



# THE PRODUCTIVITY CHALLENGE

Jobs and incomes  
in the dawning era  
of intelligent robots

FELLOWSHIP INITIATIVE 2018-19



# GOING GREY, GREEN & DIGITAL

## In need of inclusive productivity growth

The jury is still out on two competing views on medium- to longer-term future trends of productivity growth. The more pessimistic view exemplified by Bob Gordon holds that the inventions of the future are unlikely to be as revolutionary as those of the “special century” from 1870 to 1970, a thesis probably well summarised in a modification of Robert Solow’s 1987 quip, “You can see (the computer age) intelligent robots everywhere but in the productivity statistics”. Indeed, the observed trend deterioration of productivity growth in many advanced economies lends support to this view. Europe, in particular, has suffered from rather anaemic productivity growth already well before the crisis.

The technology-optimists, on the other hand, argue that the world is undergoing a technological revolution of a scale, speed and complexity that is unprecedented. In the ‘intelligent robots’ view of the next ten or twenty years, machine learning will allow many jobs or tasks to be automated; from driving taxis to diagnosing disease and from cashiers to translators. It is not just about AI, but also about the pervasive impact of digitalisation and automation on production structures, in not only manufacturing, and economic activity in general. According to this view, both the scope and pace of the current technological revolution are likely to be at least as great as any that has gone before.

What both scenarios have in common is that they will be associated with fundamental changes to the world of work, employment patterns, income generation and its functional and personal distribution, and the welfare systems as we know them. However, economic history suggests that in all likelihood the technological revolution outlook is ultimately a more positive one than that of low innovation and persistent low growth. Obviously, a big wave of automation could be very disruptive and have significant downsides, especially if many

professions are affected at the same time. Lower employment does not necessarily follow, but it is a serious concern. Reskilling is not always possible, and our out-of-work benefits systems may not be fit for purpose. Moreover, if wealth ownership is very unequal (as it is), and capital poorly taxed (as it is), then inequality could rise further unless policy changes. Still, at the risk of oversimplifying, questions of distribution are perhaps easier to address in an environment of dynamic economic activity – provided there is political will – than the nasty distributional consequences that tend to arise in the absence of growth.

Against that backdrop, DG ECFIN’s fellowship initiative 2018-19 has solicited contributions reassessing Europe’s productivity challenge at the current juncture. In view of possible hysteresis effects after the crisis and in the general context of ageing populations and globalisation, the aim has been to re-examine the ongoing trends and drivers and to identify policies to tap fully the potential for inclusive productivity growth. In total, eight fellowships have been awarded to prominent scholars in the field to interact with staff in ECFIN and other Commission colleagues, and to prepare final reports on specific research questions within this general topic. In the weeks to come, these reports will be published on line in the DG ECFIN’s Discussion Paper series. We hope that the overview provided below will serve as a teaser to interested readers.

### **Mary Veronica TOVSAK PLETESKI**

Director “Investment, growth and structural reforms”  
Directorate-general for economic and financial  
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# FROM NEW TECHNOLOGY TO PRODUCTIVITY



**Eric J. BARTELSMAN**

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This paper reviews briefly the scientific literature on new technologies and future trends and on how and why the technologies may affect production, labour relations, and living conditions. Recent evidence points towards a slowing of productivity growth and a growing sense of unease in EU households concerning the impact of future economic developments. The paper argues that new digital technologies not only have the potential to change economic interactions, but also change the framework needed by economists to analyse the supply side of the economy. With appropriate policies, the technological advances can continue apace and will translate into productivity growth, so that households can contribute to and benefit from the new goods and services that the future economy will produce.

