BBVA Research

The Impact of Technological Change and the Future of Employment

November 27, 2018

Creating Opportunities

The consequences for human welfare involved in questions like these are simply staggering: once one starts to think about them, it is hard to think about anything else

Robert E. Lucas, “On the Mechanics of Economic Development," 1988

In the same vein, the effects of the digital revolution on employment, productivity, inequality and welfare could be so stunning that, once we start to think about them, it is hard to think about anything else

Key messages

- Economic progress and social welfare depend on technical progress in the long run. Technological and digital transformation represents an opportunity in the history of mankind, but also enormous challenges
- The digital revolution is having disruptive effects on employment, occupations, required skills, the wage premium, inequality and polarization, although so far there are no grounds to claim that it affects unemployment at aggregate level
- It is crucial for societies (public sector, firms and workers) to anticipate and manage actively the digital revolution, using a broad array of policies that
  - ensure equal opportunities,
  - enhance the long-term positive effects of an inclusive technical and digital progress to bring this age of new opportunities to everyone, and
  - reduce transition costs in the short and medium term

Contents

01

Introduction

Introduction: The conventional wisdom

- **Long-run progress and welfare in societies are determined by technological change**, which boosts productivity, wages and income per capita

- Over the last two centuries, technological change has allowed for **increasing employment without raising unemployment rates**

- On an individual basis, workers with **complementary skills to new technologies** have traditionally benefited from better employment opportunities and higher wages (greater productivity and division of labor, Adam Smith)

- On the contrary, workers with **skills that are partial or perfect substitutes for automation** have experienced wage losses and even unemployment during the transition to new occupations

Introduction: Is the digital revolution different?

- **Is the current technological and digital transformation different from previous industrial revolutions?**
- To what extent will the automation of **routine and non-routine tasks** materialize?
- How will the impact of technologies such as computerization, robotisation, big data and artificial intelligence differ from that of previous technologies?
- We can attempt to forecast some trends by analyzing the immediate impact and scope of emerging technologies
- **Growing interest** academia, think tanks, international institutions and many other: a new line of research at **BBVA Research**

02

Overview and historical evidence of the effects of technical progress

Overview: The pessimistic vision of a world without labour

PESSIMISTS

- **Luddites**, who destroyed industrial looms between 1811 and 1816, and the Swing Riots of 1830, where threshing machines were destroyed
- Marx (1867): **machines replace workers**, whose value falls. This contradiction will mark the end of capitalism
- Frey and Osborne (2013): **47% of employment in the US is under threat from computers**
- Brynjolsson and McAfee (2014): Digital innovations are contributing to the stagnation of average incomes in the United States and the disappearance of many middle-level jobs
- Piketty (2014): **Capital (in the hands of only a few) grows more than GDP and exacerbates inequality**
- Benzell et al (2015): A long-term decrease in labor's share in the redistribution of income from losers to winners. Smart machines can mean long-term misery for all
- De Stefano (2016): **risks for workers from new forms of work**
- Milanovic (2016): Technological progress, sectoral reallocation of labor, globalization and current policy are generating a second Kuznets curve that will not disappear any time soon
- Avent (2016): New technologies will create new and good jobs, but they will not be enough to absorb the over-abundance of workers

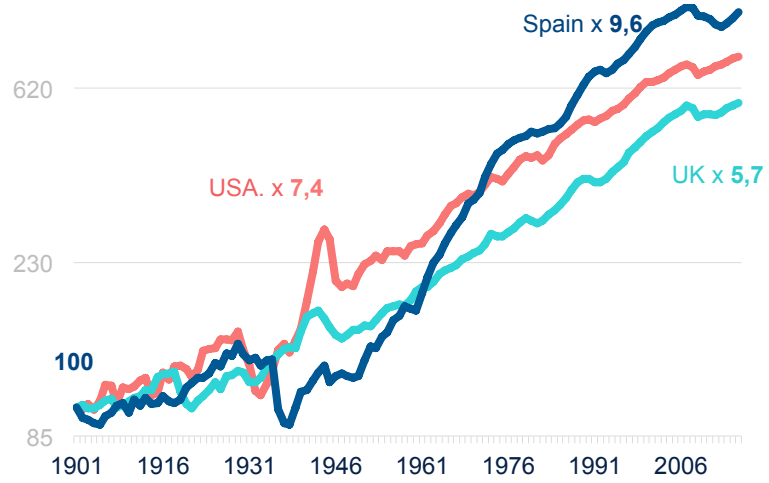
Overview: A more optimistic vision of technical progress

OPTIMISTS

- Technical progress has been a constant feature in history. At the height of the Luddite movement A. Lovelace, the creator of the first programming algorithm, was born in 1815
- Progress in some sectors increase income growth, which raises the demand for production in other sectors, and prompts the appearance of new goods and services, which in turn increases employment
- Moretti (2010): A job created in high-tech sectors creates further 4.9 jobs in non-trade Goods sectors
- Mokyr (2014): the future holds occupations that will seem as strange to us as many of those today seem to our grandparents. Our lack of **imagination is largely responsible for much of today's pessimism**
- Arntz et al (2016): When one considers the various different tasks in each occupation, only 9% of employment is capable of being automated on average in 21 OECD countries, which is far below the number estimated by Frey and Osborne (2013)
- Gregory et al (2016): Technical change that substitutes routine work has positive net effects on overall employment in a sample of 27 countries between 1999 and 2010, as the externalities predominate which compensate the substitution of certain jobs by capital
- Conseil d'Orientation pour l'Emploi (2017): Estimates do not take account of the fact that current jobs will change or of direct and indirect job creation deriving from technological change
- The "gig economy" can improve employment match-ups and labour market efficiency

