties. How does this heterogeneity affect the design of specific industrial policy?
- How does looking at interaction patterns between regions help in building local indicators of competitiveness and how can these indicators help policy makers in designing industrial policies?
- What are the limitations of current theoretical models aimed at understanding the interactions between firms and how can these limitations cloud our understanding of policy relevant issues?

3. Contribution expected from CONCORDi 2019

The first section of this chapter introduces the three broad thematic areas of CONCORDi 2019 and the related expected scientific contribution made by the papers selected by the Conference. The second section presents the abstracts of these subjects to be covered by the speakers invited. The third section provides a voice for the policy-stakeholder panellists, and the final section presents the chairs, moderators, and summing up facilitators.

3.1 Main themes of the Conference and contributions from scientists and research analysts

CONCORDi 2019 is organised around three main themes develop around the contribution of novel scientific work presented in twenty parallel sessions. The sixty-six papers that will be presented and discussed during these parallel sessions will help to reinforce the research based evidence needed to address specific aspects of the three main themes. A succinct description of the papers presented in each of the twenty parallel sessions of the Conference is found in Appendix I.

3.1.1 New technologies, structural change, and industrial transformation

Manufacturing industry is undergoing major paradigm shifts, transitioning from tangible products to increasingly service-integrated products and product-related services (Lightfoot *et al.* 2013; Neely, 2008; Oliva and Kallenberg, 2003). While traditional industrial capital assets mainly composed of mechanical and electrical parts (characterised by expensive breakdowns and maintenance), their integration with digital technologies (sensors, connectivity, etc.) is increasing reliability and capability, transcending and enhancing the traditional product boundaries (Evans and Annunziata, 2015; Ayala *et al*. 2017; Coreynen *et al.,* 2017).[10]

Several countries have created policies to steer the development of Industry 4.0 and foster the adoption of digital technologies such as the “High-Tech Strategy 2020" in Germany (where the concept of Industry 4.0 was born), “Advanced Manufacturing Partnership" in the United States, and “Made in China 2025” in China. However, the adoption of such technologies is challenging for many firms, especially SMEs (Müller *et al* 2018(1)), and those that are lagging behind, and those in emerging countries (Hall and Maffioli, 2008; Kumar and Siddharthan, 2013). The industrial policy push finds justification in the academic literature on the expected benefits from the uptake and integration of digital technology (Kagermann *et al*., 2013). Firms that adopt these new technologies adapt faster to various kinds of shocks (such as production line breakdowns), thereby increasing their productivity (Schuh *et al*., 2017). The new industrial technologies have also implications for the growth of firms because firms can combine resources to adapt to changes in the market by implementing collaborative networks (Brettel *et al*., 2014).

[10] The discussion on the effects of digitalisation of industrial production and the industrial application of "smart" and "intelligent" devices relates to the long-discussed concept of computer integrated manufacturing (CIM), already prominent in the 1980s (Groover, 2007).

This theme is covered by the scientific papers that will be presented in the following six parallel sessions at the Conference (the identifiers of the parallel sessions are in brackets)[11]:

(I C) R&D gaps and dynamics;

(II A) Digital transformation;

(II C) Global and local innovation;

(III A) Industry 4.0;

(V A) Advanced Manufacturing: local and global aspects;

(VII B) Firm dynamics and barriers.

3.1.2 Industrial innovation and socio-economic transformation

Acceleration of technological change, urbanisation, an aging society, and increased global connections are several trends driving the current socio-economic transformation. On the one hand, if these trends have created a great many opportunities for firms—as entirely new markets have opened up—they have produced important economic, social, and human impacts, sometimes having undesirable consequences: regional disparities, skills erosion, job losses, increasing inequality, and environmental degradation (Narula, 2012).

Therefore, the policy focus is gradually shifting from economic growth to sustainable growth (Kardos, 2014). Whereas most of the work on sustainability was initially on environmental aspects of globalisation, now it is directed towards social sustainability, where policymakers face several challenges in the labour markets. Indeed, the increase in openness can accentuate inequality and the vulnerability of domestic labour markets to external shocks (Bacchetta and Jansen, 2011). However, from the company perspective, the opportunities from industrial transition are met with challenges regarding the individual company's competitiveness and future viability, together with significant implementation issues (Müller et. al. 2018(2)).

Brynjolfsson and McAfee (2014) argue that while the current industrial revolution is increasing productivity in a wide range of industries, it is also specifically having adverse effects on low- and medium-skilled workers. The cheaper and better digital technologies are increasing substituting labour for (cheaper) capital, and the labour share of income, especially among median-wages, is falling.

The two prevailing explanations for unemployment among certain skill groups are either technology upgrading or globalisation, or a combination of these two (Autor and Dorn, 2013). Although technology is having pervasive impacts on labour markets, it is not clear whether future technological development is likely to radically change the occupational structure with no net negative effect on overall employment, or whether the digital revolution will eventually reduce the demand for jobs (Autor, 2014).

This theme is covered by the scientific papers that will be presented in following six Conference's parallel sessions (the identifiers of the parallel sessions are in brackets)[12]:

[11] See also Appendix 1 and the full programme for the Conference: https://iri.jrc.ec.europa.eu/documents/10180/1788210/Draft%20Programme

[12] See also Appendix 1 and the full programme for the Conference: https://iri.jrc.ec.europa.eu/documents/10180/1788210/Draft%20Programme

(II B) Digitalisation and employment;

(IV C) Innovation and employment;

(V B) Sustainability;

(VI A) Skills;

(VII B) Green technologies;

(VII C) Social return of technological change.

3.1.3 Intangibles, diffusion of technology, and policy

The capacity to transform R&D investment into economic growth and the integration of innovation in any territory also depends on factors external to the local economy such as local social, institutional, and political structures (Markusen 1987; Rodríguez-Pose 1998). Although many empirical analyses have found a strong association between investment in intangibles (R&D, patents, trademarks, etc.), and increases in productivity and growth (Romer 1990; Grossman and Helpman 1991; Lichtenberg 1992; Eaton and Kortum 1995), the relationship is seldom direct and there are still large gaps in our knowledge. Consequently, the returns on investments in R&D and other intangibles, and the adoption and diffusion of technologies are some of the most studied topics in the economics of innovation (Hall *et al.* 2010, Keller 2004, Geroski, 2000).

While human capital and skills are critical for the adoption of new technologies, institutional factors also play a role. Indeed, in the same way that institutional quality promotes technology adoption, dysfunctional institutions may impede technological progress. Caselli and Coleman (2001) show that cross-country differences in computer adoption not only correspond to differences in human capital levels, but also trade openness and protection of property rights. Furthermore, winner-takes-all dynamics (where the benefits from innovation and productivity gains are increasingly concentrated among a few top firms) slow down the diffusion of new technologies especially in environments with strict product and labour market regulations (Scarpetta and Tressel 2002, Comin and Hobijn 2009).

In an era of systemic changes in current structures of employment and production, policy support to stimulate innovation and technology change can include many types of policy instruments. The most appropriate instrument may depend on the stage of the innovation process or the respective sector (Pavitt, 1984). The development of new policy mixes may be particularly important to sustainability transitions (Kivimaa and Kern 2016). These transitions not only call for the development of disruptive innovations but also for policies stimulating wider change in socio-technical systems due to regime destabilization.

This theme is covered by the scientific papers that will be presented in the following six parallel sessions at the Conference (the identifiers of the parallel sessions are in brackets)[13]:

(I A) Productivity and technology diffusion;

(I B) Internationalisation of R&D;

[13] See also Appendix 1 and the full Conference's programme: https://iri.jrc.ec.europa.eu/documents/10180/1788210/Draft%20Programme

(III B) Policy for innovation;

(III C) Effectiveness of R&D tax credits;

(IV A) Policy challenges;

(I V B) Intangibles;

(VI C) Patents and technology transfer;

(VII A) R&D subsidies.

3.2. Contributions from keynote speakers

CONCORDi 2019 will benefit from the contribution by distinguished professionals representing academia, policy-making, and industry. A short abstract of the keynote presentations is presented below according to the order in the Conference programme.