**“We would like to conclude this paper with the data-driven prediction that productivity growth will come in at 2.5 percent per year, on average, for the next 30 years, leading to a doubling of well-being in the next generation. But we cannot. Time-series extrapolations of the past 30 years of labor productivity growth data gives no reason for such optimism. (...) Nonetheless, there are some positive stories concerning time lags between the introduction of new technology and the productivity effects that would point towards a sharp uptick in productivity growth in the not too distant future. Balancing this, there are some negative observations of market imperfections, possibly brought on by the new technologies themselves that do not portend well for future productivity.”**

# PRODUCTIVITY AND INNOVATION COMPETENCIES IN THE MIDST OF THE DIGITAL TRANSFORMATION AGE: AN EU-US COMPARISON



**Bart VAN ARK** <sup>1,2</sup> **Klaas DE VRIES** <sup>1</sup> **Abdul ERUMBAN** <sup>1,2</sup>

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This paper reviews the latest evidence on productivity growth by industry and innovation competencies by occupation to observe whether, beneath the productivity slowdown of the past decade in both the European Union and the United States, signs can be detected of structural performance improvements due to digital transformation.

We find that in the US, the digital-producing sector has continued to contribute strongly to aggregate productivity in recent years. While labour productivity growth in the US was only 0.6 percent from 2013-2017, as much as 0.5 percentage point (or 86 percent) was coming from digital-producing industries representing only 8.2 percent of US GDP. Other industries, which account for the remaining 92 percent of the US economy, including some of the most digital intensive-using industries, have seen a dramatic decline in their contribution to productivity growth. In the EU, the digital-producing sector has seen a strong decline in its contribution to productivity growth, which by 2013-2017 was only one third of the US contribution at 0.15 percentage points. However, the most digital intensive-using industries

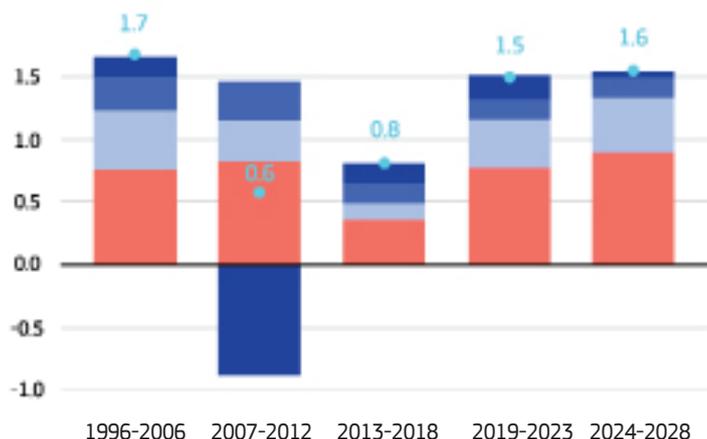
contributed 4 times as much to labour productivity as in the US driving overall labour productivity growth from 2013-2017 up to 0.9 percentage point – 0.3 percentage points higher than in the US. A positive factor, both in the EU and in the US, is that total factor productivity (TFP) growth in the most intensive digital-producing industries, notably trade and business services has improved. Digital intensive-using manufacturing industries generally contribute less to productivity than digital intensive-using services, partly because of slower productivity growth and partly because of their smaller size. A novel measure of innovation competencies by occupation shows that, when applied to industries, those industries with the highest competencies also show positive productivity contributions, and the most intensive digital-using industries are strongly represented in this category. Overall, while the evidence is still thin due to time lags in the data, there are signs of positive contributions to productivity growth related to digital transformation even though those effects are still not widespread observable across the economy.

## GROWTH ACCOUNTING PROJECTIONS, 1996-2028

- TFP
- Labor Quality
- Capital Quality
- Capital Quantity
- Labor Productivity

Note: Europe including EU-28 plus Iceland, Norway and Switzerland.

Source: The Conference Board Global Economic Outlook, November 2018.