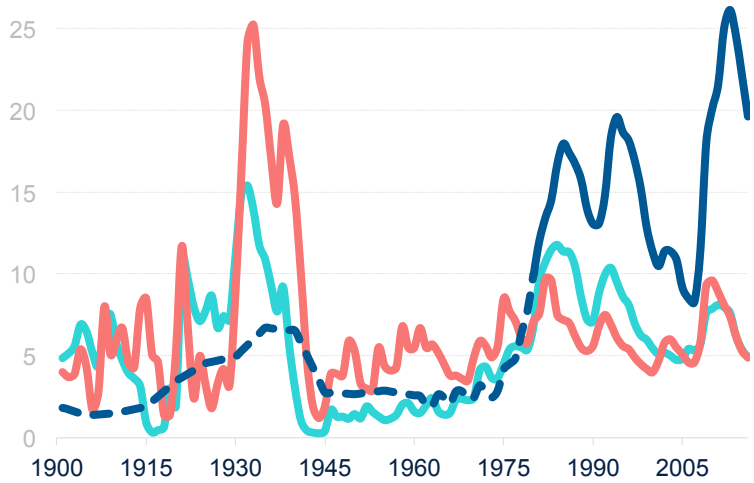
Today's unemployment in the US and the UK are at rates similar to those at the start of the 20th century

GDP per capita in the United States, United Kingdom and Spain 1901-2016 (1901 = 100)



Source: Andrés and Doménech (2018) based on Prados de la Escosura (2017), The Maddison Project and OCDE. Data in logarithm form

Unemployment rate in the US, Spain and the United Kingdom, 1901-2016

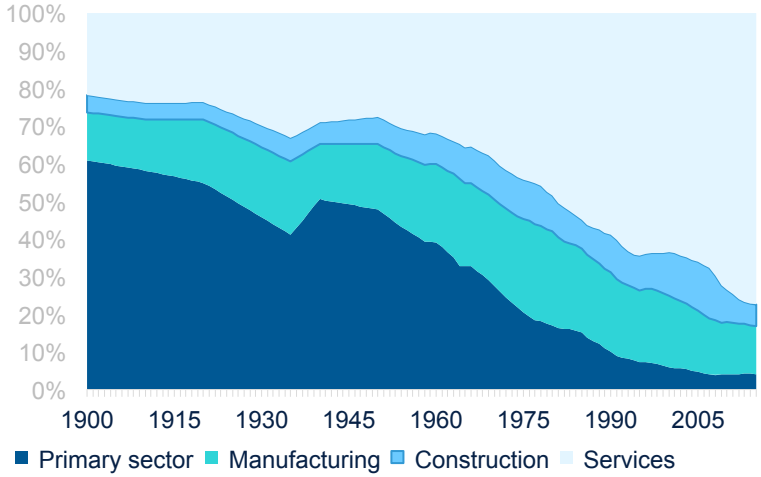


Source: Andrés and Doménech (2018) from Lebergott (1957), BLS, BoE, OECD. INE, Alcaide (2007) and de la Fuente (2017)

For over a century, technical progress has not destroyed jobs in aggregate terms, despite population growth and the increase of women labor participation rates

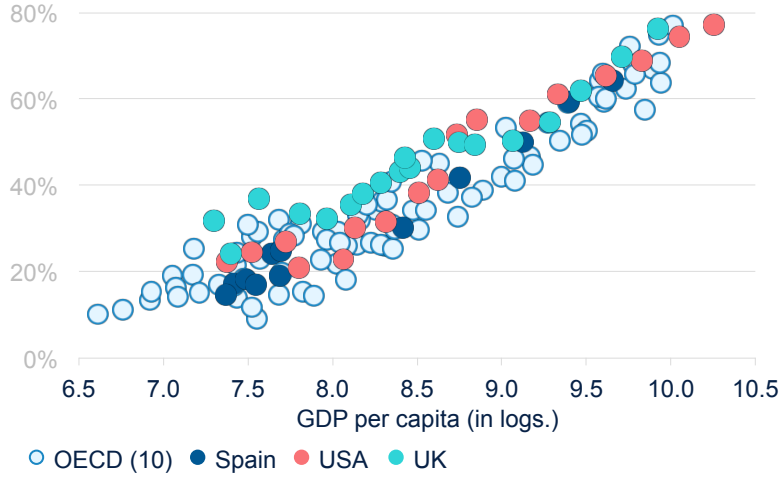
A continuous process of creative destruction, new occupations, and sectoral reallocation

Sectoral distribution of full-time equivalent employment, Spain, 1900-2015



Source: Andrés and Doménech (2018) based on Prados de la Escosura (2017)

