

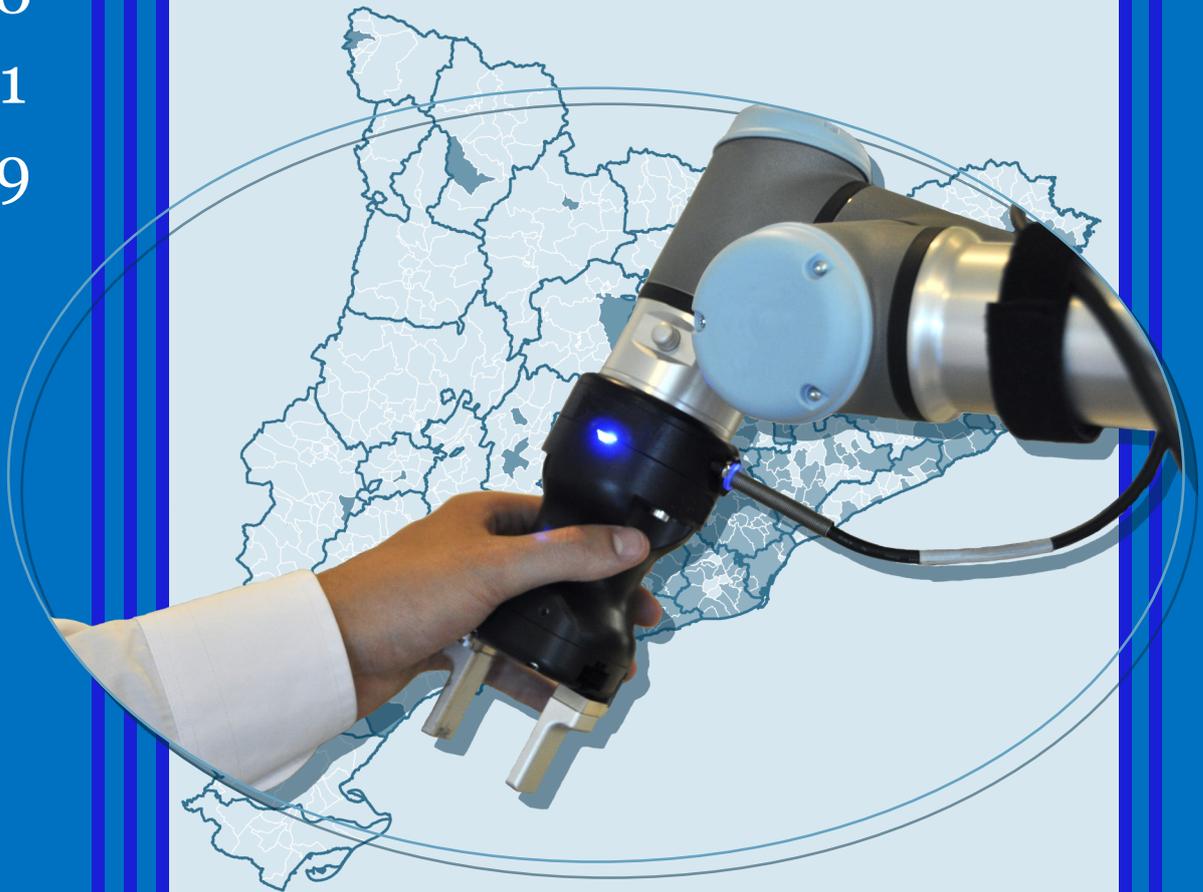
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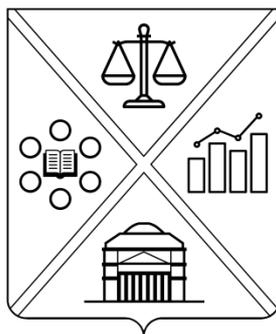
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The impact of robots and automation in Catalonia

An analysis of citizens' opinions about employment and public policies

ARNAU GUIX I SANTANDREU



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Dedicated to the parents and godparents of the author.

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ARNAU GUIX I SANTANDREU

ABSTRACT

[ENG] Robots and automation processes have arrived to stay. Despite positive outcomes derived from new technologies, such as a remarkable rise in productivity over time and easier communications, humans are observing how new *species* are irrupting at their current labour posts. It is estimated that approximately 50% of jobs have potentially automatable tasks, and that the remaining ones will experience radical transformations. Also, humans, in most of the cases without knowing it, are the source of information for the learning of algorithms, which are beginning to execute intellectual tasks with extreme precision and quality.

The present analysis is articulated in three fronts: at first, are exposed the main international indicators that justify concerns about the *silicon newcomers*; secondly, is elaborated a descriptive study of citizens' opinions in Catalonia about the impact of robots and automation processes, also covering the desirable public policies that could be applied; and finally, is developed an econometric model that unveils what profile characteristics of citizens are relevant to evaluate robots and digitalisation like a threat to society, or otherwise like an opportunity, thus verifying the initial hypotheses of the study.

[CAT] Els robots i els processos d'automatització han arribat per quedar-se. Malgrat les conseqüències positives derivades de les noves tecnologies, com un increment remarcable de la productivitat al llarg del temps i les comunicacions més fàcils, els humans estan observant com noves *espècies* estan irrompent als seus llocs de treball. S'estima que aproximadament el 50% de les feines presenten tasques potencialment automatitzables, i que les que romanguin experimentaran transformacions radicals. A més, les persones són, en la majoria dels casos sense saber-ho, la font d'informació per l'aprenentatge de complexos algorismes, que estan començant a executar tasques intel·lectuals amb extrema precisió i qualitat.

El present anàlisi està articulat en tres fronts: en primer lloc, s'exposen els principals indicadors internacionals que justifiquen preocupacions sobre els *nouvinguts de silici*; en segon lloc, s'elabora un estudi descriptiu sobre les opinions dels ciutadans de Catalunya sobre l'impacte dels robots i processos d'automatització, també cobrint les desitjables polítiques públiques que es podrien aplicar; i finalment, es desenvolupa un model economètric que desvela quines característiques del perfil dels ciutadans són rellevants per a avaluar els robots i la digitalització com una amenaça cap a la societat, o bé com a una oportunitat, verificant així les hipòtesis inicials de l'estudi.

[CAS] Los robots y los procesos de automatización han llegado para quedarse. Aunque hay consecuencias positivas derivadas de las nuevas tecnologías, como un incremento remarcable de la productividad a lo largo del tiempo y las comunicaciones más fáciles, los humanos están observando como nuevas *especies* irrumpen en sus puestos de trabajo. Se estima que aproximadamente el 50% de los trabajos presentan tareas potencialmente automatizables, y que las que permanezcan experimentarán transformaciones radicales. Además, las personas son, en la mayoría de los casos sin saberlo, la fuente de información para el aprendizaje de complejos algoritmos, que están empezando a ejecutar tareas intelectuales con extrema precisión y calidad.

El presente análisis está articulado en tres frentes: en primer lugar, se exponen los principales indicadores internacionales que justifican preocupaciones sobre los *recién llegados de silicio*; en segundo lugar, se elabora un estudio descriptivo sobre las opiniones de los ciudadanos de Catalunya sobre el impacto de los robots y procesos de automatización, también cubriendo las deseables políticas públicas que se podrían aplicar; y finalmente, se desarrolla un modelo econométrico que desvela cuales características del perfil de los ciudadanos son relevantes para evaluar los robots y la digitalización como una amenaza hacia la sociedad, o bien como una oportunidad, verificando así las hipótesis iniciales del estudio.