# THE AUTOMATISATION CHALLENGE MEETS THE DEMOGRAPHIC CHALLENGE: IN NEED OF HIGHER PRODUCTIVITY GROWTH



**Sandra LEITNER & Robert STEHRER**

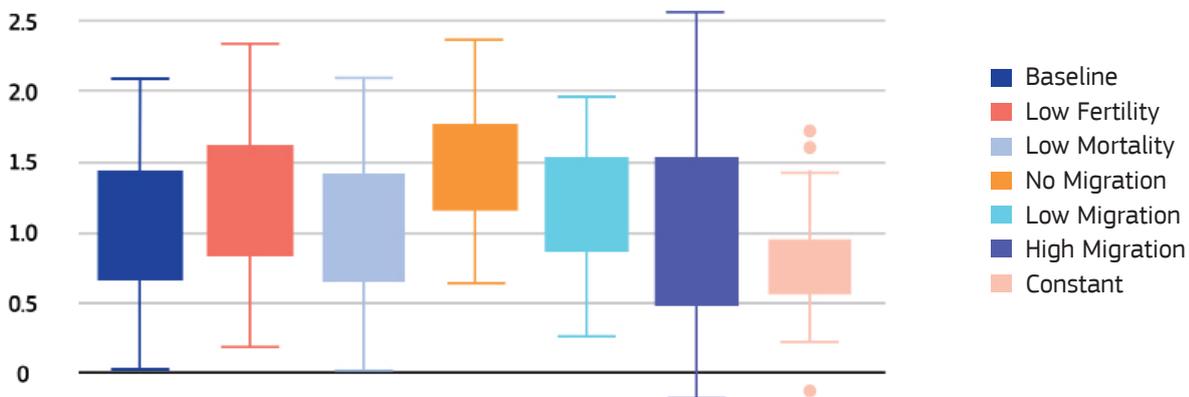
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The future of employment and labour demand growth in the dawning era of intelligent robots and other new technologies is heavily debated. This paper argues that this discussion needs to be complemented by a second trend that has been unfolding in Europe for some time, namely the demographic decline. Various demographic scenarios for many EU countries point towards a significant decline in the working-age population in the near future, which puts the functioning of labour markets at risk as labour shortages become increasingly more likely and subsequently threaten economic growth.

In this context, this paper gives an overview of recent trends in the growth of real value added, labour productivity and employment as well as of

demographic scenarios. Based on these trends, the hypothetical increase of labour productivity growth, which would be required to keep real GDP growth at its current level, despite the projected reduction in the workforce, is calculated. Results show that the hypothetical labour productivity growth rate required is about one percentage point higher than the actual growth rate, suggesting that the current labour productivity growth rate in the EU needs to more than double. A complementary econometric analysis shows that even though robots exhibit a positive impact on labour productivity growth, this is not (yet) strong enough to close the gap between the recent and the hypothetical labour productivity trend growth rate which would be required.

**BOXPLOT OF THE HYPOTHECALLY NEEDED INCREASE IN LABOUR PRODUCTIVITY GROWTH RATES ACROSS EU COUNTRIES FOR VARIOUS DEMOGRAPHIC SCENARIOS**



Source: Own calculations.