Employment in services and per capita income in OECD countries, 1840-2000

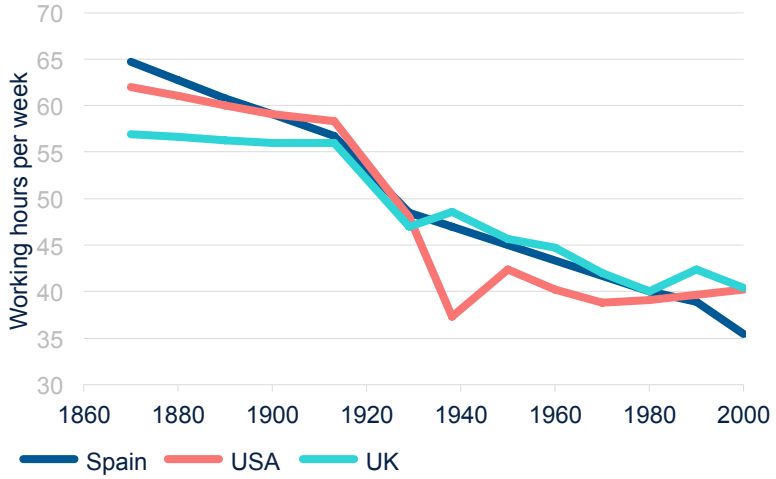


Source: Andrés and Doménech (2018) based on own elaboration from Herrendorf et al (2014)

Sectoral development due to technical progress, increasing globalization and changes in consumer preferences (Baumol, 1967)

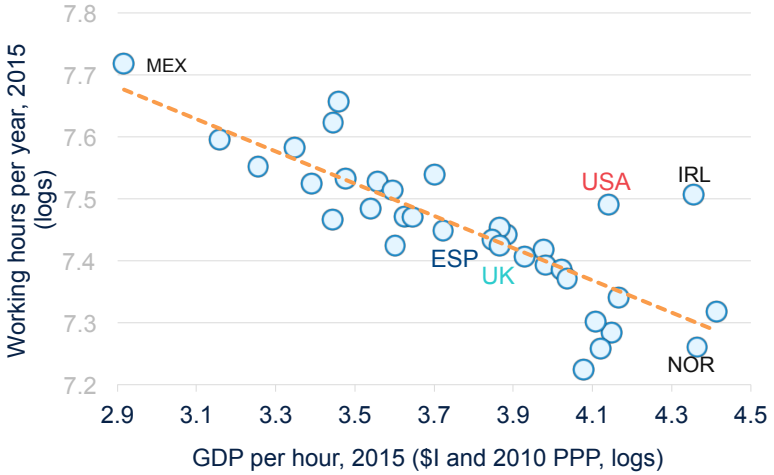
Thanks to technical progress, working hours have voluntarily fallen over time, contradicting Keynes

Weekly hours worked in the United States, the United Kingdom and Spain, 1870-2000



Source: Andrés and Doménech (2018) based on Huberman and Minns (2007)

Hours worked and productivity in the OECD, 2015

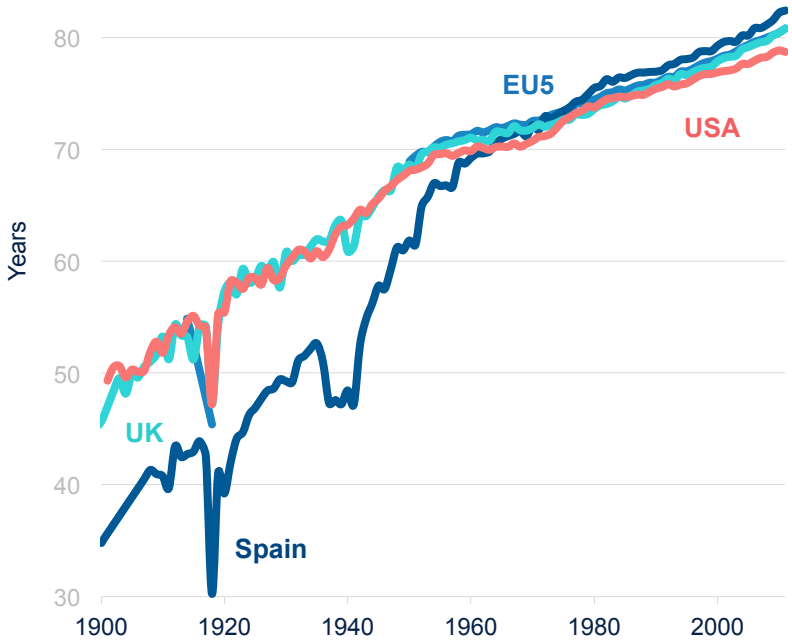


Source: Andrés and Doménech (2018) based on OECD

Keynes (1930) predicted that in the long run the working week would be 15 hours to keep employment stable, which has not been the case so far