[FRA] Les robots et les processus d'automatisation sont arrivés pour rester. En dépit des résultats positifs dérivés des nouvelles technologies, tels qu'une augmentation remarquable de la productivité au fil du temps et des communications plus faciles, les humains observent comment de nouvelles *espèces* font irruption à leurs postes de travail actuels. On estime qu'environ 50% des emplois ont des tâches potentiellement automatisables et que les autres resteront en plein changement. De plus, les personnes, dans la plupart des cas sans le savoir, sont la source d'informations pour l'apprentissage des algorithmes, qui commencent à exécuter des tâches intellectuelles avec une précision et une qualité extrêmes.

La présente analyse s'articule autour de trois fronts: dans un premier temps, sont exposés les principaux indicateurs internationaux qui justifient les inquiétudes suscitées par les *nouveaux venus de silicium*; deuxièmement, est élaborée une étude descriptive des opinions des citoyens de Catalogne sur l'impact des robots et des processus d'automatisation, couvrant également les politiques publiques souhaitables qui pourraient être appliquées; et finalement, est développé un modèle économétrique qui dévoile quelles caractéristiques de profil des citoyens sont distinguées pour évaluer les robots et la numérisation comme une menace pour la société, ou comme une opportunité, vérifiant ainsi les hypothèses initiales de l'étude.

[ITA] I robot e processi di automazione sono arrivati per restare. Nonostante i risultati positivi derivati dalle nuove tecnologie, come un notevole aumento della produttività nel tempo e comunicazioni più facili, gli esseri umani stanno osservando come nuove *specie* stanno irrompendo nei loro attuali posti di lavoro. Si stima che circa il 50% dei lavori hanno compiti potenzialmente automatizzabili e che i restanti subiranno trasformazioni radicali. Inoltre, le persone, nella maggior parte dei casi senza saperlo, sono la fonte di informazioni per l'apprendimento degli algoritmi, che stanno cominciando a eseguire compiti intellettuali con estrema precisione e qualità.

La presente analisi è articolata su tre fronti: all'inizio, sono esposti i principali indicatori internazionali che giustificano le preoccupazioni per i *nuovi arrivati di silicio*; in secondo luogo, viene elaborato uno studio descrittivo delle opinioni dei cittadini in Catalogna sull'impatto dei robot e dei processi di automazione, che copre anche le desiderabili politiche pubbliche che potrebbero essere applicate; e infine, viene sviluppato un modello econometrico che svela quali caratteristiche del profilo dei cittadini sono rilevanti per valutare i robot e la digitalizzazione come una minaccia per la società, o invece come un'opportunità, verificando così le ipotesi iniziali dello studio.

[OCC] Es robòts e es procèssi d'automatizacion an arribat entà demorar. Maugrat es conseqüències positives derivades des naues tecnologies, coma un increment remercable dera productivitat ath long deth temps e es comunicacions mès faciles, es umans obsèrven coma naues *espècies* irrompen as sòns lòcs de trabalh. S'estime qu'apuprètz 50% des trabalhs presenten prètzhèts potenciauments automatizables, e qu'es que demoraràn experimentaràn transformacions radicaus. Ath delà, es persones son, ena majoria des casi sense sabé'c, era hònt d'informacion per l'aprendissatge de complèxes algoritmes, que comencen a executar prètzhèts intellectuaus damb extrèma precision e qualitat.

Era presenta analisi ei articulada en tres fronts: en prumèr lòc, s'expausen es principaus indicadors internacionaus que justifiquen preocupacions sobre es *nauvenguts de silici*; en dusau lòc, s'elabòre un estudi descriptiu sobre es opinions des ciutadans de Catalonha sobre er impact des robòts e procèssi d'automatizacion, tanben en tot corbir es desirables politiques publiques que se poirien aplicar; e fin finau, se desvolòpe un modèl econometric que desnidera quines caracteristiques deth perfil des ciutadans son relevants entà avalorar es robòts e era digitalizacion coma ua menaçà entara societad, o ben coma ua oportunitat, en tot verificar atau es ipòtesis inicials der estudi.

GENERAL INDEX

CHAPTER I / INTRODUCTION	10
1.1. IN FRONT OF A CRITICAL JUNCTION	11
1.2. METHODOLOGY	12
1.3. THE PRECEDENT RESEARCH OF THE EU PARLIAMENT	13
CHAPTER II / INTERNATIONAL OVERVIEW	14
2.1. PRODUCTIVITY	15
2.2. ACTIVITY RATE	16
2.3. ELDERLY POPULATION	17
2.4. LABOUR HOURS PER WORKER	18
2.5. DIFFUSION OF INDUSTRIAL ROBOTS	19
2.6. AUTOMATION: JOBS AT POTENTIAL HIGH RISK	20
2.7. AUTOMATION: THE THREE WAVES.....	21
2.8. UNEMPLOYMENT RATE	22
2.9. POPULATION WORKING IN THE INDUSTRIAL SECTOR	24
2.10. GENERAL PUBLIC DEBT	26
2.11. INVESTMENT IN EDUCATION.....	27
2.12. INVESTMENT IN RESEARCH AND DEVELOPMENT	30
CHAPTER III / RESEARCH HYPOTHESES	32
3.1. TERRITORIAL HYPOTHESES.....	33
3.2. TECHNOLOGICAL HYPOTHESES	35
3.3. EDUCATIONAL HYPOTHESES	36
3.4. PUBLIC POLICIES HYPOTHESES	38
CHAPTER IV / DESCRIPTIVE ANALYSIS	39
4.1. HOW WILL BE THE FUTURE OF WORK AFTER TWENTY YEARS?	40
4.2. WHAT IS THE BEST GOVERNANCE LEVEL TO REGULATE ROBOTS AND ARTIFICIAL INTELLIGENCE?.....	44
4.3. ARE ROBOTS OR ALGORITHMS POSSIBLE SUBSTITUTES AT ONE'S EMPLOYMENT?	47
4.4. WHAT MEASURES ARE PREFERABLE, IN CASE OF TECHNOLOGICAL UNEMPLOYMENT?.....	51
4.5. WHAT IS THE DEGREE OF USE OF SMARTPHONE APPS?.....	53
4.6. WHAT SMARTPHONE APPS ARE MORE POPULAR?	55
4.7. HOW ARE EVALUATED THE SOCIAL POLICIES DEPLOYED BY THE EUROPEAN UNION?	56

CHAPTER V / EMPIRICAL ANALYSIS	58
5.1. ECONOMETRIC MODEL OF THE FUTURE OF WORK.....	59
5.2. ESTIMATION AN RESULTS	61
5.2.1. <i>TERRITORIAL HYPOTHESES</i>	61
5.2.2. <i>TECHNOLOGICAL HYPOTHESES</i>	64
5.2.3. <i>EDUCATIONAL HYPOTHESES</i>	66
5.2.4. <i>PUBLIC POLICIES HYPOTHESES</i>	66
CHAPTER VI / CONCLUSIONS.....	68
6.1. INTERNATIONAL ANALYSIS	69
6.2. DESCRIPTIVE ANALYSIS	72
6.3. EMPIRICAL ANALYSIS	73
CHAPTER VII / REFERENCES.....	74
ANNEXES	80
ANNEX I.....	81
ANNEX II.....	85
ANNEX III	87