# ROBOTS AND THE RISE OF EUROPEAN SUPERSTAR FIRMS

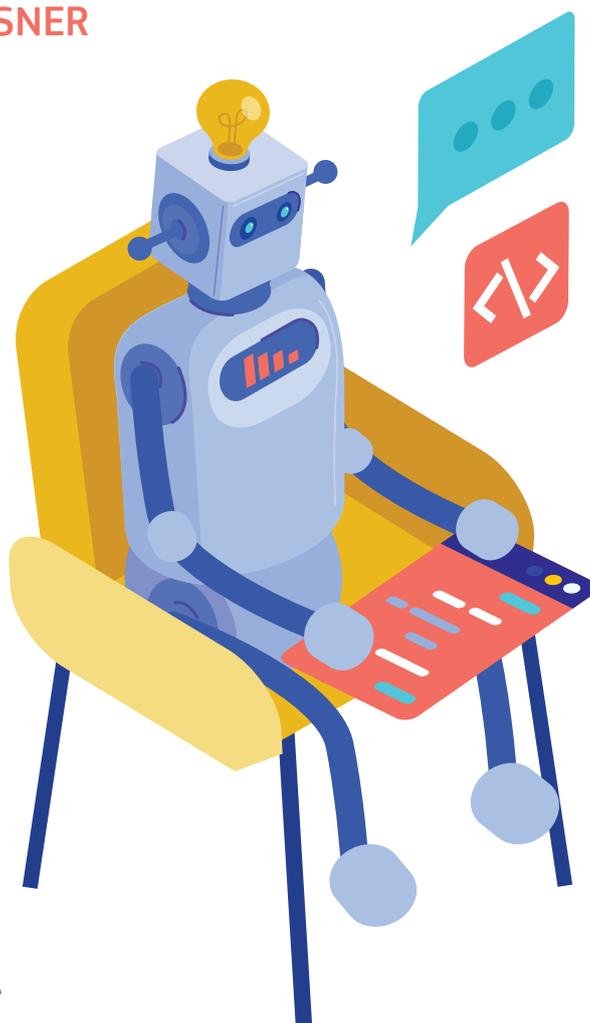


**Jens SUEDEKUM & Nicole WOESSNER**

DICE, Heinrich-Heine University Düsseldorf

We estimate the impact of a recent digital automation technology (industrial robotics) on the distribution of productivity and mark-ups within industries. Our empirical analysis combines data on the industry-level stock of industrial robots with firms' balance sheet data for six European countries from 2004 to 2013. We find that robots dis-proportionally raise productivity in those firms that are already most productive to begin with. Those firms are able to increase their mark-ups, while mark-ups tend to decline for less profitable firms within the same industry, country and year. We also show that industrial robots contribute to the falling aggregate labour income share through a rising concentration of industry sales. In short, our paper suggests that robots boost the emergence of superstar firms within European manufacturing, and thereby shifts the functional income distribution away from wages and towards profits.

**“These economic trends call for an economic policy that supports productivity growth across the broader economy, not just among top firms at the technological frontier, and distributes the rents created by new technologies more equally. (...) Useful policy steps (...) could be measures to foster profit sharing, employee stock options, or similar arrangements. Those instruments would aim for a wider distribution of asset ownership in the society at large.”**



# TRENDS AT THE FRONTIER IN CORPORATE R&D IN THE DIGITAL ERA: FACTS, PROSPECTS AND POLICIES



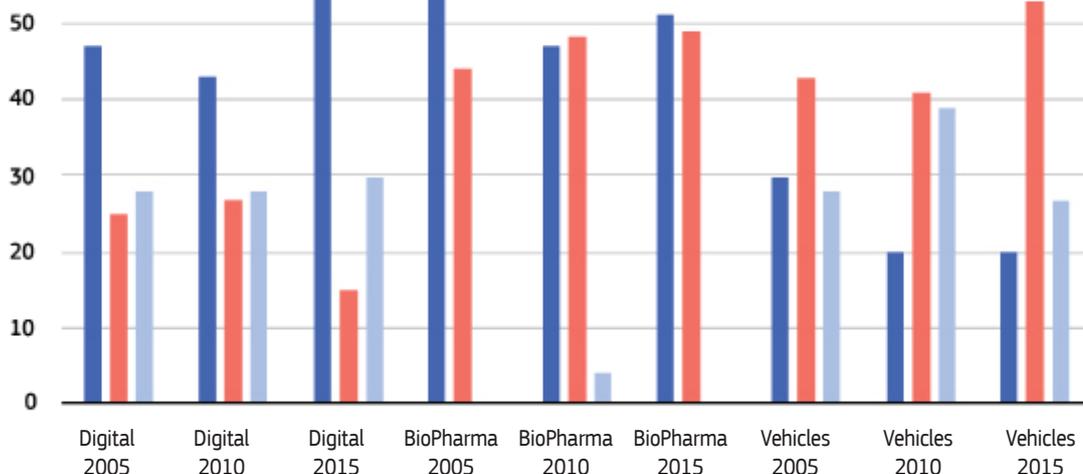
**Reinhilde VEUGELERS**  
KU Leuven

Both technological change, especially the digital revolution, and globalisation are predicted to lead to “winner takes most” industries, dominated by a happy few superstar firms. As the importance of large fixed investments driving scale and scope advantages increase, and as network effects become more prominent, sectors will be increasingly concentrated in a small number of firms, leaving an increasingly unequal corporate landscape. This may have important implications for aggregate productivity trends, particularly if the “winners” are the biggest firms with highest productivity growth and innovative performance and the laggards increasingly less likely to produce productivity growth. This contribution examines how concentrated R&D spending is in few “winners”. It finds a high