Technical progress in health has increased life expectancy

Life expectancy at birth, 1900-2011

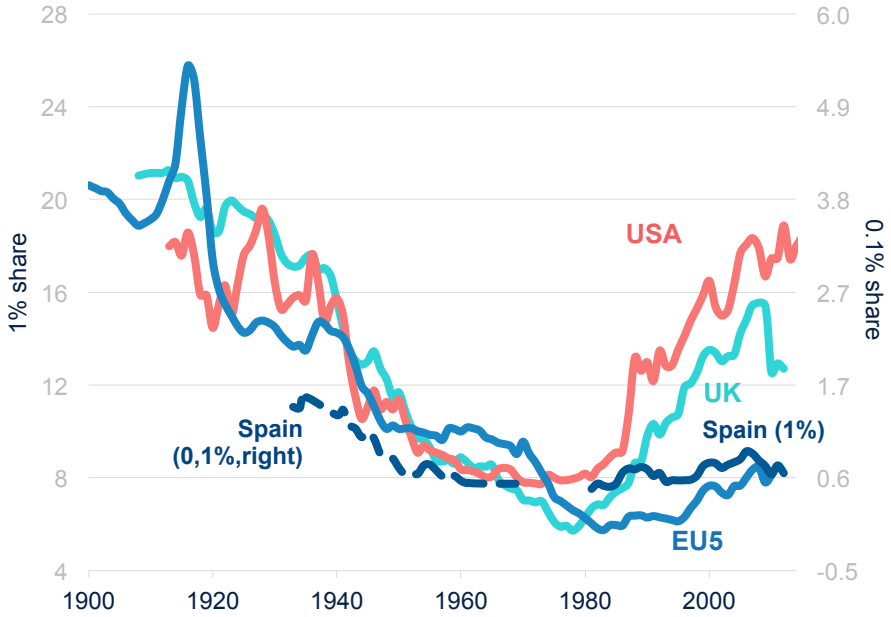


- Since 1960 life expectancy has increased by 1.9 years per decade
- Life expectancy at age 65 years is increasing more than one year per decade
- The increase in life expectancy is one of the determinants of the great improvement in well-being
- A challenge for the pension system. Retirement age (65 years) has remained virtually unchanged since 1916

Source: Own work based on www.clio-below.eu
EU5: Denmark, Finland, Germany, the Netherlands and Sweden

Inequality: shifting trends in the last century

Income share of the top 1%, 1900-2012



- Inequality increased at the end of the 19th century
- The Great Levelling 1920-1970
- Inequality (personal and functional) has increased since 1980, mainly in major Anglo-saxon countries …

  … affected by the interaction between technical progress, demography, educational policies, globalization, competition in product and labor markets, and the response of the welfare state

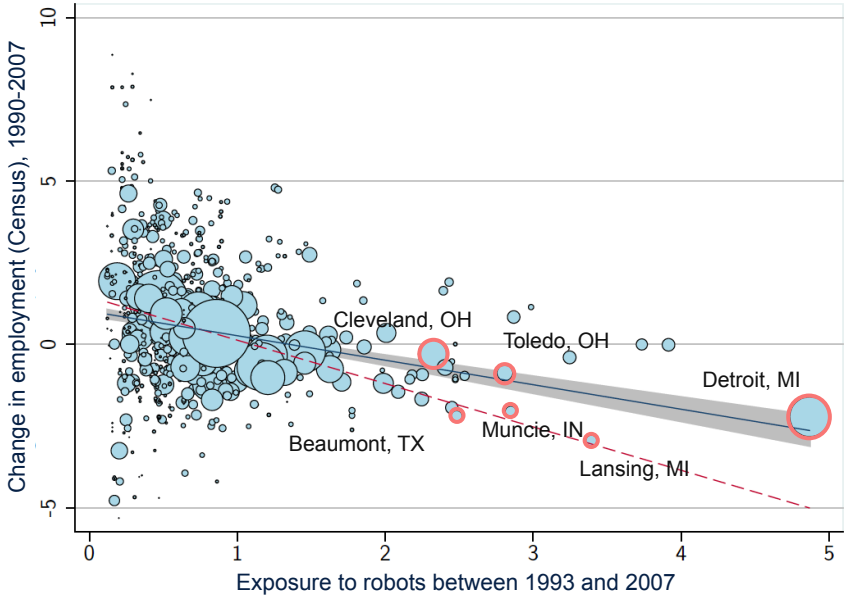
Source: Own work based on www.wid.world
EU5: Denmark, Finland, Germany, the Netherlands and Sweden

03

The effects of the digital revolution
Will this time be different?

Is automation destroying employment? An open debate

Correlation between exposure to robots and employment for metropolitan areas of the US



Source: Acemoglu y Restrepo (2017)

The race against the machine

Acemoglu y Restrepo (2017):

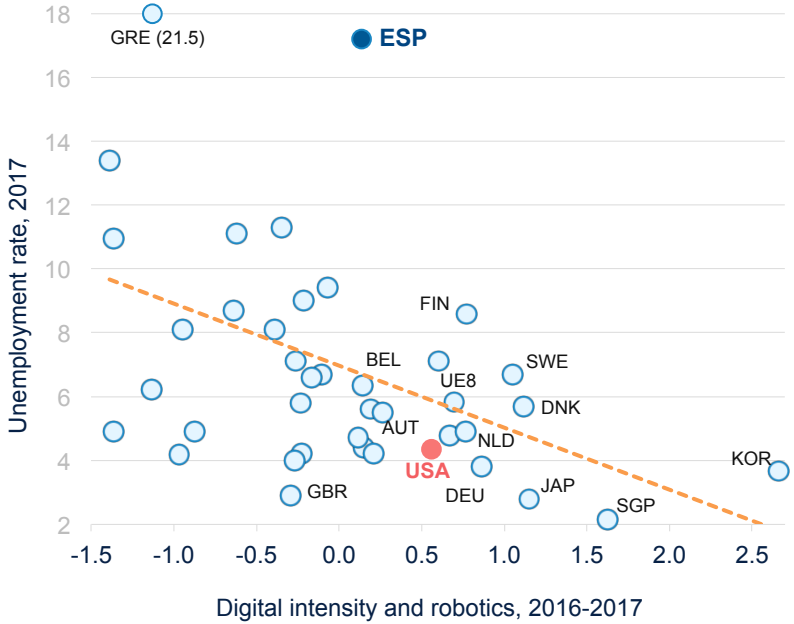
- One additional robot (autonomous machines with multiple reprogrammable applications) per thousand employees reduces the employment rate by 0.18 - 0.34pp and wages by 0.25 - 0.5pp
- Greater effect among more exposed industries, manual occupations and workers without a university education