INDEX OF FIGURES

Figure 1. Municipalities integrating the Metropolitan Area of Barcelona and «expanded» concept used in the present research.	12
Figure 2. GDP per hour worked as a measure of productivity derived from labour (1970 – 2018).....	15
Figure 3. Activity rate: labour force divided by the total population (1960 – 2017).....	16
Figure 4. Percentage of population aged 65 years old and above, related to the total population.....	17
Figure 5. Annual labour hours per worker (1977 – 2017).....	18
Figure 6. Estimated annual sales of multipurpose industrial robots, 2016 and 2017.	19
Figure 7. Estimated share of jobs at potential high risk of automation (coloured bars). Estimated share of citizens with high vulnerability to automation, with ISCED 2 and 3C (grey dots).....	20
Figure 8. Estimated share of jobs at potential high risk of automation for each of the three waves.	21
Figure 9. Monthly unemployment rate (January 1989 – April 2019).....	22
Figure 10. Average employment change, by NUTS 2 regions (2008-2013).....	23
Figure 11. Percentage of population employed in the industrial sector, related to the population aged between 15 and 64 years old.	24
Figure 12. Share of industry in employment, by NUTS 2 regions (2013).	25
Figure 13. Gross debt of the general government as a percentage of GDP (1995 – 2018).	26
Figure 14. Investment in education, in % of GDP of 2014 (coloured bars). Mean performance in reading at PISA test score of 2015 (grey dots)	27
Figure 15. Early leavers from education and training, by NUTS 2 regions (2017). In % of population aged 18-24 years old.	28
Figure 16. Employment rate of recent graduates, by NUTS 2 regions (2017).....	29
Figure 17. Investment in research and development, in % of annual GDP (1981 – 2017).	30
Figure 18. R&D investments relative to the GDP, by NUTS 2 regions (2015).	31
Figure 19. Population employed in the industrial sector. Catalonia and Spain.	35
Figure 20. Unemployment rate according to the educational attainment.	37
Figure 21. Opinions regarding the impact of robots and AI over employment, by territory.....	40
Figure 22. Opinions regarding the impact of robots and AI over employment, by educational attainment.	41
Figure 23. Opinions regarding the future of work over ten points, by county of residence.	42
Figure 24. Kernel density of the expected impact of robots and automation, over ten points.	42
Figure 25. Evaluation of the future of work, over ten points and by sector of personal identification.	43
Figure 26. Opinions regarding the desired regulator of robots and AI, by territory.....	44

Figure 27. Opinions regarding the desired regulator of robots and AI, by educational attainment.....	45
Figure 28. Opinions regarding the desired regulator for robots and AI, by sector of personal identification.	46
Figure 29. Opinions regarding the possible substitution by a robot or algorithm at work.	47
Figure 30. Opinions considering the possible substitution by a robot or algorithm at work, by county of residence (coloured bars). Industrial gross value added (grey dots).	48
Figure 31. Opinions considering the possible substitution by a robot or algorithm at work, in percentage and by sector of personal identification.....	49
Figure 32. Possibilities in case of affirming a possible substitution by a robot or algorithm, by sector of personal identification.	50
Figure 33. Preferences regarding assistance measures in case of substitution at work.	51
Figure 34. Preferences regarding assistance measures in case of substitution at work, by sector of personal identification.....	52
Figure 35. Average use of different categories of smartphone apps, by age and territory.	53
Figure 36. Average use of different categories of smartphone apps, by sector of personal identification..	54
Figure 37. Average use of different categories of smartphone apps, by territory.	55
Figure 38. Evaluation of European Union’s social policies, by educational attainment.	56
Figure 39. Evaluation of EU’s social policies, by origin.....	56
Figure 40. Evaluation of European Union’s social policies, by sector of personal identification.....	57
Figure 41. Locally weighted regression of the urban density index and the average opinions about the future of work. Municipalities with the greatest number of participants.	62
Figure 42. Locally weighted regression of the municipal disposable income and the average opinions about the future of work. Municipalities with the greatest number of participants.....	63
Figure 43. Locally weighted regression of the local unemployment rate and the average opinions about the future of work. Municipalities with the greatest number of participants.	64
Figure 44. Linear regression of the substitution index and the residuals of the estimation of the future of work. Municipalities with the greatest number of participants.	65
Figure 45. Linear regression of the evaluation of EU social policies and the residuals of the estimation of the future of work. Municipalities with the greatest number of participants.....	67
Figure 46. Estimated annual sales of industrial robots, by macroregions.	70



Chapter I / Introduction

1. INTRODUCTION

1.1. IN FRONT OF A CRITICAL JUNCTION

Societies are experiencing important changes due to the arrival of innovations, that many years before were considered to be in terrain of science fiction: robots and information and communication technologies are re-shaping our world, and is on our hands if we accept them without inconveniences, adapting us to the new paradigm and difficult outcomes that may arise, or we decide and regulate how new technologies will affect us.

One of the critical aspects to be considered is whether robots will wipe out most of the existing jobs, deriving in massive unemployment, and how the public administration can manage appropriately the dramatic consequences that could appear. Several studies, elaborated recently, point out that in approximately twenty years, half of the current labour posts could be suppressed by new technologies¹, with a different impact across countries.

Industry is not alone in the exposed dramatic circumstances, which could be qualified partially as *the robots' uprising*². Sectors such as services and logistics, considered in the past to be relatively protected by the nature of the work they represent, will be severely impacted in the following years due to automated processes and algorithms. Tasks that articulate a routine are susceptible to be transferred to non-human entities, no matter if the replacement takes place in an industrial arm of a considerable size, or inside the electronic components and software of a tiny computer.

Traditionally, Economics literature has considered the Schumpeterian view, which expected that the extinction of labour posts in several sectors was compensated with the creation of new jobs in other areas³. Academic contributions against the conventional thesis⁴ were left as silly and not documented⁵. Despite this, nowadays the result is not that clear. Disagreement among experts is expressed in this field with higher intensity: in the past, the crisis of industry derived in the development of services, but now sectors and jobs that could offset the pace of automation are not well determined, as new technologies are susceptible to intervene almost everywhere.

Very remarkably, avant-garde legislation will play a key role to mitigate the resulting impacts of automation, with three important possible fronts: a guaranteed basic income for the citizens in a context of a rising «precariat»⁶, or the implementation of other measures to attend conveniently the constitutional right (and duty) to work; the deployment of taxes to the owners of robots to maintain the Social Security schemes and the sustainability of public finances; and civil and military legislation that attends new occurrences, requiring high coordination efforts at the international scene. Automation is a challenge for social stability and appears in a moment of climate change, limited resources and vast migration flows. The XXIst century appears complex.

¹ Among them: FREY, Carl Benedikt; OSBORNE, Michael (2013): "The future of employment: how susceptible are jobs to computerisation?". *Technological Forecasting and Social Change*, Vol. 114 (2017), pp. 254-280.

² FORD, Martin (2015): *Rise of the Robots*. New York, Basic Books. For the Castilian Edition (2016): *El auge de los robots. La tecnología y la amenaza de un futuro sin empleo*. Barcelona, Espasa Libros.

³ FREEMAN, Chris; SOETE, Luc (1994): *Work for all or Mass Unemployment? Computerised technical change into the 21st Century*. London, Pinter Publishers Ltd. For the Castilian edition (1996): *Cambio tecnológico y empleo. Una estrategia de empleo para el Siglo XXI*. Madrid, Fundación Universidad-Empresa.

⁴ RIFKIN, Jeremy (1994): *The end of work. The decline of the global labour force and the dawn of the post-market era*. New York, Putnam Berkley Group. For the Castilian edition (1996): *El fin del trabajo. Nuevas tecnologías contra puestos de trabajo: el nacimiento de una nueva era*. Barcelona, Editorial Paidós.