degree of concentration in R&D, much more than sales and employment. The analysis finds no evidence for increasing concentration in the global R&D landscape, only more recently in the digital services sectors, with in particular the top 1 percent of R&D spending firms in these sectors forging ahead. Incumbent R&D leaders slowly lose their positions to new R&D-leading firms. But overall, R&D leadership is persistent and turbulence is relatively modest. Digital services is the most turbulent high-tech sector. The US and China are more likely to produce new R&D leaders taking over top positions from incumbent R&D leaders. This poses difficult questions for Europe, which is at risk of losing out in terms of R&D leadership in more technologically advanced sectors.

## SHARE OF COUNTRY/REGION IN TOP 10 PERCENT R&D SPENDING, BY SECTOR

- North America
- Europe
- Asia



Source: Bruegel on the basis of EC-JRC-IPTS R&D scoreboard data. Note: numbers are calculated from the time-comparable subsample, which has 202 biopharma firms, 466 digital firms and 99 vehicles firms.

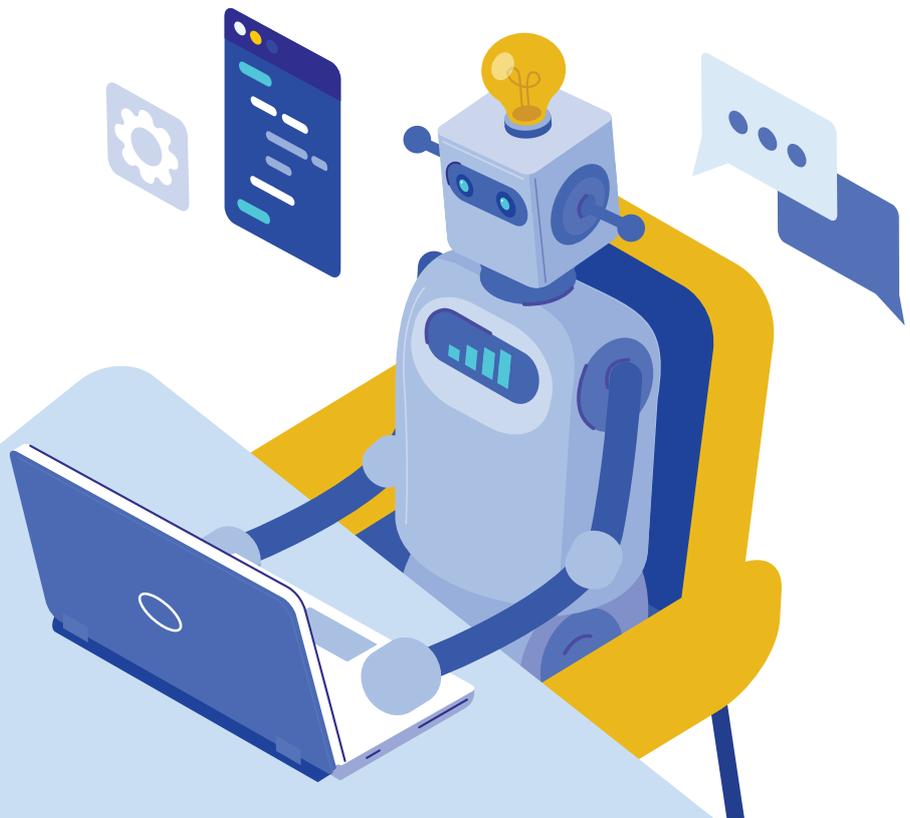
# LABOUR DEMAND IN THE PAST, PRESENT AND FUTURE