Graetz y Michaels (2016)

- In 14 industries in 17 countries (1993-2007), robots boost productivity and wages, and reduce prices but not aggregate employment, although they do that among the least skilled

Is automation destroying employment? An open debate

Digital intensity and unemployment in 40 countries, 2016-2017



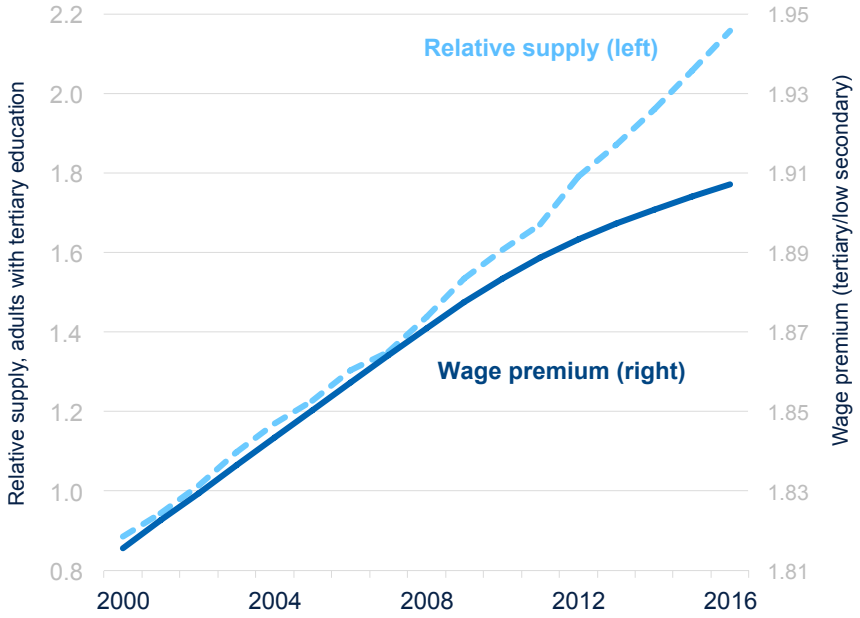
Source: BBVA Research based on data from Eurostat (2018), European Commission (2017), International Telecommunication Union (2017), and the International Federation of Robotics (2017)

The race against the machine

- There is a negative correlation between the digital and robotics intensity and unemployment is observed
- The digital revolution is fostering new activities, while boosting demand for less innovative sectors

Skill biased technological change

Relative supply of human capital and relative salary in 18 OECD countries, 2000-16



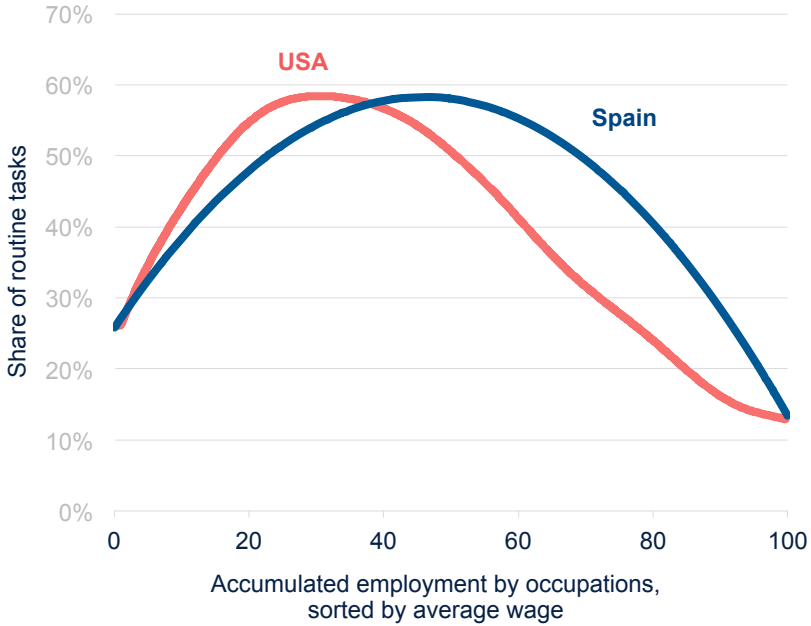
Source: Andrés and Doménech (2018) based on the OECD (2018)