Dirk Pilat (Deputy Director - Directorate for Science, Technology, and Innovation at the OECD) will speak about "A transforming industry: the role of Artificial Intelligence (AI)" also based on the joint EC/JRC - OECD/STI report whose results will be disclosed on this occasion. *His talk will draw on new evidence on artificial intelligence that is emerging from OECD research, new insights resulting from this, and the questions this raises for research and policy related to AI, industrial innovation, and transformation. His talk will touch on three key areas of work, namely: 1) evidence for the development of AI in science, innovation, and entrepreneurship, and the contribution of Europe versus other major global players; 2) the factors and policies influencing the role of AI, including data, human resources, R&D, and diffusion, competition, entrepreneurship, and trust, and its potential impacts on innovation and productivity; 3) policies that can help strengthen EU performance in AI. In addition, he will emphasise the importance of better measurement and further empirical analyses of these issues, therefore supporting the development of appropriate policy responses.*

Koen Frenken (Utrecht University, NL) will offer an academic lecture on "Related industrial diversification as an economic development strategy: theory, empirics, and policy considerations" *Evolutionary economic geography has produced a large body of empirical research on economic development as a process of diversification into related industries with increasingly greater complexity. However, the wealth of empirical research stands in contrast with limited advances in evolutionary theorising. Theorising remains important for policy thinking as statistical evidence does not translate well in one-place, one-time policy contexts. This speech describes the theoretical basis of related diversification and the policy principles that can be derived from it. In particular, I will go into the question of additionality of an industrial policy targeting related industries, and the relationship between industrial policy and generic policy in both a 'developing' and a 'developed' country context.*

Anita Schjøll Brede (Co-founder and" CEO of IRIS.AI, NO) will touch upon the central argument of CONCORDi 2019 which is innovation and industrial transformation from an entrepreneurial angle: "An entrepreneurial experience aiming to change the world using artificial intelligence, science, and weirdness" *The world is transforming at an unprecedented pace. Every individual part of our industries is changing in front of our eyes although we cannot or will not always see it. What does it take to embrace this change? Or even more importantly, what does it take to effect this change? To step out of your comfort zone and lead the way in the*

entire transformation of your - and others' - industry. In this talk we will visit a good mix of definite technological and societal trends, what they mean for us as leaders, and we will talk about artificial intelligence and digital transformation, and about entrepreneurship and heavy industry. Occasionally, we will feel as if we are living in a sci-fi novel, and we will talk about what it means to be human in the middle of it all and why embracing strong ethics is more important today than it has ever been.

Hiroshi Kuniyoshi (Deputy Director-General, United Nations Industrial Development Organization - UNIDO) who will introduce the "Industrial innovation and the achievement of Sustainable Development Goals" *In thinking about industrial innovation and the achievement of Sustainable Development Goals (SDGs), one should be ready to recognise and manage distinct trade-offs, especially trade-offs resulting from traditional interpretations of how industrial innovation contributes to development, which are often at odds with the comprehensive and intertwined nature of SDG´s. The challenge is for industrial innovation to deliver win-win solutions, simultaneously balancing growth, environmental, and social concerns. This presentation calls for collective action as the basis for strategies to underpin the achievement of SDGs. This is a long-term project that requires commitment and periodic monitoring, evaluation, and improvement.*

Marco Vivarelli (Università Cattolica di Milano, IT) will offer a keynote speech on a crucial topic at the Conference: "Impact of innovation and industrial transformation on employment and skills" *This talk will critically discuss the theoretical and empirical literature on the quantitative and qualitative employment impact of technological change, comparing the relative explanatory power of competing economic theories. The second part of the talk will discuss and test a model addressed to framing the sectoral patterns of job creation and job destruction in order to distinguish the alternative effects of embodied vs disembodied technological change operating into a vertically connected economy. Finally, various policy implications will be outlined briefly.*

3.3 Contributions from EU policy stakeholder round table panellists

The Conference will enjoy state of the art inputs into important debates at the intersection of theory and practice and will make suggestions on how the EU can tackle challenges of industrial innovation as key element for socio-economic transformation.

The round-table of policy stakeholders will discuss the central focus of this edition of the Conference and connect it to the EU policy agenda. Policy stakeholders from the European Commission will provide input from the perspective of their respective services and contribute to the discussion. The following main areas will be addressed:

- Regional and urban policy: *Smart and sustainable growth*
- Research and innovation: *Research & innovation strategy and foresight*
- State Aid: General Scrutiny and Enforcement: *Access to finance, R&D&I, and the Environment*
- Employment: *Youth employment, Entrepreneurship, Microfinance Facility.*

The roundtable will also offer a timely opportunity to contribute to policy discussions around a new EU industrial policy strategy for 2030 and the design of related EU financial support instruments in the context of the post-2020 multiannual financial framework.

3.4 Contributions from chairs, moderators, and summing up facilitators

The Conference will be inaugurated by the welcome talk of Rogelio Velasco Pérez (the Andalusian Regional Minister for Economics, Knowledge, Enterprise and University, ES) ad by the opening speech of Vladimír Šucha (Director-General, Joint Research Centre - JRC, European Commission), and Bronwyn H. Hall (University of California at Berkeley and NBER, USA; MPI-Munich, DE; IFS-London, UK) will act as Chair in this first Plenary Session.

The second Plenary Session will be chaired by María Ángeles Martín Prats (Founder and President of Skylife Engineering, and Professor at the University of Seville, ES).

The third Plenary Session will be chaired by Luis Delgado (Acting Director, Directorate for Growth and Innovation, JRC, European Commission). Alessandro Rainoldi (Head of Unit, JRC, European Commission, ES) will summarise and conclude the derived policy messages from the round-table discussion by European Commission policy stakeholders in this plenary.

Chaired by Irmgard Nübler (International Labour Organisation, CH), the fourth Plenary Session will be opened by Antonio Pulido Gutiérrez (Presidente de la Fundación Cajasol, ES).

The closing plenary session (fifth) will focus on a summary of the main scientific output from CONCORDi 2019, streamlining the links to EU policy. The summary will be offered by three members of the Scientific Committee: Chiara Criscuolo, Mariagrazia Squicciarini (OECD, FR), and Reinhilde Veugelers (Katholieke Universiteit Leuven, BE). Their summary will build on the key inputs that they will receive from the 20 outstanding Chairs of the Parallel Sessions. Luis Delgado (Acting Director, Directorate for Growth and Innovation, JRC, European Commission, ES) will elaborate on the concluding statements and close the Conference.

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APPENDIX 1 - Content of the scientific papers presented at the Conference

The sixty-six papers accepted by CONCORDi 2019 will be presented and discussed in 20 specific parallel sessions grouped in seven main sessions. The following is a short description of the papers to be presented in each of the parallel sessions.

Session I

(I A) Productivity and technology diffusion

Chair: Mercedes Teruel *(Universitat Rovira i Virgili, ES)*

Wednesday, 25/15h30 – 16h45

» **Determinants of Productivity Gap in the European Union: A Multilevel Perspective**
(R.L. Bruno, E. Douarin, J. Korosteleva, and S. Radosevic)

EU economies have ceased to converge in recent decades. This paper analyses the determinants of the divergence and identifies long-term technology gaps between countries. A possible solution in terms of strengthening FDI/GVC industrial innovation policies is also provided.

» **Do Low-Wage Workers Benefit from Productivity Growth Recovery?**
(T. Ciarli, E. Salgado, M. Savona)

This paper examines empirically whether productivity gains (losses) are shared with wages, and the sources of heterogeneity that characterise this link. The authors use matched employer-employee data from the UK Annual Survey of Household Earning and the Annual Business Survey for 2011 to 2015. The analysis uses matched worker-firm fixed effects to identify the causal effect of productivity changes on wages for different age cohorts, wage quintiles, unionised workers, and different sectors' model.

» **Regulations and technology diffusion in Europe: the role of industry dynamics**
(S. Amoroso and R. Martino)

The productivity gap between frontier and lagging firms is largely attributable to socio-economic barriers in technology diffusion and adoption, which are: product market regulation, employment protection legislation, and access to finance. The authors address the role of each of these barriers in preventing technological diffusion.

(I B) Internationalisation of R&D

Chair: Antonio Vezzani *(Roma Tre University, IT)*

Wednesday, 25/15h30 – 16h45

» **Local cooperation for innovation and multinationals in Spanish ICT**
(A. García Sánchez and R. Rama)

This paper investigates whether foreign firms are likely to make a technological contribution towards domestic innovative capabilities in the Spanish ICT sector. The analysis is based on micro-data from the Spanish National Statistics Institute on local cooperation for innovation.