**Georg GRAETZ**  
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Since the beginning of the Industrial Revolution, technological change has led to the automation of existing tasks and the creation of new ones, as well as the reallocation of labour across occupations and industries. These processes have been costly to individual workers, but labour demand has remained strong, and real wages have steadily increased in line with productivity growth. I provide evidence suggesting, however, that in recent decades automation has outpaced the creation of new tasks and thus the demand for labour has declined. There is strong disagreement about the future of labour demand, and predictions about technological breakthroughs have a poor track record. Given the importance of overall labour demand for workers' standard of living as well as their ability to adjust to a changing labour market, obtaining accurate forecasts should be a priority for policy makers.

**“In 2017, a panel of expert economists were asked to evaluate the statement “Holding labor market institutions and job training fixed, rising use of robots and artificial intelligence is likely to increase substantially the number of workers in advanced countries who are unemployed for long periods”. 38 percent agreed, 33 disagreed, and 29 percent were uncertain.”**



# TOTAL FACTOR PRODUCTIVITY AND THE QUALITY OF SOCIAL INSTITUTIONS: INSTITUTIONAL COMPLEMENTARITIES AS KEY DRIVERS OF BALANCED INNOVATION



**Kurt HUEBNER**

University of British Columbia

We suggest a macro-socioeconomic framework that stresses the relevance of systemic features of national *growth models* for productivity outcomes to allow for highlighting national peculiarities. A prominent feature of domestic growth models are institutional settings that vary from case to case but where some key institutions are characteristic for particular groups of economies. We label such groupings as *productivity regimes*.

The term “social institution” refers to a broader array of analytical concepts, which have in common that they focus on regular patterns of behaviour of economic actors that result in structural features as well as of normative beliefs or narratives held by individuals and collectives which account for these regularities. Institutions in this sense are seen mainly as norms and regularities, which are deeply, enshrined the behaviour of actors. In the varieties-and-diversity-of-capitalism literature institutions are more widely conceptualized and try to capture the types of institutions that guide interactions of actors. Following Amable (2003) vital social institutions are identified in the literature by the

kind of product market competition, labour market institutions, the financial sector and corporate governance, social protection, and the educational system. Particular national institutional configurations guide in this perspective idiosyncratic economic decisions and processes that result in differing economic outcomes across a spectrum of institutional configurations, i.e. varieties of capitalism.

Whereas Amable suggests the existence of five kinds of capitalisms, our approach is not so much interested in the number of diverse varieties of capitalisms than in the effort to identify institutional configurations that are beneficial or detrimental to productivity performance. Still, our analysis makes use of such a concept of social institutions but adds a much more comprising list of variables that make up critical social institutions, which guide economic processes and eventually produce particular outcomes. By looking into the potential complementarities of social institutions, we suggest differentiating distinct *productivity regimes* that come with different productivity outcomes.



# INSTITUTIONS AND THE PRODUCTIVITY CHALLENGE FOR EUROPEAN REGIONS



**Andrés RODRÍGUEZ-POSE & Roberto GANAU**

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Europe has witnessed a considerable labour productivity slowdown in recent decades. Many potential explanations have been put forward to try to address this so-called productivity ‘puzzle’. However, how the quality of local institutions influences labour productivity in different parts of Europe has been, so far, overlooked by the literature. This paper addresses this gap in our knowledge by evaluating how the quality of local institutions affects changes in labour productivity at a regional level, across 248 European regions during the period between 2003 and 2015. The results indicate that institutional quality plays a crucial role in determining different regional labour productivity trajectories. This role is both direct – as improvements in institutional quality have a substantial impact on productivity growth – as well as indirect – as the returns of investments in human capital and local innovative capacity rise significantly as the quality of government increases.

**“Institutional quality is at the heart of the productivity challenge in Europe. No solution to the low productivity growth conundrum can be achieved without a significant improvement in the quality of local and regional institutions, especially in those areas of Europe where lack of transparency and accountability, high levels of corruption, or poor governance performance drag economic activity and innovation down.”**