The race against the machine

- Goldin and Katz (2008) and Acemoglu and Autor (2011). Despite the increase of workers with higher education, their relative wage has risen compared to those with lower educational levels
- **Technical progress is complementary** to skilled workers, increasing their demand faster than their supply

Routine tasks and occupations

Share of routine tasks by occupations ranked by wages



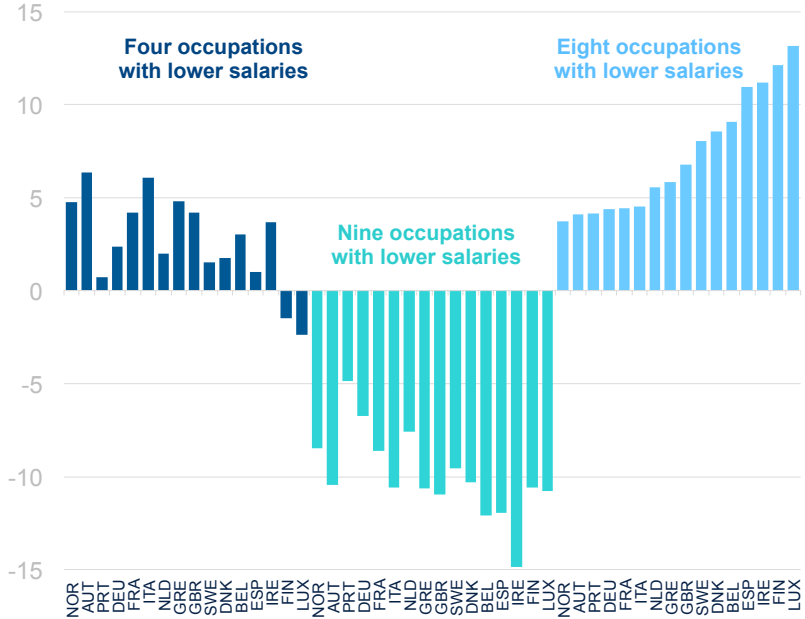
Technical progress biased against routine work

- Autor, Katz y Kearney (2006) find that automation and computerization complement workers who perform non-routine and abstract tasks, substitute those who carry out routine work, and do not affect those who undertake manual and non-routine activities
- Polarization has also occurred in Europe in the last two decades

Source: BBVA research based on Aum et al (2018), and Díaz, Doménech and Neut (2018)

Job polarization

Change in employment between 1993 and 2010 in 16 European countries



Source: Andrés and Doménech (2018) based on data from Goos, Manning and Salomons (2014)

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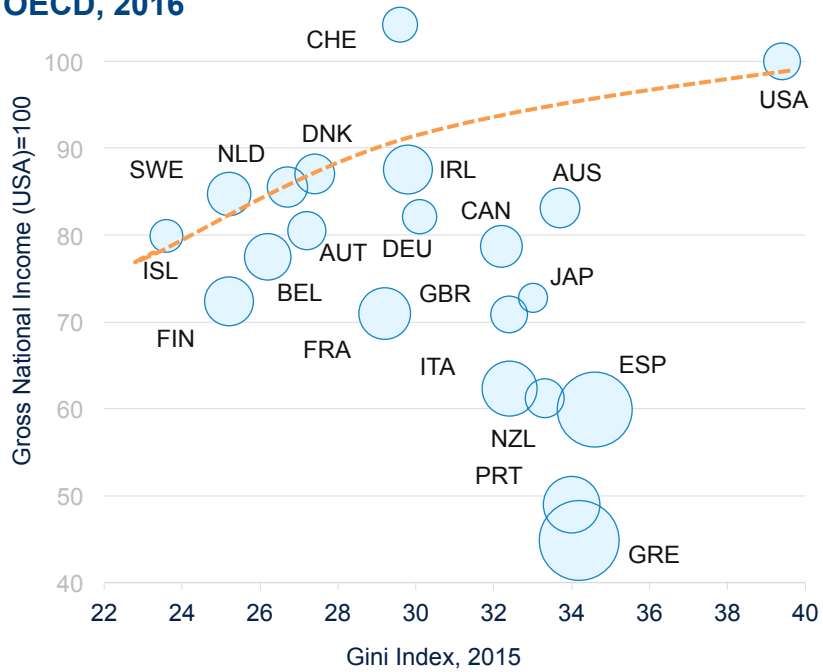
Skill biased technological change and job polarization are having heterogeneous effects across countries

Per capita income, inequality and unemployment OECD, 2016



An efficient and fair transition

- There are **big disparities among advanced economies** as regards to per capita income, unemployment and inequality
- The challenge is **to manage the technological and digital transformation by** spurring growth while reducing both **inequality and the unemployment rate**.
- Certain countries, such as **Spain**, are far from the frontier, allowing for higher-growth policy strategies that do not raise unemployment and inequality