» **Links between R&D, innovation, and export across European manufacturing firms**
(A. Segarra-Blasco, M. Teruel, and S. Cattaruzzo)

This paper aims to analyse the links between R&D, innovation, productivity, and export for an extended sample of firms from seven European Union countries. The authors expand the traditional CDM model by introducing the export dimensions and the impact of the exports on subsequent productivity.

» **Innovation and Legal Enforcement of Competition Policy: Theory and international evidence from overseas subsidiaries of Japanese auto-parts suppliers**
(Y. Takeda and I. Uchida)

This paper presents a theoretical game model of innovation and legal enforcement of competition policy suggesting relationships concerning average treatment effects of legal enforcement on entrant's R&D or incumbent's deterrence activities, conditional on the degree of law and order in host countries. The authors test these results on micro data from Japanese subsidiaries in the auto parts sector.

(I C) R&D gaps and dynamics Chair: Carolina Castaldi *(Eindhoven University of Technology, NE)*	Wednesday, 25/15h30 – 16h45

» **The EU vs US corporate R&D intensity gap: investigating key sectors and firms**
(P. Moncada-Paternò-Castello and N. Grassano)

Research and Development (R&D) by companies are considered to be a crucial factor in achieving a more competitive EU economy and form a major objective in EU policies. Yet, EU R&D intensity lags behind the USA. This paper identifies the differences in sector compositions that are resulting in this gap.

» **Mapping Technological Trends: An analysis from the technological effort in the pharmaceutical industry**
(F. Gisele Basso, G. Silveira Porto)

The paper aims to identify how the technological trajectories resulting from the P&D&I effort of the 10 largest pharmaceutical industries are configured. In particular, the specific objectives are to verify the areas of technological development and which organizations are involved in these routes. The paper looks at the patent citations network and uses Search Path Link Count to identify technological routes. The patents in each technological routes are then analysed to see the main actors and their characteristics.

» **Dynamics of product and process innovation in low and medium-low technology (LT & MLT) and high and medium-high technology (HT & MHT) firms in Poland**
(P. Dzikowski)

This paper proposes a study of the Polish innovation system and sectoral dynamics in different technology groups based on a longitudinal study of two groups of firms representing low and medium-low and high and medium-high technology in Poland. This will also shed light on the impact of private and public support policies.

Session II

(II A) Digital transformation Chair: Katarzyna Sledziewska *(Warsaw University, PL)*	Wednesday, 25/17:15 -18:15

» **Robots and their knowledge generation: patenting and firm-level performance**
(F. Montobbio, J. Staccioli, M.E. Virgillito, and M. Vivarelli)

This paper firstly aims to identify and characterise the knowledge base underlying robotics; secondly pinpointing the relevant actors across industries; thirdly, analysing the firm level performances of the latter; and lastly, assessing their edge with respect to the rest of the universe. The authors perform an extensive empirical analysis relying on two granular-level micro-datasets of patents and firms.

» **Digital servitization in manufacturing firms**
(B. Dachs)

This paper investigates the relationship between new digital production technologies (or Industry 4.0) and product-related services offered by manufacturing firms. The central hypothesis is that both Industry 4.0 and product-related services help firms to remain or become more competitive and stimulate employment growth in firms. The analysis is based on data from the European Manufacturing Survey, so cross country comparisons can be made.

» **Digital adoption in Europe and the United States**
(D. Rückert, R. Veugelers and C. Weiss)

The paper identifies six different digitalisation profiles based on the current use of digital technologies and future investments in digitalisation of firms in the EU and the USA. Those six groups of firms are compared in terms of their different shares in the EU and the USA and their different potential in terms of employment growth, productivity, and mark-ups.

» **Where are those robots? Towards Europe's Robot Geography: territorial and sectorial**

concentration versus diffusion of industrial robots
(Z. Cséfalvay)

This paper analyses the territorial and sectorial development of industrial robots installed in Europe during the last two decades. A constant expansion diffusion pattern in the last two decades was found. It also looks at the sectoral distribution of robots, finding it to be the main driver behind the geographical differences in robotisation.

(II B) Digitalization and employment Chair: Sven Schimpf *(Fraunhofer Group for Innovation Research, DE)*	Wednesday, 25/17:15 -18:15

» **Digital technologies and their impact on EU employment and production**
(C. Midoes, and G. Petropoulos)

The authors of this paper study the impact of digital technologies on EU labour markets and production on both aggregate and individual countries and industries by looking at changes in the role of capital and labour for production.

» **Digitalisation and employment: Evidence from Indian service sector firms**
(N. Mathew and B. Verspagen)

This paper provides an empirical account of the effects of digitalisation (proxied by software acquisition expenses) on employment using a micro level database of Indian firms. The analysis provides insight into the heterogeneity of this effect in different sectors, varying from significantly positive to significantly negative in different industries, a crucial map to inform policy during the digital transition.

» **The digital transformation and labour demand in Italian enterprises**
(A. de Panizza and S. De Santis)

This paper addresses the relationship between digitalisation, human capital endowment, and the characteristics of labour demand in Italian enterprises. Different digitalisation profile clusters are identified and the paper looks at the impact of investments in advanced technological areas and employment shifts in specific professional profiles.

» **Artificial Intelligence and Robotics Innovation: A sectoral and geographic mapping**
(V. Van Roy, D. Vertesy and G. Damioli)

This paper aims to map and analyse the global innovative landscape of AI by exploring 155,000 patents identified as AI-related by means of text-mining techniques. It highlights the emergence and evolution of AI technologies and identifies AI hotspots across the world. It explores the scale and pervasiveness of AI activities across sectors, and evaluates the economic performance of AI innovators using firm accounting information. Finally, it assesses recent trends in venture capital investments towards AI as financial support to promising AI startups.

(II C) Global and local innovation Chair Raquel Ortega-Argilés *(University of Birmingham, UK)*	Wednesday, 25/17:15 -18:15

» **Place-based Innovation Ecosystems: Different Routes to Success? A Comparative Analysis of Five Case Studies**
(R. Compañó, G. Rissola and J. Haberleithner)

The authors developed a conceptual framework on the territorial dimension of innovation that allows comparing different case studies related to place-based innovation ecosystems. The analysis is done by looking for common patterns of specific elements such as the proximity of physical space, network relationships between stakeholders and the role of specific orchestrators. The aim is to understand why innovations take place in certain places and not in others and which are the contextual conditions and public interventions enabling such innovations to happen in a specific site. The paper tested this framework on four European and one US case studies.

» **Towards a better understanding of firms' R&D and innovation value chains: insights from qualitative and quantitative evidence**
(M. Dosso and P. Ramirez)

This paper examines the partitioning and international configuration of MNE research, development,

and innovation (RDI) value chains using both quantitative and qualitative data from different industries. The way in which MNEs distribute these activities across global networks of actors and places is very different for the various RDI activities, and for different industries.

» **The Machinery Value Chain: mapping for upgrading**
(C. Fróes de Borja Reis)

This paper identifies and maps upgrading opportunities in machinery value chains based on the new structuralist approach taking a demand-side macroeconomics perspective. The study is based on structural and financial/managerial analyses using both quantitative and qualitative data.

» **Productivity growth and global value chain participation in the digital age**
(C. Battiati, C. Jona-Lasinio, and S. Sopranzetti)

This paper explores the linkages between productivity growth and global value chain (GVC) participation taking the extent of ongoing digital transformation at the industry level into account. Using the EU KLEMS and WIOD databases, the authors both compare different countries and different periods (pre-crisis and post-crisis), in particular looking at participation in digital sectors.

Session III

(III A) Industry 4.0

Chair: Kai-Ingo Voigt *(Friedrich-Alexander-Universität Erlangen-Nürnberg, DE)*

Thursday, 26/10:00-11:15

» **How Artificial Intelligence is Shaping Science**
(S. Bianchini, M. Muller, and P. Pelletier)

This paper investigates the diffusion of Deep Learning (DL) in science focusing on Life Sciences and Biomedicine. The authors address the question of whether DL is becoming a ubiquitous scientific instrument for researchers, sooner or later shaping the process of knowledge creation and dissemination. A new approach to differentiating between papers that contribute to DL methodologically from papers using DL is proposed which applies NLP techniques to scientific abstracts.