⁵ CASTELLS, Manuel; ESPING-ANDERSEN, Gösta (1999): *La transformación del trabajo*. Colomers, La Factoría Cultural, p. 14, regarding the debate created previously by Jeremy Rifkin.

⁶ STANDING, Guy (2011): *The Precariat. The New Dangerous Class*. London and Oxford, Bloomsbury Academic. For the Castilian Edition: *El Precariado. Una nueva clase social*. Barcelona, Ediciones de Pasado y Presente.

1.2. METHODOLOGY

Between December 2018 and April 2019, a survey exclusively in printed format has been deployed by the author⁷ in Barcelona and Girona provinces, asking sixteen general questions, most of them with multiple-choice answers. The mentioned territories contain most of the Catalan population (83.76%), having Barcelona province 73.86% of the total and Girona 9.9%⁸. In this inquiry had participated 1,405 persons, having permanent residence in 218 municipalities⁹, having a greater sample of 41 local entities¹⁰. Some participants live outside the bi-province framework, but still in Catalonia, and had been included in the study. Citizens had been consulted in public spaces and had collaborated several educational centres for adults and other institutions.

The sample is thus representative of three territorial identities: the metropolitan space in Barcelona province, the areas in Barcelona province with less urban density and finally the territory of Girona province. In order to delimit the metropolitan sector, municipalities integrated within the transport system up to the third zone had been considered as «metropolitan», not coinciding with the definition of Barcelona's Metropolitan Area (AMB), which is a public administration conformed by 36 local entities¹¹. This organization excluded important urban centres in the nearest areas¹², and for this reason has been adopted a different approach, always with the objective to be more accurate with the geographical reality. The concept of «metropolitan area» is widely extended all over the world and is preferable to adopt a vision that can foster the international comparability and better comprehension for non-Catalan readers.

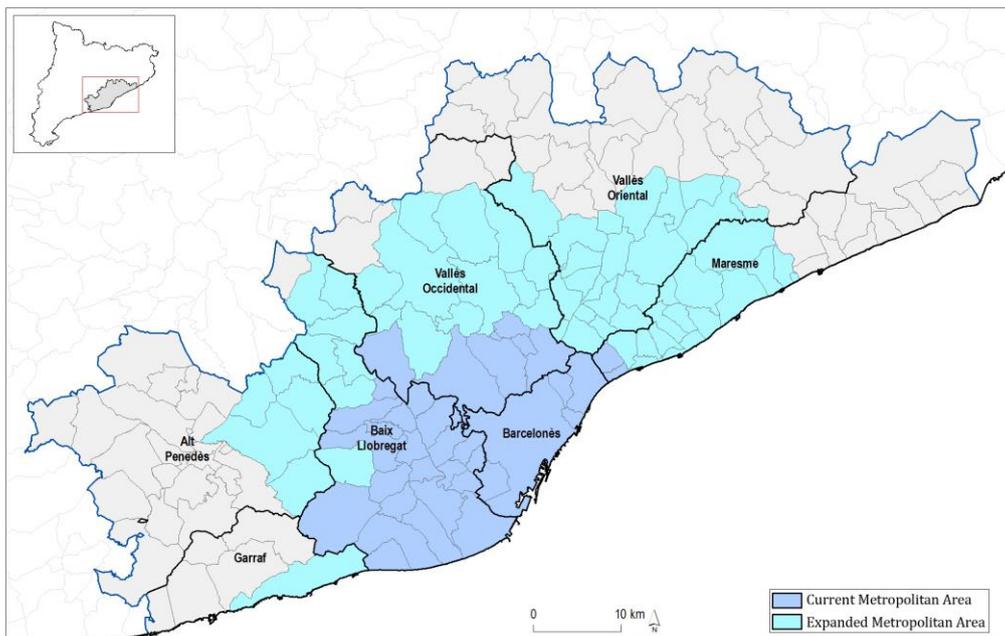


Figure 1. Municipalities integrating the Metropolitan Area of Barcelona and «expanded» concept used in the present research¹³.

⁷ The author has effectuated personally all the process of data gathering, in order to assure the quality of responses.

⁸ According to IDESCAT (The Catalan Institute of Statistics), the population of Catalonia in 2018 was of 7.54 million inhabitants. Barcelona province had 5.57 millions and Girona province only 0.75 millions.

⁹ Vid. Annex I with the classification of municipalities considering their number of participants.

¹⁰ Vid. Annex II with more details about the municipalities where had participated more citizens.

¹¹ According to IDESCAT, the population of the Metropolitan Area of Barcelona (AMB, for the Catalan acronym) was in 2018 of 3.24 million inhabitants, covering 636 square kilometres. For more information about AMB:

<http://www.amb.cat/s/home.html>

¹² For example, the cities of Terrassa, Sabadell, Mataró and Granollers contain together 0.62 million inhabitants.

¹³ Map adapted by the author, extracted from IERMB (Institut d'Estudis Regionals i Metropolitans de Barcelona): <https://iermb.uab.cat/ca/enquestes/enquestes-de-mobilitat/>

This enquiry allows a double analysis. First of all, results can be grouped and studied in the form of a descriptive analysis. This perspective assesses the opinion of citizens regarding their expectations about the future of employment in a twenty years lapse, what could be the preferable regulator over robots and artificial intelligence, and what measures would be better for the surveyed person if he/she was unemployed because of technological innovations, among other interesting aspects that had been object of the consultation. In all sections are used figures elaborated by the author that allow a better understanding of the discoveries of the research.

Also, results are of important utility to conduct an empirical analysis. The number of participants is significant to carry out an econometric model that will assess the factors of the citizens that have influence in delivering a positive or negative opinion about the impact of robots and artificial intelligence over employment. The OLS regression will allow verifying fourteen hypotheses, which will be exposed at Chapter 3 and resolved at Chapter 5.

1.3. THE PRECEDENT RESEARCH OF THE EU PARLIAMENT

As a precedent in the present study, the European Union prepared a public consultation at the beginning of 2017, entitled *Civil Law Rules on Robotics*. Such works followed the Resolution of the EU Parliament of 16 February 2017 (2015/2103 (INL)). This questionnaire was exclusively in online format, and the inquiry was organised by the Directorate General of the European Parliamentary Research Service (EPRS), on the request of the Committee on Legal Affairs.

Two surveys were designed: one for the general public (15 questions) and one for a specialized audience (17 general questions plus 47 optional). Both of them had multiple choice and open ended questions, and five of them had been a methodological source to design the survey that concerns the present analysis, modifying in some cases the text. At the end of the period of data gathering, the European Parliament's public consultation received only 259 responses from private individuals and 39 responses from organizations¹⁴. It should be considered that the European questionnaire was not anonymous, compared to the present case, and that this fact reduces the willingness of citizens to participate, but results are very poor. This problematic has encouraged the author to conduct a specific research covering Catalonia.

It is clear that the European Union has enough resources to conduct a better study by obtaining a greater sample. In fact, the EU has invested 2.6 billion euros of the programme Horizon 2020 over artificial intelligence related areas, like robots, big data, health, transport and other emerging technologies¹⁵. The EU is aiming at becoming a global leader in robotics and AI, and the main initial goal is based in establishing a stable legal environment to promote the trust of citizens and businesses, necessary to achieve the leadership afterwards¹⁶. For this reason, surprises the low commitment of the EPRS to conduct the mentioned public consultation. The general perception is that Europe is lagging behind the United States, China, Japan and South Korea on technological matters and this gap could be amplified in the following years. The next chapter will assess if this point of view is justified or not.