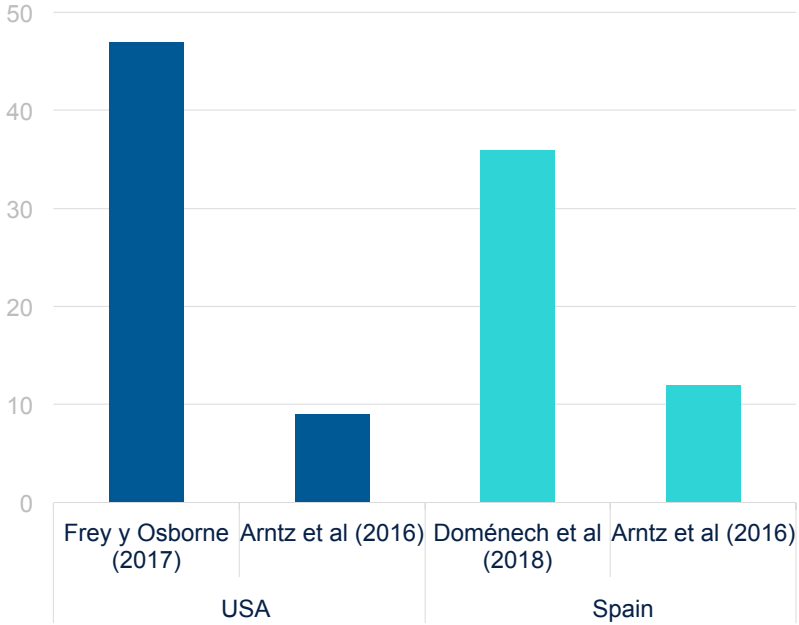
Source: BBVA Research based on the OECD and Eurostat. The size of each circle is in proportion to unemployment

The future of employment

- It is much easier to estimate which jobs are going to be affected than to guess which ones are going to be created
- **The Baumol effect**: Richer societies demand more labour-intensive services, increasing wages: health and personal care (ageing), education, leisure and tourism activities, personal services, …
- The challenge is a fair transition from jobs destroyed to jobs created: **Protecting people rather than jobs** (Tirole, 2017)

Workers affected by the digital revolution

Percentage of workers in occupations with high risk of automation in the U.S. and Spain*



- According to Frey and Osborne (2017), 47% of jobs in the U.S. face a high risk of automation
- With the same methodology, in Spain the percentage is 36%
- When you take into account the various tasks of each occupation the risk is around 10%

Source: Andrés and Doménech (2018) based on data from Fey and Osborne (2017), Arntz et al (2016) and Domenech, García, Neut and Montañez (2018)

Workers affected by the digital revolution

Characteristics of workers in jobs most at risk of being automated in Spain*

- Low level of education
- Do not undertake non-formal education
- Young people
- Women
- Seeking a new job
- Without positions of responsibility
- Have come out of unemployment
- Not telecommuting
- Private sector
- With temporary contract
- In small firms
- In the sector:
  - Primary
  - Manufacturing
  - Trade
  - Hotels, restaurants and cafés
  - Finance
  - Property

- The probability of automation of individuals is determined by variables that differentiate between each employee with regard to personal characteristics, as well as employment and the firm
- Technological transformation is both an opportunity and a challenge
- Although the aggregate impact is positive, it may have very different effects for different groups of workers
- It is essential to lead the change with policies that smooth the transition, cushion the costs and boost the benefits

Source: Domenech, García, Neut and Montañez (2018)

04

Policies for the digital revolution

Policies for managing technological change: Education

01

Investing in human capital is crucial to achieving skills complementary to technical progress, even for less-skilled tasks

02

Raising the **quality of jobs in the services sector** and improving society's views towards many of them

03

Improving professional (e.g. languages), social, managerial and personal **skills** which are required to meet society's growing needs

04

Continuous training and flexibility to change occupations over working life. New tasks for public employment services and in collective bargaining

05

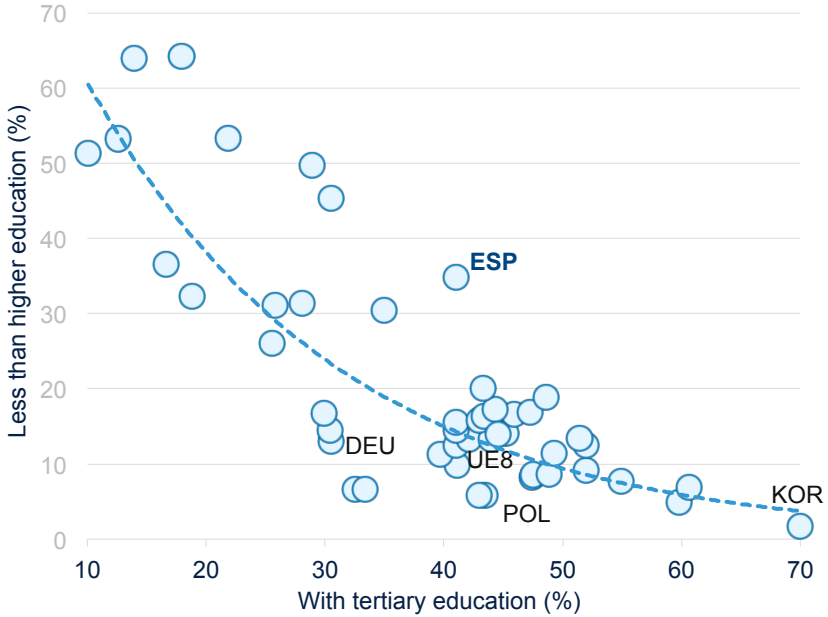
Adapt the educational system and training to **new demands** tanking into account skill biased technological progress