» **The impact of robots on labour productivity: A panel data approach covering nine industries and 12 countries**
(A. Jungmittag, A. Pesole)

This paper looks at the impact of the intensified use of robots to the growth of labour productivity. This is done by estimates Cobb-Douglas production functions, using data for 12 EU countries and nine manufacturing industries. The empirical results for the models pooling all available data confirm that the intensity of robots on non-ICT capital contributes significantly to labour productivity growth in the period from 1995 to 2015. The analysis is also performed for sub-periods and for different sectors.

» **Competencies for the in-house development of digital innovations in German mechanical engineering companies**
(S. Kinkel)

This paper investigates the extent to which companies in the German mechanical engineering industry are able to independently develop digital products and services and what kind of competencies they need to do this successfully. This is done using a mixed method approach of surveys and expert interviews. The analysis shows how recruitment of relevant specialists is only one of the capabilities required at firm level to appropriate value from digital transformation, the other capabilities being broader cultural aspects of management, internal knowledge management, and the ability to cooperate directly with IT companies.

(III B) Policy for innovation

Chair: Zoltan Csefalvay *(European Commission - JRC, ES)*

Thursday, 26/10:00-11:15

» **Can stimulating demand drive costs down? World War II as a natural experiment**
(F. Lafond, D. Greenwald and D. Farmer)

While learning-by-doing is both theoretically and empirically a well-accepted concept, the estimation of the causal impact of quantity produced in learning is not so clear. Indeed an open issue in the empirical validation of experience curves is the possible inverse causality between demand and costs. This paper

uses the natural experiment of World War II as an exogenous source of demand in specific sectors (ships, aircrafts) to test the direction of causality between cost reduction and increase in demand.

» **Legitimisation and effects of (mission-oriented) transformative innovation policies: A spillover perspective**
(M.J. Janssen)

This paper aims to identify the range of spill-overs relevant in the light of currently unfolding mission-oriented innovation policies. The authors develop a comprehensive framework, linking the various types of spill-overs that may be at play. The framework, which is also illustrated in an empirical setting, offers a basis for reflecting on which dynamics may be expected when encouraging private firms to contribute to the collective exploration of new innovation paths. This analysis allows the authors to distinguish different type of firms involved in public procurement innovations, and the different effects that this has on their innovative performances.

» **Innovation performance and signal effect: Quasi-experimental evidence from European program**
(N. Levratto and A. Quignon)

This paper estimates the effect of R&D grants on innovation performance in Europe by exploiting selection into the SMEI program. To overcome the unconfoundedness bias, the authors compare pre-intervention characteristics of recipient and non-recipient firms by implementing a conditional difference-in-differences design. The authors show that proof of concept grants positively increased patents and the probability of patenting, these effects being greater for older and larger firms, and R&D grants increase capital accumulation and signal the project quality of young firms to early-stage investors.

(III C) Effectiveness of R&D tax credits Chair: Bettina Peters *(Zentrum für Europäische Wirtschaftsforschung, DE)*	Thursday, 26/10:00-11:15

» **Impact of R&D tax incentives on greenfield FDI projects in R&D activities**
(J. Baumgartner and M. Falk)

This paper investigates the impact of tax incentives on R&D and related activities in greenfield FDI projects in European countries. The analysis is based on the Financial Times' Foreign Direct Investment Database for Foreign Greenfield Investments, using data at community level (cities). Preliminary evidence shows that between 20 and 50 per cent of greenfield FDI projects in R&D are in the capital region or the economic centre of a country.

» **Are the results in the tax incentive literature so unambiguous? A meta-regression analysis**
(F. Blandinieres, D. Steinbrenner and B. Weiss)

What do we know about the effects of R&D tax incentives? This meta-analysis aims to improve understanding of the moderating role of the context in which they are implemented by answering to the following questions: a) How do R&D tax credits interact with other innovation policies in a given country? b) To what extent do the characteristics of the R&D tax credits influence the magnitude of the results? Using a FAT-PET-PEESE estimation model to filter out publication bias, the authors confirm the impact of R&D tax credit policies. Moreover, they also show the impact of specific characteristics of R&D tax credits on innovation.

» **R&D tax incentives: heterogeneous effects and the role of policy mix**
(S. Appelt, M. Bajgar, C. Criscuolo and F. Galindo-Rueda)

This paper presents a new approach to the study of the impact of R&D tax credits, which combines the strengths of the macro and the micro approaches. Thanks to a collaboration between the OECD and national experts with access to relevant micro data, it applies harmonised cleaning, statistical, and estimation routines to representative firm-level data on R&D performing firms. The approach allows the authors to provide robust cross-country evidence addressing several questions for which evidence has so far either been non-existent or limited to a small number of country-specific studies.

Session IV

(IV A) Policy challenges Chair: Alessandra Colecchia (*OECD, FR)*	Thursday, 26/11:45-13:15

» **Innovation for Inclusive Structural Change**
(T. Ciarli, M. Savona and J. Thorpe)

This paper proposes the foundations of an analytical framework to identify innovation pathways that lead to inclusive structural change in low and medium-income countries. The authors then apply the framework to the identification of typical trade-offs between inclusion and structural change, and identify policy options to tackle these trade-offs and achieve outcomes of inclusive structural change. Finally, a research agenda is proposed to build on the framework and directly inform policies for inclusive structural change.

» **Back to the future: scoping dynamics in industrial innovation**
(W. Bauer and S. Schimpf)

This paper analyses the history of industrial innovation by using the key action fields of the Fraunhofer R&D Assessment model with the aim of anticipating future developments. An adapted and reduced version of the scenario technique is applied, focussing on the identification of a limited set of the most significant influence factors and consideration of the most probable orientation of potential future developments. This leads to the development of five theses on how innovation will look in the year 2030.

» **Experimental innovation policy**
(A. Bravo-Biosca)

This paper reviews the case for policy experimentation in the field of innovation policy, describes the different types of experiments that can be undertaken, discusses some of the unique challenges to the use of experimental approaches in innovation policy, and summarises some of the lessons emerging, focusing on randomized trials. The paper concludes by describing concrete examples of working with governments across the OECD to help them overcome the barriers to policy experimentation in order to make their policies more impactful.

» **Industrial Innovation in Transition: international findings and national innovation system reform in Finland based on these findings**
(E. Ormala)

The Industrial Innovation in Transition project (IIT) surveyed the innovation practices of companies in Europe, and examined the processes, support tools, and policy instruments used in innovation. The research approached innovation at three inter-connected levels: (1) the practice of innovation management in firms; (2) innovation ecosystems; and (3) the policies and instruments promoting and supporting innovation. The study explored several research themes and the most critical challenges companies are facing. It also makes for cross-country comparisons. This study describes the results of this research and the impact they had on the Finnish innovation system reform in 2018.

(I V B) Intangibles Chair: Michele Cincera *(Université libre de Bruxelles. BE)*	Thursday, 26/11:45-13:15

» **Market Power and Innovation in the Intangible Economy**
(M. De Ridder)

This paper looks at the secular shift in the way that firms produce, which jointly explains three trends that have been central in the recent macroeconomic debate among academics and policy makers: the slowdown of productivity growth, the fall in business dynamism, and the rise of market power. In particular, the author both theoretically and empirically identifies the increase in the use of intangible inputs in production as the main driver of these patterns. The main implication for policy makers is that digitisation, while initially boosting productivity, can be a threat to long-term growth.

» **Concordance and complementarity in IP instruments**
(M. Grazzi, C. Piccardo, and C. Vergari)

This paper investigates whether different IP instruments, namely patents and trademarks, exhibit a complementary effect on firm performance. Furthermore, the authors propose a measurement of the degree of concordance between different categories of patents and trademarks, and assess whether firm

performance is also related to the degree of concordance exhibited by the two sets of IP instruments, patents, and trademarks.

» **Complementarities in capital formation and production across EU member states: tangible and intangible assets**
(P. Goodridge, J. Haskel, A. Thum-Thysen, and P. Voigt)

This paper looks at the relationship between tangible and intangible capital across EU member states. Firstly, based on a sample of 15 European countries, the authors estimated a general translog production function and found evidence of complementarities between tangible and intangible capital and among specific intangible assets. In a second step, at industry-level, the authors estimated elasticities of factor demand and substitution by using (non-farm market industry) data from 11 European countries and the USA but finding only weak evidence for complementarity.