¹⁴ DIRECTORATE GENERAL OF THE EU PARLIAMENTARY RESEARCH SERVICE (2017): *Summary of the public consultation on the future of robotics and artificial intelligence (AI) with an emphasis on civil law rules*. On line [Last consultation in 30/08/2019]:

<http://www.europarl.europa.eu/cmsdata/130181/public-consultation-robotics-summary-report.pdf>

¹⁵ The sum of EU's public (700 million euros) and private (2.1 billion euros) funds. EUROPEAN COMMISSION (2018): *Artificial Intelligence for Europe*. Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Brussels, COM (2018) 237 final, p. 5.

¹⁶ THIRION, Elodie (2019): *Cost of non-Europe in robotics and artificial intelligence. Liability, insurance and risk management*. Brussels and Strasbourg, European Parliamentary Research Service, PE 631.752, p. 18.



Chapter II / International overview

2. INTERNATIONAL OVERVIEW

This section will develop a brief international analysis, studying some of the main magnitudes related to automation. Here had been selected eight countries, which represent four distinct social models: the European-Continental (France and Spain), the European-Scandinavian (Sweden and Norway), the Anglo-Saxon (United Kingdom and United States of America) and the most advanced societies in Asia (Japan and South Korea). The exposed countries had been chosen also because of a larger availability of data from international organisations and will be represented in the next sections with specific colours. In order to be more accurate, had been analysed NUTS 2 magnitudes from Eurostat to understand better the position of Catalonia in the European context.

2.1. PRODUCTIVITY

The following graph illustrates the evolution of productivity in the mentioned countries over the last decades, concretely the productivity derived from the factor of labour (gross domestic product per hour worked). It is characterised by a sustained growth, which according to «classic» postulates of economics, implies that the relationship between factors of production of the economy and time is improved progressively. In other words, with the same effort of employees, the economy can produce more, and the resulting welfare can be distributed among the members of society. Despite this, in the last decades the expected path has been divergent from theory: real salaries are not improved by productivity increments and inequality is soaring.

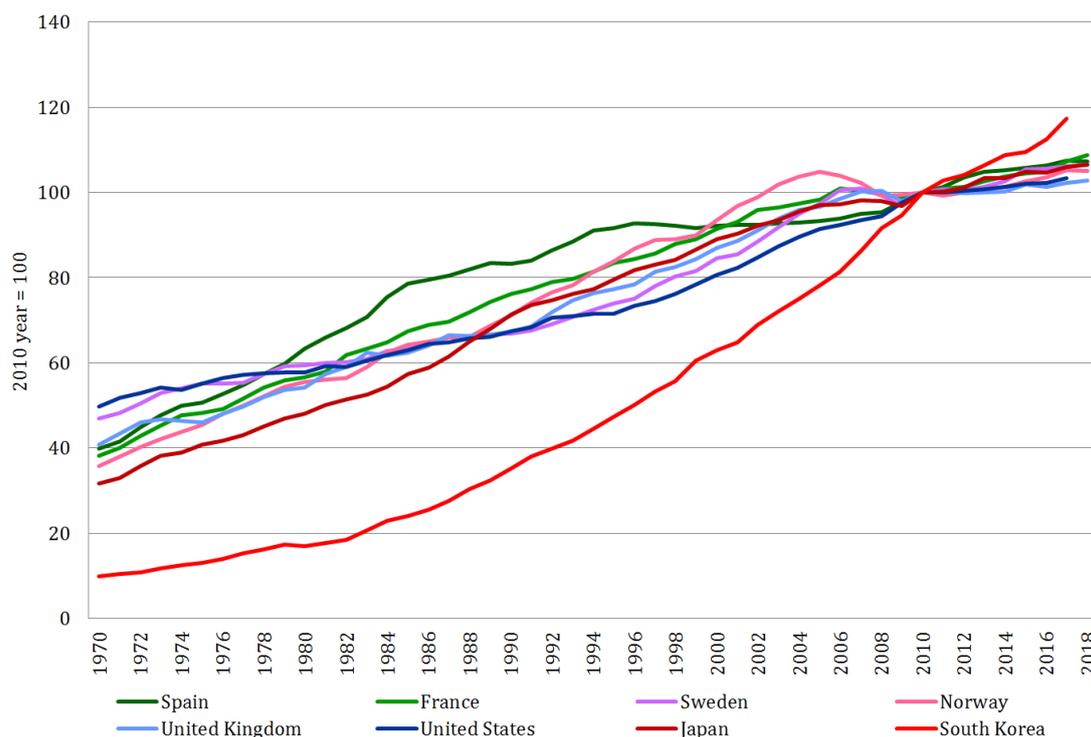


Figure 2. GDP per hour worked as a measure of productivity derived from labour (1970 – 2018)¹⁷.

The graph shall be viewed as having the year 2010 as the reference. During the 80s, Spain positioned at levels that were progressively stabilising, which is very different from South Korea, still growing. From 2005 to 2010, Norway’s productivity suffered a remarkable descent. In most of advanced economies, the growth rate of productivity has decreased over years, and in countries like Italy has experienced negative values. This fact can be explained by an ageing population.

¹⁷ Graph created by the author. Source of data: OECD (2019): GDP per hour worked (indicator). DOI: 10.1787/1439e590-en

2.2. ACTIVITY RATE

Over years, the fraction of population employed and searching to be employed has increased in all the countries object of study. The factors that had determined this greater proportion are the extension of part-time jobs and the increase in women's (official) labour force. When observing the graph, the departing point of Spain was the lowest one, and after 1986, when the country joins the European Economic Community, registers a sharp increase that stops after the beginning of the crisis in 2008. Norway had a similar beginning, but at the time Spain was entering at the Union, the Nordic country had arrived at far superior levels, approaching to half of the population being active. The same path was followed by the United States, but during the 90s stabilised the ratio. Considering the present moment, France is the country with the lowest rate, only considered to be active 44.20% of the total population.