06

The educational system must evolve in step with society, fomenting creativity, boosting non-cognitive skills and improving social intelligence

Policies for managing technological change: Education

Percentage of the population aged between 25 and 34 years by education level in 2016



- Skill-biased technical progress and new jobs that might be hard to imagine at the present time not only require more but, above all, better and more flexible training
- The dual distribution of educational levels in Spain means that approximately one third of the younger population may lack the skills needed for the digital transformation

Source: Doménech, García, Neut and Montañez (2018) based on data from the OECD (2017)

Labor market policies

01

Removing barriers to job creation, investment and firm growth: finance, start-ups, taxes, red tape, regulations in product markets, quality of institutions, etc,

02

Better labor market regulations, and active and passive policies: A more efficient and equitable

03

Improving the matching process between vacancies and the unemployed using **big data + AI**. Additional information to improve skills

04

A better **tax structure** that allows for redistribution without harming employment or investment in new technologies

05

Adapt labor regulations to the **gig economy** and the needs of independent workers and new employers in the labor market

Policies for inclusive growth and redistribution

01

Education and employment policies are necessary conditions, but may be not enough

02

Greater welfare for all in the long run, but substantial **transition costs** for many workers in the medium term

03

First, ensure **equality of opportunities** and later insure individuals against adverse situations (ex-post redistribution)

04

Efficiency of public policies: ensure inclusive growth at the lowest possible cost in terms of employment and investment in innovation

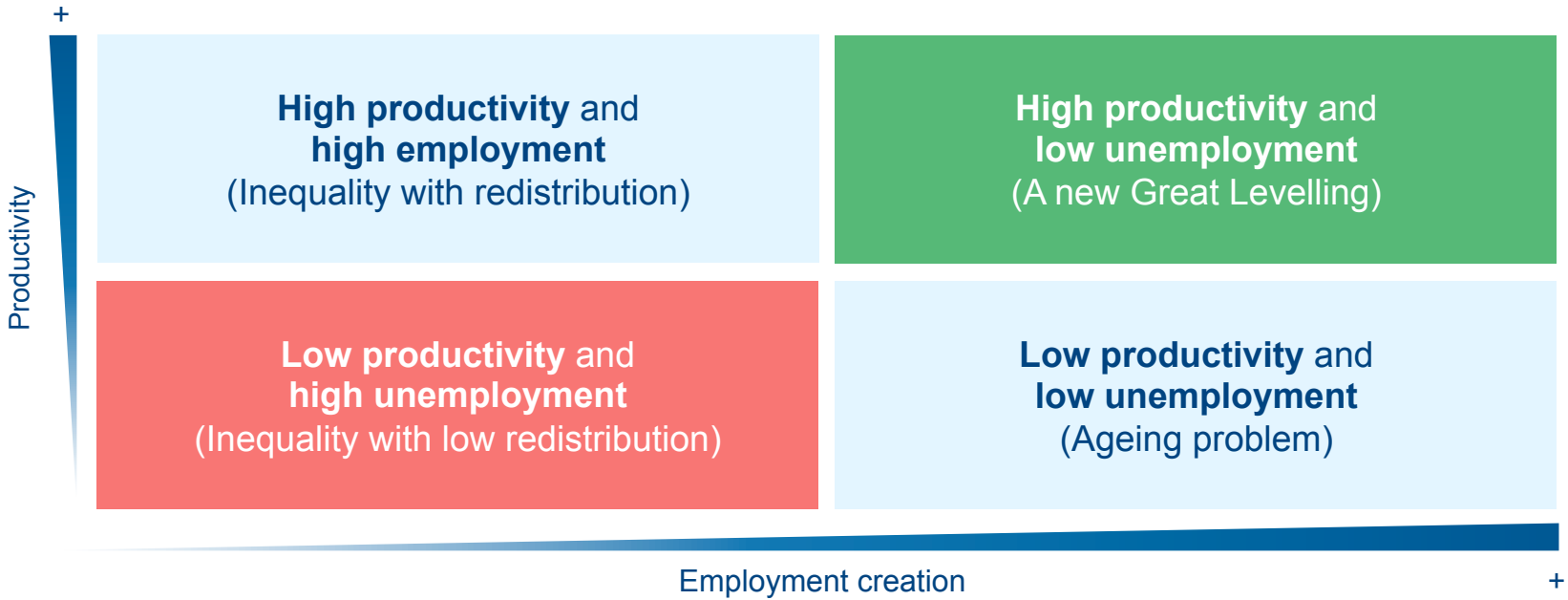
05

The challenge is to **distribute wealth and not to curb its creation**, with taxes on automation (what is a robot?), artificial intelligence or big data

06

The welfare state still has a lot of scope for improvement in boosting employment, income and equality before proposing a **basic universal income**

Multiple transitions: Winners and losers?



Countries can end up in very different equilibria, depending on how they manage the digital revolution. Better policies will allow more successful outcomes.
A new international division of labor and wealth (strategic map)

05

Conclusions

Key messages

- Economic progress and social welfare depend on technical progress in the long run. Technological and digital transformation represents an opportunity in the history of mankind, but also enormous challenges
- The digital revolution is having disruptive effects on employment, occupations, required skills, the wage premium, inequality and polarization, although so far there are no grounds to claim that it affects unemployment at aggregate level
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