» **A competence perspective on the relation between innovation and firm growth**
(C. Castaldi and M. Dosso)

The main question this paper attempts to answer is: how do top R&D investors leverage product and service competencies to increase sales? The authors characterise firms and their competencies by their degree of tangibility in the continuous range between pure-product and pure-service competencies. Empirically, firm competencies are captured using original trademark-based indicators. Using the EU Industrial R&D Investment Scoreboard as the data source, the authors estimated quantile regressions where the dependent variable was the growth of net sales, and found positive effect for overall market capabilities of firms and for the tangibility of those capabilities.

(IV C) Innovation and employment Chair: Nathalie Greenan *(Centre d'études de l'emploi et du travail, FR)*	Thursday, 26/11:45-13:15

» **Employment Effect of Innovation**
(A. Kancs and B. Siliverstovs)

This paper provides evidence about the innovation-employment nexus by decomposing it according to R&D intensity and by relaxing the linearity assumption. Using a large international firm-level panel data set for OECD countries and employing a flexible semi-parametric method – the generalised propensity score – the authors recover the full functional relationship between the R&D-driven innovation and firm employment. Results confirm that the relationship between innovation and employment involves significant non-linearities responsible for significant differences in employment response to innovation at different R&D intensity levels.

» **The Effects of Product and Process Innovation on Different Types of Employment across the Value Chain: An Empirical Case of Spanish Manufacturing Firms**
(A. Barge-Gila, G. Arenas Díaz, and J. Heijs)

This paper studies the effects of innovation on employment across the value chain. The authors analyse Spanish manufacturing firms in terms of the differential effect of product and process innovation of competitors, providers, and customers on different types of workers (skilled vs unskilled). The main results show that employment is boosted by product innovation of the focal firm and that it is reduced by process innovation by the focal firm. Across the value chain, the authors observe that product innovation by competitors or customers shows a negative effect on employment of the focal firm. However, product innovation from providers increases focal firm employment.

» **Employment effects of innovation and R&D private and public collaboration: the role of knowledge spillovers in Europe**
(L. Aldieri, B. Bruno, L. Senatore, and C.P. Vinci)

The aim of this paper is to explore the role of knowledge spill-overs on leading firms' employment in Europe, especially R&D spill-overs on the total factor productivity (TFP) on the basis of technological proximity. The analysis is based on EU R&D investment scoreboard companies. The empirical results suggest a significant impact of R&D spillovers on firm employment. The results reveal some useful implications for industrial policy strategy as the private sector innovations are derived from public-sector research investments.

» **Firm innovation and wage inequality**

(T. Ciarli, A. Marzucchi, M. Savona (SPRU – University of Sussex Business School, UK), and E. Salgado)

This paper investigates the transmission of firm rents obtained from innovation to workers. In analysing the rent-sharing effect of R&D investment, the authors found that differences in wages can be explained by observable and unobservable characteristics of the employees and the assortative matching between firms and workers. The authors rely on matched employer-employee data for the UK, merged from different sources of data. The results show that R&D expenditure leads to a significant increase in wages. However, this is not evenly spread across occupations: the best paid occupations gain more from R&D investments than low paid ones.

Session V

(V A) Advanced Manufacturing: local and global aspects

Thursday, 26/16:45-18:00

Chair: George Chryssolouris *(University of Patras, GR)*

» **Additive manufacturing and industrial transformation: evidence from the literature** (M. Holmén)

This paper analyses how additive manufacturing is transforming industries. The authors systematically review journal and conference publications that have conceptually and/or empirically contributed to understanding the intersection between AM and company business models. Since AM will arguably affect the micro, meso, and macro levels, the authors will examine the research into how AM affects firms, industries, and the wider economy from visionary, emerging, and factual perspectives.

» **Regional diversification patterns and key enabling technologies (KETs) in Italian regions** (R. Antonietti and S. Montresor)

This paper investigates the determinants of related vs. unrelated regional diversification by addressing two aspects neglected in the literature: the socio-technical development of the sectors in which regions specialize and diversify, and the 'complementarity' between existing local activities through whose combination new techno-economic ones can emerge. The authors claim that once these neglected aspects have been placed at the centre of the debate, the role of KETs becomes crucial. This is tested empirically by looking at the technological portfolio of Italian regions.

» **Dual use inventions: specialisation or hybridisation?** (F. Caviggioli, A. De Marco, G. Scellato, P. Gkotsis, and A. Vezzani)

Military patents are identified in this paper by implementing a novel methodology based on patent data. The authors define dual use cases based on citations flowing from civil to military patents. In other words, dual-use cases can be seen as a measure of the knowledge spill-overs from military to civil applications. The empirical analysis identifies the characteristics of military patents in terms of technological complexity, quality, and geographical scope, which feed subsequent civil applications, and the difference between dual use patents and non-dual use patents. Overall, the authors find important differences in terms of both dual and non-dual use patents and in different National Innovation Systems.

(V B) Sustainability

Thursday, 26/16:45-18:00

Chair: Claudia Ghisetti *(Catholic University of Milan, IT)*

» **Industrial Innovation Analysis and Evaluation Towards Industrial Symbiosis application in the Circular Economy Transformation** (M. Demartini, F. Bertani, F.Barberis, M. Raberto, S.Cincotti, and F. Tonelli)

In this paper, a hybrid Agent Based-System Dynamics modelling captures the complexity of interactions between industry, resources, and policy. It focuses on modelling industrial symbiosis (IS) processes (i.e. the ability of one industry to imitate another) and effects on the transition towards a zero-waste economy. The model developed accounts for different firms each purchasing raw materials for production and waste generation. Results show that industrial symbiosis lies at the core of the positive feedback loop which supporting transition towards a zero-waste economy.

» **Understanding the EU's Regional Potential in Low-Carbon Technologies** (E. Bergamini, T. Linta, D. Tokuyama and G. Zachmann)

This paper explores the regional dimension of technological specialisation in order to estimate the potential for low-carbon technologies inside European countries. In particular, it investigates the policy, labour market, and institutional aspects that might lead regions to create, realise, and exploit this

potential. The role of European public funds for R&I in the European context is also explored. From a methodological point of view, innovation activity is approximated by the number of patents filed in a specific patent category in a region, transformed into measurements of Revealed Technological Advantage.

» **Employment effects of sustainable transport – A scenario analysis for Germany using input-output modelling**
(L. Sievers and A. Grimm)

This paper uses an input-output analysis to examine the employment effects along the complete supply-chain of all directly and indirectly affected industries. The aim of the paper is to identify which direct and indirect employment effects can be expected for Germany in 2035 from changes in the demand for transformed transport as a result of environmental sustainability needs. The research question is answered for two scenarios in 2035, one oriented towards the electrification of road-bound traffic, and the other oriented towards multi-modal transportation. Lastly, the results of this experiment are compared with other changes expected in employment due to automation and demographic effects in order to discuss the possible impact on policy of the mobility industry transition.

Session VI

(VI A) Skills

Friday, 27/09:50 – 11:00

Chair: Enrique Fernandez-Macias *(European Commission, JRC. ES)*

» **Innovation and inequality. A Schumpeterian look at the skill premium**
(L. Cattani, G. Guidetti, R.Leoncini)

The paper approaches the role of technological change in producing inequality. To task the authors use Schumpeter's insights to understand the relationship between technological change and inequality in two respects. First of all, considering how the diffusion or the knowledge incorporated in R&D should slowly reduce the impact of knowledge polarization on inequality. On the other hand, a Schumpeter Mark II model can help in better understand the relationships between Patents and inequality. These two hypothesis will be tested empirically on a sample of 9 countries for 15 years.

» **Does Targeting R&D Grants towards SMEs Increase Employment and Demand for Skilled Labour?**
(S.-O. Daunfeldt, D. Halvarsson, P. Gustavsson Tingvall, and A. McKelvie)

This paper aims to measure the effectiveness of targeted R&D grants among growth-oriented SMEs in terms of influencing labour demand from firms. Because selective grants are designed to target specific firms, any effects on the outcome of the targeted firms observed can equally well be a result of the selection process. In contrast to previous studies, the authors tackle this issue by using Coarsened Exact Matching to construct a control group from longitudinal data on the full population of Swedish firms. The authors found no robust evidence that the government firm support programs had any positive and statistically significant effects on the number of employees brought into these growth-oriented firms. In addition, there is no robust evidence of the grants having an impact on the skill composition of the labour force (relative demand for skills).