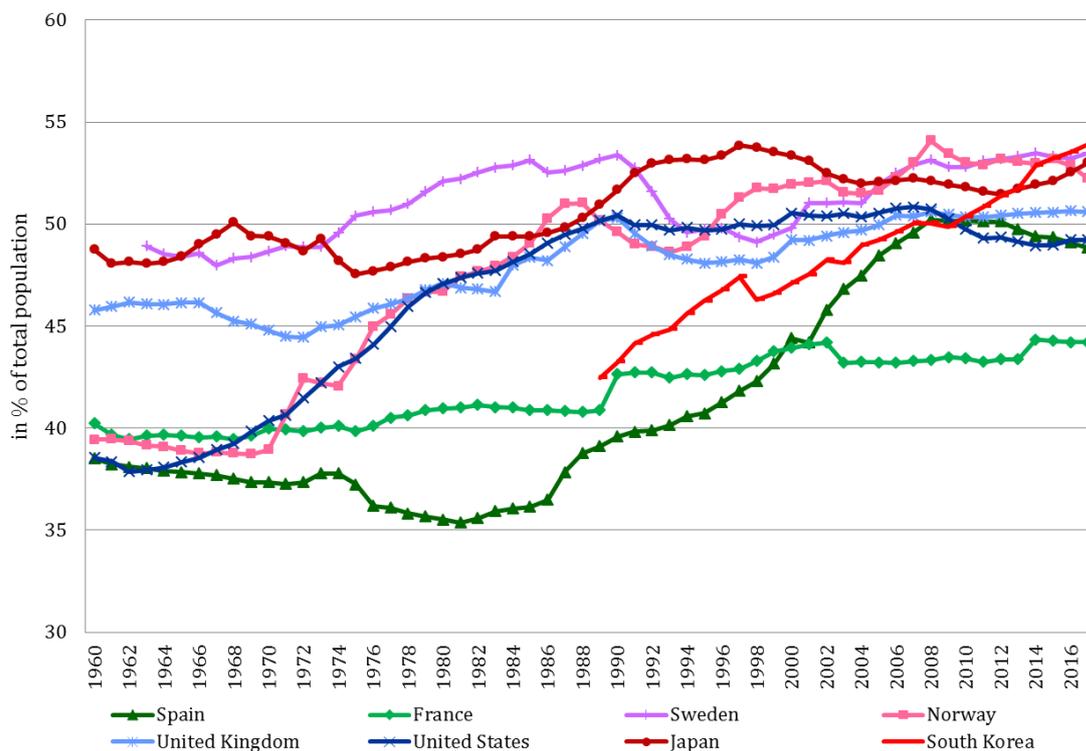


Figure 3. Activity rate: labour force divided by the total population (1960 – 2017)¹⁸.

The activity rate has important implications for the future of work. In a context of hypothetical scarcity of employment caused by the diffusion of new technologies, having an important fraction of the population without being able to find a job would cause social unrest. Moreover, in developed countries is becoming extended the fact that employed individuals cannot satisfy a minimum level of income due to part-time jobs and salaries, which are insufficient to cover their monthly expenses, and fall into a poverty spiral grounded on very unstable jobs in a time where the support of the community has been eroded¹⁹. In Spain, 38% of the unemployed population is aged more than 45 years old and 61% of them are represented by women²⁰. Discriminations, based on age and gender among other aspects, are at the focus of an important loss of human talent and become incompatible with societies of large life expectancies, as will be assessed at the following section.

¹⁸ Graph created by the author. Source of data:

OECD (2018): *Labour force* (indicator). DOI: 10.1787/ef2e7159-en

United Nations Population Division. Published by the World Bank (2018).

¹⁹ STANDING, Guy (2011): *The Precariat. The New Dangerous Class* (op. cit.), pp. 87-88 (Castilian edition).

²⁰ ZURDO, Juan Pablo (2019): "La oportunidad de una vida mejor". *Cruz Roja*, No. 1.019, p. 11.

2.3. ELDERLY POPULATION

One of the greatest challenges for advanced economies is the demographic stagnation, which will have an important impact over the following decades. Mass media has treated this issue only referring to the difficulties that will arise over the pension system²¹, but in practice the outcomes will also affect productivity and the competitiveness of countries at the long run. In such context, the diffusion of robots and automation processes could help to mitigate the undesired effects. The graph below shows the percentage of the total population aged more than 65 years old. All the countries have experienced a sustained increment over years, with the exception of certain decades, where the migratory flows have reduced the general trend (like France in 1978-84).

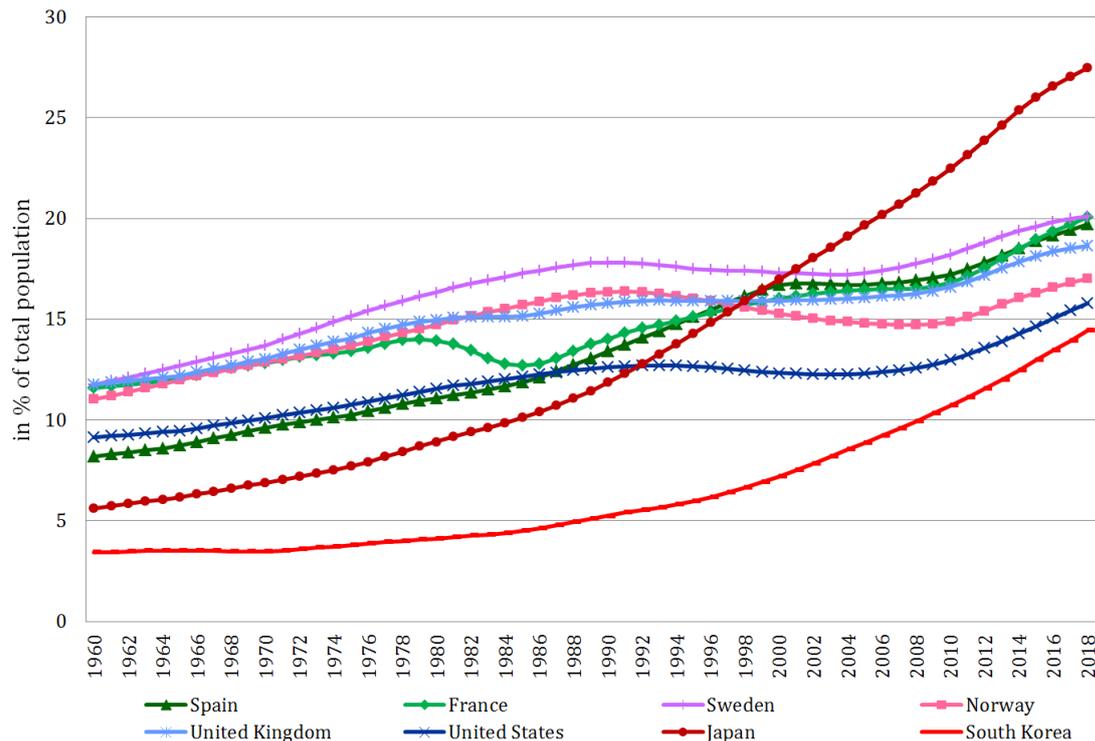


Figure 4. Percentage of population aged 65 years old and above, related to the total population²².

The departing point of Asian countries was clearly below the average, but Japan surpassed the Western block at the change of millennium and now is the country with the largest fraction of elderly population. The number of inhabitants of this archipelagic State is decreasing since December 2018, when reached approximately 128 million inhabitants, and it is expected to arrive at 100 million inhabitants by 2050. This demographic crisis is unprecedented in human history²³. European countries follow a similar path, partially smoothed by the arrival of foreign citizens. In the next decades, will take place a demographic implosion in Europe, while in Africa will be precisely the contrary, a large expansion that is estimated to double the current population of the continent at 2050²⁴. In a context of climate change and wars for the scarce resources available, the migratory pressure on Europe will be considerable.

²¹ Thereby promoting contributions of employed citizens to the private pension funds. More expenses for families.

²² Graph created by the author. Source of data:

WORLD BANK (2019): *Population aged 65 and above (% of total population)*. Code: SP.POP.65UP.TO.ZS. Data originally extracted from the United Nations Population Division: *World Population Prospects*.

²³ KATO, Hisakazu (2019): “¿Sobrevivirá Japón con una sociedad des poblada y envejecida?”. *Vanguardia Dossier*, No. 71, pp. 51-52.

²⁴ BOUSSEMART, Jean-Michel; GODET, Michel (2018): “Europe 2050: Demographic Suicide”. *European Issues*, No. 462. Paris and Brussels, Fondation Robert Schuman, p. 2.

2.4. LABOUR HOURS PER WORKER

Very related with the activity rate is the count of labour hours per worker in every country. In this case, most of the countries had experienced an important decrease of labour time since 1977. The only exception is Sweden, fluctuating around 1,600 annual hours. When observing the reduction of labour time, it is clear that two factors are key for this change: at first, the openness of international trade has allowed that countries that were kept only as reserves of commodities until the 70s, had entered to the global value chain providing low cost labour force and had absorbed part of the production of goods, that previously was concentrated in the so-called «Triad» (Europe, North America and Japan)²⁵. And secondly, new technologies had increased the general productivity of workers, and by these means the same output is produced consuming less units of time. Here, the analysis focuses only in the case of developed countries, but of course would be very interesting to analyse specific data regarding certain regions of China, India and Bangladesh.