» **Innovation intensity and skills in firms across five European countries**
(M. Falk and E. Hagsten)

This paper attempts to establish the importance of specific skills for innovation intensity (expenditures) in firms by using linked and comparable official firm-level data for a group of five European countries. This contrasts with previous analyses of R&D intensity because specific kinds of firms can be discriminated. Pooled ordinary least squares (OLS) estimations show a strong significantly positive relationship between the innovation expenditures ratio and human capital, but the results are very heterogeneous between countries.

(VI B) Firm dynamics and barriers

Friday, 27/09:50 – 11:00

Chair: Maria Savona *(University of Sussex, UK)*

» **Intangible investments and productivity performance**
(M. Cincera, J. Delanote, P. Mohnen, A. Santos and , Weiss)

The paper compares the effect of different types of intangible investments (R&D expenditures, ICT activities, employees training and improvement of the organisational process) on productivity and analyses the obstacles to such investment that firms face in several dimensions. The analysis uses survey data from EIBIS and is based on a modified CDM approach to tackle the endogeneity of the various steps of the investment process. The results show relevant differences across sectors and countries.

» **Financial constraints and intangible investments: Deterring or revealed barriers to engaging in innovation?**
(S. Montresor and A. Vezzani)

This paper investigates the extent to which financial constraints hamper the firms' investment in intangibles as a way of engaging in innovation. Acknowledging the distinction that should be kept between non-innovators and innovators, in particular with respect to the role of financial barriers, and the distinction between different types of intangibles, the authors estimate two sets of Multivariate Probit Models (MPM) – for innovative and non-innovative firms' investments. Results show that financial barriers are both deterring and only revealed for intangibles that are inherently innovative and organisational. On the other hand, financial barriers to other intangibles are either only deterring or only revealed, if not even absent.

» **Landmarks as lighthouses: innovation by firms and exit routes during the crisis**
(E. Cefis, A. Coad and A. Lucini-Paioni)

This paper investigates the relationship between innovation and survival of firms. The authors investigate the effects of time-varying innovative behaviours of firms on both the instantaneous hazard and the total (cumulative) probability to exit the market. Different innovative activities by firms over time are related to exit routes using several innovation indicators in the context of a landmark analysis, measuring these effects in a punctuated way rather than reporting "average" effects over the period of analysis. The authors also use Cumulative Incidence Functions to plot the cumulative probability of exit in the case of competing risks. Innovation in terms of product and process generally has a negative effect on the probability of exit (in particular, via acquisitions and by closure) while organisational and marketing innovation generally have a positive effect.

(VI C) Patents and technology transfer Chair: Petros Gkotsis *(European Commission, JRC. ES)*	Friday, 27/09:50 – 11:00

» **Patent Transfers and Patent Citations**
(L. Ciaramella, F. Gaessler, D. Harhoff, and B.H. Hall)

The aim of this paper is to investigate the effect of international patent transfers on patent citations in the country of initial ownership and in the country of new ownership. The aim is to provide an understanding of knowledge diffusion generated by patent transfer as well as of the strategic corporate behaviours associated with it. For each patent transferred, the authors create a benchmark of "control" non-transferred patents. The econometric model employed controls for the diffusion and the obsolescence of the focal technology, and tackles the issue of inverse causality by using the patent box in the country as an instrument for patent transfer.

» **The prevalence of NIH-funded research in commercial products**
(G. De Rassenfosse, E. Raitani)

This paper explores the prevalence of NIH-funded research in commercial products using a novel method. We find that more than half of commercial products by biotechnology and pharmaceutical firms, and 12 percent by medical device firms, exploit NIH-funded research. Products that are commercialized by smaller firms are more likely to involve direct NIH-funded research. Finally, science takes more than 20 years to translate into commercial products. Our method can be adopted to study the role of government funding in products across a range of industries.

» **The Micro-Foundations of Catch-up. Evidence from European Patent Data for South Korean and Chinese Firms**
(B. Ebersberger, M. Feit, and H. Mengis)

International collaborations and international knowledge flows are considered to be sources of technological catch-up for developing and emerging countries. This paper examines this empirically by examining how international knowledge flows affect the quality of patents in Chinese and Korean firms. The authors consider co-invention by Chinese and Korean firms with both developed and emerging

countries, thereby also exploring the under-investigated topic of co-invention between emerging countries.

Session VII

(VII A) R&D subsidies

Friday, 27/11:15 – 12:20

Chair: Hanna Hottenrott *(Technical University of Munich, DE)*

» **R&D Subsidies and Debt Financing of Firms**
(A. Bellucci, L. Pennacchio, and A. Zazzaro)

This paper explores the effects of public subsidies for R&D projects on total amount, composition, and cost of debt of recipient firms for firms not receiving public subsidies. The analysis uses data from a subsidy program running in the Marche region of Italy in the period 2005–2012. The estimation strategy uses a difference-in-differences approach, combined with matching methods to select control groups of (similar) firms not receiving subsidies. The analysis shows that R&D subsidies did not affect the overall level of indebtedness of recipient firms in either the short or medium term. However, subsidies allowed firms (i) to modify the structure of their debt towards long-term financing; (ii) to increase banking debt; and (iii) to reduce the average cost of debt.

» **Funding breakthrough innovation: evidence from a regression discontinuity**
(A. Mina, P. Santoleri, I. Martelli, and A. Di Minin)

This papers looks at the impact of R&D subsidies (focusing on the SME instrument) on a wide range of firm activities (i.e. firm-level innovation outputs, balance-sheet variables, survival likelihood, and external financing), providing novel evidence exploiting a quasi-experimental identification strategy. The authors adopt a sharp regression discontinuity design (RDD) which correctly identifies the effect of the policy. In fact, the SME Instrument establishes that only projects scoring above a certain level on an assessment by a panel of external independent experts would be subsidised. This study is therefore able to provide a coherent characterization of the impact of the studied R&D subsidy in many respects, also providing heterogeneous results for the various phases of the subsidy instruments analysed.

» **Effectiveness and Efficacy of R&D Subsidies: Estimating Treatment Effects with One-sided Noncompliance**
(P. Böing and B. Peters)

This study addresses the role of R&D subsidies tackling two possible biases: selection bias and the effect of misappropriation of R&D subsidies. The authors show that this issue can be consistently estimated by the intention-to-treat (ITT) effect and the complier average causal effect (CACE), once the first ITT estimation has been corrected by entropy balancing to address the selection issue and simulate a quasi-experimental scenario. Interestingly, this framework allows the investigation of the consequences of such noncompliant behaviour on the effectiveness of R&D policy in stimulating firms' R&D expenditures. The analysis uses Chinese firm-level data for the period 2001-2011. The study confirms the anecdotal evidence of substantial misappropriation of R&D subsidies in China, with an estimated 42% of funds being misappropriated.

(VII B) Green technologies

Friday, 27/11:15 – 12:20

Chair: Ester Martínez-Ros *(Universidad Carlos III de Madrid, ES)*

» **Predicting innovation dynamics in the technological ecosystem**
(A. Pichler, F. Lafond, and J. Doyne Farmer)

This paper examines literature on technology networks and innovation dynamics. By using the whole record of US patents from 1836 to 2017, the authors show strong empirical evidence of innovation growth synchronization in the presence of network linkages. Following this empirical result, the authors propose a simple model of network-dependent knowledge production which is able to explain the observed empirical pattern. Finally, the authors test this insight by making out-of-sample predictions and hen use the validated framework to predict future innovation rates in green energy technologies.

» **Sustainable energy transition and policy mix design in the European Union: a trade-based supply value chain approach**

(V. Costantini and E. Paglialunga)

This paper looks at which policy mix is able to foster a sustainable energy transition and jointly ensure benefits for international competitiveness, focusing on the specific domain of energy efficiency in the residential sector. The paper simultaneous considers policy regulation, technological trajectories, and international relationships and spill-overs. This is achieved by developing an econometric model that jointly allows the domestic and foreign influence to be considered in a temporal dynamic structure. The model is tested using data from various sources (trade, patents, R&D expenses, IEA Energy Efficiency Policy, and Measure, tax and price rates). After examining all the possible links, the authors suggest that taking a "transition approach" would help in understanding the coevolution and mutual influences between the energy, innovation, and policy-mix systems.

» **Design and innovation: Does the "green-matching" actually help?**
(C. Ghisetti, S. Montresor and A. Vezzani)

The authors of this paper investigate causal linkages between design investment and green technologies. They then examine whether there is a significant difference in this effect between green technologies and other technologies. Is the effect design exerts on green technologies nothing more than the effect it would display on (standard) innovations? The authors use a sample of top corporate R&D investing firms from the EC-JRC/OECD COR&DIP© database to address the issue.

(VII C) Social return of technological change

Friday, 27/11:15 – 12:20

Chair: Mafini Dosso *(European Commission, JRC. ES)*

» **Innovation, Structural Change, and Inclusion. A Cross Country PVAR Analysis**
(A. Saha and T. Ciarli)

This paper looks at the three-way relationships between innovation, structural change, and inclusion. Given the multidimensionality of each (innovation, structural change, and inclusion), the authors extract the underlying unobserved common factor structure from various well-known macro indicators. Using a structural vector auto regression (SVAR) model for a short panel of developing countries over 13 years, the authors firstly confirm the virtuous cycle between innovation and structural change and then find a positive effect by inclusion on both innovation and structural change. In decomposing the innovation index (formal, firm-level, and ICT), the authors find each relates to both structural change and inclusion differently.

» **Threats and opportunities in the digital era: automation spikes, trade, and employment dynamics**
(G. Domini, M. Grazzi, D. Moschella, and T. Treibich)

This paper investigates how trade activities and investment in automation technologies impact on job creation and destruction within firms and across occupations. Using international trade data and employer-employee data from French manufacturing employers, the authors show how exporting and importing activity by firms affects their growth path and how such patterns are affected by imports of intermediates embedding automation technologies. The results show that net employment growth is systematically higher for trading than for non-trading firms, and that hiring rates and separation rates are systematically lower. Automation spikes correlate positively with preceding and contemporaneous growth in employment across skill categories.

» **Technological innovation and local labour markets: A complex system analysis**
(A. Sbardella, L. Napolitano, and E. Pugliese)

Complex network techniques are used in this paper to propose an empirical strategy to study the exposure of US local labour markets to technological innovation, focusing on the impact of different new technologies on local wage and employment levels. The authors look at which industrial sectors lose or gain in terms of employment and wage levels in a county in a year after a technology has been developed and patented in that same area in a previous year. The signal is filtered through the noise using an algorithm that looks for correlations larger than expected at random considering the characteristics of the network. This defines a taxonomy of industrial sectors based on the impact of the technological classes that have a significant (positive or negative) impact on the wage or employment levels of each industrial sector.

Appendix 2 – Innovation for industrial transformation: the challenges for the EU policy agenda – some examples

The European Union identified a number of challenges facing the EU and ones it will face in the future on the subject of the CONCORDi 2019. Some key challenges are introduced below in chronological order:

- "**A vision for European Industry until 2030**" (Final report of the Industry 2030 high-level industrial roundtable –23 August, 2019 https://ec.europa.eu/growth/industry/policy/industry-2030_en#vision2030): "In 2030, European industry will be a global leader that will responsibly deliver value for society, the environment, and the economy". To achieve such vision there are three strategic imperatives for the EU's industrial policy:

  1. Manage a fast and inclusive transformation: joint effort by industry and the public sector using new models of cooperation to address the big societal challenges, paving the way to EU industry's worldwide leadership in new clean technologies; support for its continued digitalisation and transformation to a climate-neutral, resource efficient circular economy by 2050 – across industrial actors of all sizes, in all sectors and value chains; invest in ambitious RDI and technological infrastructures; ensure that the transformation is systemic and socially and geographically inclusive.

  2. Champion global competitiveness: complete and enforce the Single Market to benefit from a continent-wide market, including a swifter process for the timely availability of harmonised standards; remove barriers for the cross border uptake of new technologies; consolidate and safeguard an EU framework that effectively addresses concerns about global competitiveness in industrial sectors and strategic value chains; promote a fair global level playing field for investment, safeguard a fair, rule-based trade order, and pursue ambitious trade and investment negotiations with key trading partners; take a more proactive stance to defend EU interests in competition with China; make a clear statement on the importance of international competitiveness of industry and act accordingly, including supporting SMEs, in order to be a global leader.

  3. Address social inclusiveness, values, and governance: establish policies that address social inclusiveness and the EU's core values as drivers of growth and of successful industrial transformation; ensure that all students and workers have the opportunity to acquire the skills they will need in the future and support those that risk being left behind by structural change; encourage collaborative approaches; establish governance mechanisms and targets to integrate industrial policy considerations in other policies across all EU strategic initiatives; align innovation policies at all levels (EU/MS/regions) in a united Europe; maintain and create quality jobs in industry, including by supporting SMEs in identifying their skill needs, developing training schemes, and allocating more EU funds for this goal.

  The following are challenges and opportunities identified in the "Industry 2030" Final Report document:

  a. *Global geo-political and economic development*: "Traditional patterns of economic and social interaction are being challenged by global developments such as global power shifts, security threats by non-state actors and rogue states, the questioning of multilateralism by some international partners, rising protectionism, and climate change. Now more than ever, Europe should adopt a positive, forward-looking stance, act as a leader and role model and seek ways of influencing the global development in the right direction"

  b. *Scientific and technological developments:* "The EU is facing demographical challenges, including the ageing of its population and the consequences of migration. We are also facing challenges related to technological change, and urgently need to change our approach to skills. Moreover, the speedy transformation of industry is changing the future of work rapidly".

  c. *Social and societal developments:* "The EU is facing demographical challenges, including the ageing of its population and the consequences of migration. We are also facing challenges related to technological change, and urgently need to change our approach to skills. Moreover, the speedy transformation of industry is changing the future of work rapidly".

d. *Climate change and other environmental challenges*: "…… Climate, energy, raw materials, and bio-economy policies are key areas considered to be essential for the future of EU industry in terms of challenges and opportunities. They need to go hand in hand with industrial policy and a societal dialogue on what emission reduction and other environmental policies mean in terms of costs, benefits, and behavioural changes for everyone. …….".

- "Horizon Europe - Investing to shape our future (information as of August 2019) - "Implementing Horizon Europe - strategic planning": The strategic planning process will specifically focus on the Global Challenges and European Industrial Competitiveness pillar of Horizon Europe. It will also cover the Widening Participation and Strengthening the European Research Area part of the programme as well as relevant activities in other pillars. Among other things, the process will identify: key areas for research and innovation support and their targeted impact; European partnerships; missions; and areas of international cooperation.
One the three pillars proposed for the implementation of Horizon Europe is on *Global Challenges and European Industrial Competitiveness* (Pillar 2). It is proposed that this Pillar will also include the following areas: Health, Culture, Creativity, and Inclusive Society; Civil Security for Society; Digital, Industry, and Space; Climate, and Mobility; Food; Bioeconomy; Natural Resources, Agriculture, and the Environment.
https://ec.europa.eu/info/sites/info/files/research_and_innovation/strategy_on_research_and_innovation/presentations/horizon_europe_en_investing_to_shape_our_future.pdf

- "A Union that strives for more - My agenda for Europe" - By candidate for President of the European Commission Ursula von der Leyen: POLITICAL GUIDELINES FOR THE NEXT EUROPEAN COMMISSION 2019-2024 (16 July 2019). Following the May 2019 European elections and the political guidelines of the Commission president candidate elect Ursula von der Leyen stating that Europe will become the first climate neutral continent and presenting the Sustainable Europe Investment Plan which will support €1 trillion of investment over the next decade together with a more ambitious European Union's emission reduction target for 2030 towards 55%. The Political Guidelines focus on six headline ambitions for Europe over the next five years and well beyond:

- A European Green Deal
- An economy that works for people
- An Europe fit for the digital age
- Protecting our European way of life
- A stronger Europe in the world
- A new push for European democracy

https://ec.europa.eu/commission/sites/beta-political/files/political-guidelines-next-commission_en.pdf

- "Building Europe's sustainable future" – The Directorate-General for Research and Innovation of the European Commission (June 2019). This recent strategic document indicates the new way to develop policies and projects to allow the European Commission to tackle global challenges. One of the chapters of the document is about "Research and Innovation (R&I) a compass for the future we want". In it, there is a call for EU to act to attain "The European Leadership in R&I", do much better in transforming the excellent quality of scientific and Technological research, towards "R&I for Sustainable Development", to make Horizon Europe" / The EU Framework Programmes for R&I the most ambitious R&I programme in order to support the EU's transition towards an innovation-led sustainable economy; and through rely on "The European Research Area (ERA)" act as policy counterpart of the Framework Programmes and to serve strengthen the impact of these investments.