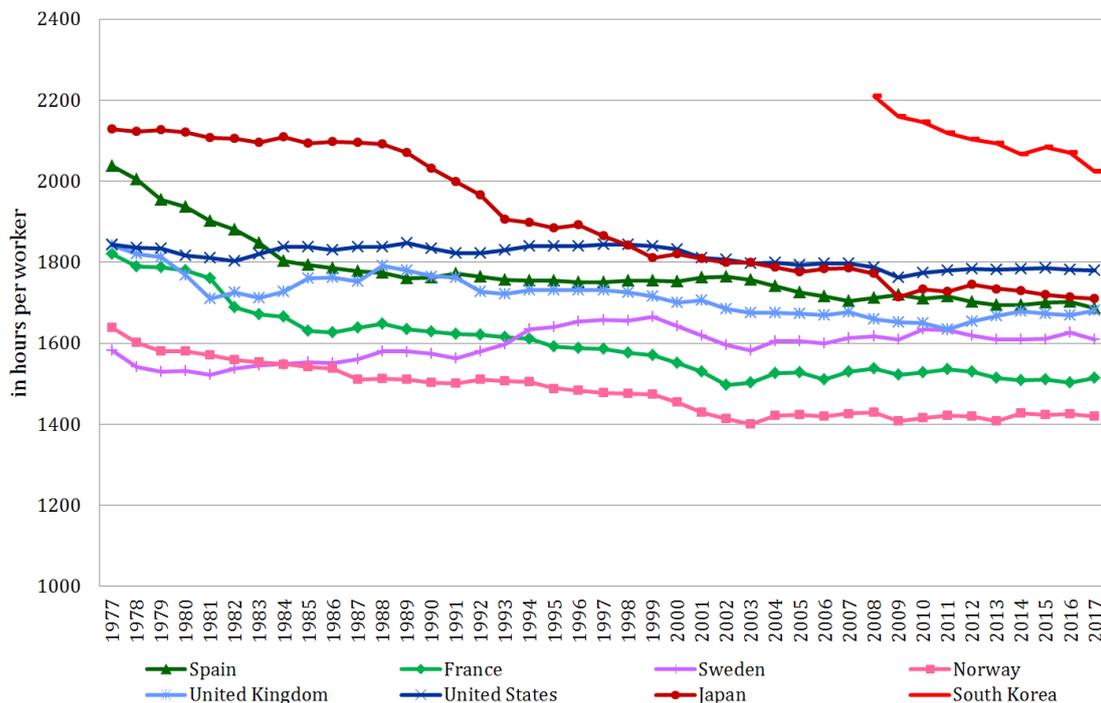


Figure 5. Annual labour hours per worker (1977 – 2017)²⁶.

At the beginning, Spain and Japan were at the top in terms of labour hours per worker. Of course, this measure does not consider the productivity of each worker, only measures the average time officially dedicated to labour activities. In 2008, the first year with data from South Korea, the country appears to be at the same levels of the 1970s in the other OECD countries, a fact that indicates that legislative standards there are set far from European social protections. Norway, France and Sweden, by this order, are at the lowest levels of labour hours per worker, getting Sweden more closely to the Anglo-Saxon countries over years. Spain and Japan appear at similar levels, but shall be considered the fact that extra hours are not counted in most of the cases, and the Nippon country would be for sure an international champion in this matter²⁷.

²⁵ MUNCK, Ronaldo (2002): *Globalisation and Labour*. Delhi, Madhyam Books. London, Zed Books. For the Castilian edition (2008): *Globalización y trabajo. La nueva "Gran Transformación"*. Vilassar de Dalt, Ediciones de Intervención Cultural / El Viejo Topo, pp. 59-67.

²⁶ Graph created by the author. Source of data:

OECD (2018): *Hours worked* (indicator). DOI: 10.1787/47be1c78-en

²⁷ In Japan, extra hours are called «Zangyō» (残業). Since 2018, the Government has limited them by law: 100 hours monthly and 720 hours annually, in order to affront the negative effects over health and the «Karoshi» (過労死) (death produced by work overload), that is publicly recognised since the end of the 80s.

2.5. DIFFUSION OF INDUSTRIAL ROBOTS

It is fundamental to assess the availability of industrial robots in the countries object of study. Their number is rising continuously and they represent the principal threat to manufacturing workers. Industry has been basic to assure stability and prosperity in advanced economies. In fact, the bargain between elites and organised labour has fostered the development of democracy and welfare States²⁸. Now, after a sustained period of delocalisation to countries where the labour force implied less costs, some factories are returning to the West, but completely automated. This fact allows them to be more competitive and nearer to the final consumer markets, notwithstanding the fact that important employment opportunities are not generated anymore, and the previous balance among social classes is disappearing in favour of greater inequality.

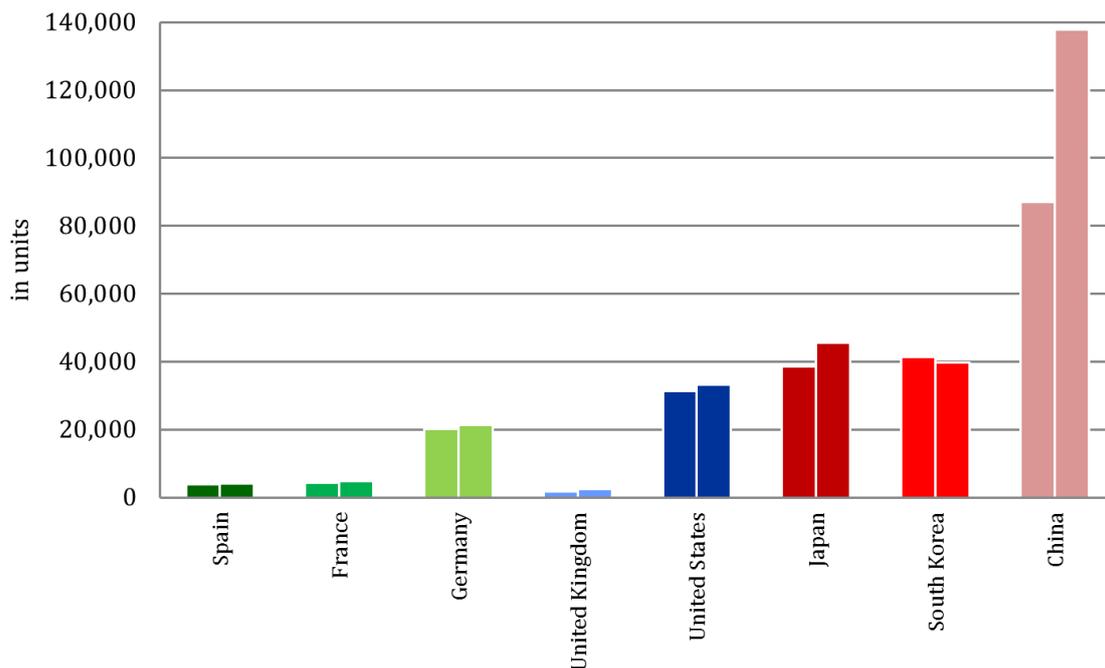


Figure 6. Estimated annual sales of multipurpose industrial robots, 2016 and 2017²⁹.