- EU budget 2020: The proposal of the European Commission (5 June 2019). The proposal focuses on jobs, growth, and security As per the proposal, the money under the 2020 budget (€168.3 billion) will go to the following priority areas: 1. competitive economy and young people; 2. and strengthening security and solidarity in the EU; 3. climate change (21% of the overall budget) and beyond.
http://europa.eu/rapid/press-release_IP-19-2809_en.htm

Concerning the first of the three priority areas, investing in a competitive economy and young people**,** more than €83 billion in commitments will boost economic growth and European regions, and will support young people. Of this money:

- €13.2 billion for *research and innovation across Europe under Horizon 2020* – the biggest and final tranche of the EU research and innovation programme (+6.4% compared to 2019) – including the final pilot phase of the European Innovation Council to support top-class innovators, small companies, and scientists with the potential to scale up rapidly in Europe and globally;
- €2.8 billion for *education* under Erasmus+;
- €117 million for the *Youth Employment Initiative* (YEI) to support young people living in regions where youth unemployment is high (total funding for YEI between 2014 and 2020: €4.5 billion);
- €1.2 billion (+75% compared to 2019) for Europe's *own global satellite navigation system Galileo* – to enable it to continue expanding its market uptake from the current 700 million users around the world to reach 1.2 billion by the end of 2020.;
- €255 million for the *European Defence Industrial Development Programme* (EDIDP) to incentivise European companies to work together to develop defence products and technology. The EDIDP allows defence cooperation at EU level to be tested under this budget period until a fully-fledged European Defence Fund is in place as of 2021.

- **2019 Semester recommendations for Research and Innovation** - European Commission. Chapeau Communication (5 June, 2019) https://rio.jrc.ec.europa.eu/en/file/12741/download?token=6P0lrMGU

"The weaknesses in global growth reinforce the need to continuously tackle the structural challenges of EU economies. Stronger reform implementation and prioritisation of reforms are crucial to strengthening the resilience and growth potential of our economies in view of the mounting economic risks and uncertainty. This includes increasing the impact and scale of innovation and ensuring the quality and labour market relevance of skills (…)"

"While not all investment needs can be addressed by EU funds, these provide considerable opportunities to address the concrete investment gaps identified in the country-specific recommendations. With the more effective policy link between the European Semester and EU funding for 2021-2027 set out in the Commission's proposals for the next EU multiannual financial framework, EU financial programmes like InvestEU, Connecting Europe Facility, Horizon Europe, and Cohesion Policy Funds provide significant opportunities."

"While the fundamentals have significantly improved in recent years, we need to continue improving the resilience and growth potential of the European economy (…) Promoting and protecting investment in education and skills, quality infrastructure, and innovation will simultaneously strengthen the growth potential of our economies and support aggregate demand. (…)"

"The overall objective of the recommendations is to encourage the Member States to increase their growth potential by modernising their economies and further strengthening their resilience. Given the expected slowdown, all Member States should prioritise reforms aiming at sustainable and inclusive growth. Moreover, the increasingly digitalised and globalised economies require smarter investments in relevant infrastructure, innovation, education, and skills (…)"

"Efficient public administrations and continued efforts to lower administrative burden support the competitiveness of European firms. Administrative burden remains a drag on investment, innovation, and company growth. In particular, smaller and highly innovative companies struggle most with the burden and inefficiencies of public administration. Recommendations for burden reduction and improving various aspects of efficiency and quality of public administration, notably to improve the efficiency of public procurement, have for example been issued this year to Belgium, Cyprus, Croatia, the Czech Republic, Hungary, Latvia, Poland, Portugal, Romania, Slovakia, Slovenia, and Spain (…)"

"Skills shortages and mismatches can be major investment obstacles. From this point of view, investment in people is a key complement to investment in innovation, research, and infrastructure, offering positive returns in terms of human capital, a more employable labour force, and stronger social cohesion (…)"

"Strengthening research and innovation activities are key to Europe's growth. There is significant scope in many Member States and regions to reinforce the cooperation ties between businesses (notably small and medium-sized enterprises), academia, research, and public sector actors. Public support for breakthrough innovations and for the creation and scale up of high growth firms, alongside sound framework conditions for business research and development, creates market opportunities and raises the innovation capacity of the economy."

"Capital investment needs vary across Member States. Fixed capital investments are needed in sectors, regions, and countries for the upgrading of production capacities. This particularly applies to laggard regions in continuing with their catching up process. In addition, advanced regions and sectors such as the automobile sector, need investment to speed up technological changes so that they can face new challenges. Investments in intangible capital are particularly necessary across the board to facilitate the adoption of new technologies."

- **"Europe in May 2019" -** Preparing for a more united, stronger, and more democratic Union in an increasingly uncertain world" (Source: European Commission, 2019: https://ec.europa.eu/commission/files/europe-may-2019-preparing-more-united-stronger-and-more-democratic-union-increasingly-uncertain-world_en)

1. *Digitalisation and new technologies* will revolutionise the way we live and work. New opportunities will emerge, in particular in the areas of health, mobility, industry, and science. They hold major potential for Europe's future competitiveness and growth. At the same time, digitalisation entails risks, particularly in its widening of the digital skills gaps and its deepening of social and regional divides within Europe.

2. *Climate change and environment***.** The impact of climate change is becoming increasingly visible with growing risks for global prosperity, sustained standards of living, and security. The clamour for action from Europe and across the world is growing louder by the day, with the impact of climate change and the measures taken to address it being increasingly felt by everybody in their daily lives. This requires determined but fair and balanced policy measures.

3. *Demography and society*. The effects of demographic change will be the root cause for some of the most predictable challenges the EU will face in the medium-term. Thanks to the high quality of life and overall wellbeing, the life expectancy of Europeans continues to increase. By 2030, Europe will become the first continent with a median age of about 45. While longer life expectancy also puts pressure on health care and welfare systems, it raises unprecedented issues in terms of inter-generational fairness and will have a lasting impact on our societies as a whole. At the same time, an overall lower birth rate is likely to cause the EU population to decline by 2050.

4. *An increasingly multipolar world*. Europe and the rest of the world are facing an increasingly complex and volatile security environment. New powers are seeking their place on the global stage, while existing powers are withdrawing or even disrupting the rules-based international system. The multilateral and rules-based global order is under severe strain at a time when it is needed more than ever. Economic competition is also increasing in the EU's neighbourhood, Africa, and across the globe. As primary resources become increasingly scarce, competition for those resources, fresh water, and food in particular, is likely to intensify and amplify security threats. Social and economic fragility around the world caused by national governments' inability or unwillingness to provide basic services or social equality, further fuel instability and security threats. In this rapidly changing global landscape, Europe and Africa in particular have much to gain from increased economic and political ties.

- **"The EU industrial policy after Siemens-Alstom"** (European Political Strategy Centre of the European Commission; March, 2019 - https://ec.europa.eu/epsc/sites/epsc/files/epsc_industrial-policy.pdf

***1**. The bigger picture:* a) Technology disruption transforming industry; b) Scale: Europe's biggest challenge? c) The rapid rise of the east (plus China playing outside the rules).

***2**. Levelling the Global playing field*: a) Making the world trade organisation fit for the purpose; b) Growing the EU's arsenal of defensive tools; c) Shifting into offensive gear: Beefing up reciprocal market access and building up leverage.

***3.** Industrial leadership starts at home*: a) the single market renaissance; b) Innovation & funding: Fast-tracking investments into the sectors of the future; c) Regulation & Standards: Building up 'Brand Europe'; d) Partnerships for the future.

- **Ten issues to watch in 2019** (European Parliament, 2019).Three clusters of challenge: **1.** *The institutional cluster*: i) 'A new European Parliament – A new European Commission', ii) 'The way forward' for a Union of 27 Member States, and iii) the 'Future financing of the Union'. **2**. *The geopolitical cluster*: a. Africa – The 'twin continent'; b. Trade war(s); c. Internal security; d. Towards a policy for the oceans; e. From artificial intelligence to collective intelligence; f. Electric mobility; g. Digital transformation**. 3.** *The technological cluster*: i. 'From artificial intelligence to collective intelligence', ii. 'Electric mobility', and iii. 'Digital transformation'. Source: http://www.europarl.europa.eu/RegData/etudes/IDAN/2019/630352/EPRS_IDA(2019)630352_EN.pdf

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