The lack of data covering Sweden and Norway allows showing in the previous graph the cases of Germany and China, which cannot be neglected. The divergent path of the European economies will be intensified for sure in the next decades, as Germany is producing and stocking an important amount of industrial robots. This fact will allow the «Bundesrepublik» to increase its competitiveness and take advantage of the continental markets, whilst other European countries will not be able to compete in this technological scenery and will suffer the pains of free trade³⁰. But the greatest concern is located in Asia. Japan and South Korea are investing in new technologies and are not losing employments in industry thanks to their high competitiveness. And China has opted for a clear expansionist strategy. By 2025, the «golden years» for foreign companies to invest in the country will have ended, as Chinese producers will have learnt from them how to be competitive in China (and abroad)³¹. The shift of power could be completed.

²⁸ RODRIK, Dani (2016): “Premature deindustrialization”. *Journal of Economic Growth*, Vol. 21, No. 1, p. 29.

²⁹ Graph created by the author. Source of data:

INTERNATIONAL FEDERATION OF ROBOTICS (2018): *World Robotics 2018. Industrial Robots*. Executive Summary, p. 21. On line [Last consultation in 30/08/2019]:

https://ifr.org/downloads/press2018/Executive_Summary_WR_2018_Industrial_Robots.pdf

³⁰ The «Brexit» could help the United Kingdom to protect the remaining industries from the mentioned impact.

³¹ WÜBBEKE, Jost; MEISSNER, Mirjam; ZENGLIN, Max; IVES, Jaqueline; CONRAD, Björn (2016): “Made in China 2025. The making of a high-tech superpower and consequences for industrial countries”. *Merics papers on China*, No. 2. Mercator Institute for China Studies, p. 57.

2.6. AUTOMATION: JOBS AT POTENTIAL HIGH RISK

Predicting the impact of automation is a difficult exercise, at which economists have not succeeded in reaching the appropriate consensus among them. The academic discussion attained the public debate when in 2013 was published a seminal paper by Carl Benedikt Frey and Michael Osborne, that predicted a risk of computerisation of 47% of the United States' jobs in a period going from ten to twenty years³². They also referred to the specific occupations that could be computerised, establishing a ranking covering 702 of them, detecting important risks in transportation and logistics, administrative support and manufacturing employments.

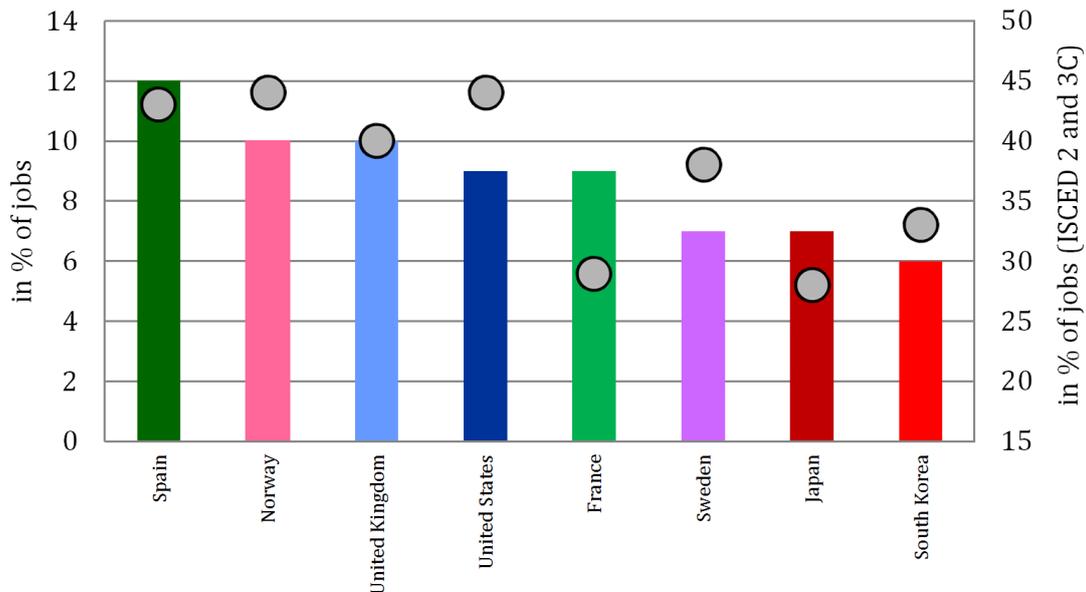


Figure 7. Estimated share of jobs at potential high risk of automation (coloured bars). Estimated share of citizens with high vulnerability to automation, with ISCED 2 and 3C (grey dots)³³.

The findings of the mentioned study were considered to be alarming and unfounded, as jobs are integrated of specific tasks, which are susceptible to be automated in different degrees. This is the perspective adopted by the Organisation of Economic Co-Operation and Development (OECD) in several pieces of research. At Figure 7 is represented the estimated percentage of jobs that are at potential «high risk» of automation in the countries of study. The results do not attain half of the labour force and move between 6 and 12% of current employment (in coloured bars)³⁴. The graph also depicts the percentage of jobs with levels of qualification ISCED 2 and 3C that are highly vulnerable to the impact of new technologies (grey dots). The cited educational grades are equivalent to lower secondary, and also upper secondary programmes destined to enter at the labour market³⁵, that in Catalonia are analogous to ESO and medium FP. Estimations show that Spain is the country with the highest risk of automation. Also, workers with low qualifications and educated youth are exposed to greater vulnerability³⁶. The list continues with other European and Anglo-Saxon countries, finishing in Asian advanced economies, with much lower risks.

³² FREY, Carl Benedikt; OSBORNE, Michael (2013): “The future of employment: how susceptible are jobs to computerisation?”. *Technological Forecasting and Social Change*, Vol. 114 (2017), pp. 254-280.

³³ Graph created by the author. Source of data:

ARNTZ, Melanie; GREGORY, Terry; ZIERAHN, Ulrich (2016): “The risk of automation for jobs in OECD countries. A comparative analysis”. OECD Social, Employment and Migration Working Papers, No. 189, pp. 33-34.

³⁴ Despite this, their research still estimates a 32% of «substantial changes» in how jobs are carried out, on average.

³⁵ OECD (1999): *Classifying Educational Programmes. Manual for ISCED-97 Implementation in OECD Countries*. Paris, OECD Publishing, pp. 33-40. In 2011 the classification was partially modified.

³⁶ This also appears in the other OECD members, as low skilled workers generally have less interest in re-training themselves. OECD (2018): “Putting faces to the jobs at risk of automation”, *Policy Brief on the Future of Work*, p. 2.

2.7. AUTOMATION: THE THREE WAVES

It is expected that automation will come in the form of three overlapping waves. The first one, now on the move, is qualified as «algorithm wave». Simple computational tasks and analysis of structured data are automated. The sectors that appear more affected are finance³⁷, insurances, information and communications. The second period is called the «augmentation wave», and focuses on automation of repeatable tasks, like filling forms, exchanging and communicating information through dynamic technological support, and analysing unstructured data in semi-controlled environments (for example, aerial drones and warehouse robots). Here the sectors more impacted will be the public administration, manufacturing and storage. This wave could reach the moment of plenitude in the mid-2020s. And the last moment is the «autonomy wave», based on the robotisation of physical labour and manual dexterity. Construction and transport, areas which require responsive actions from professionals, will be the sectors more affected. This wave would attain an important level of maturity in the 2030s³⁸.

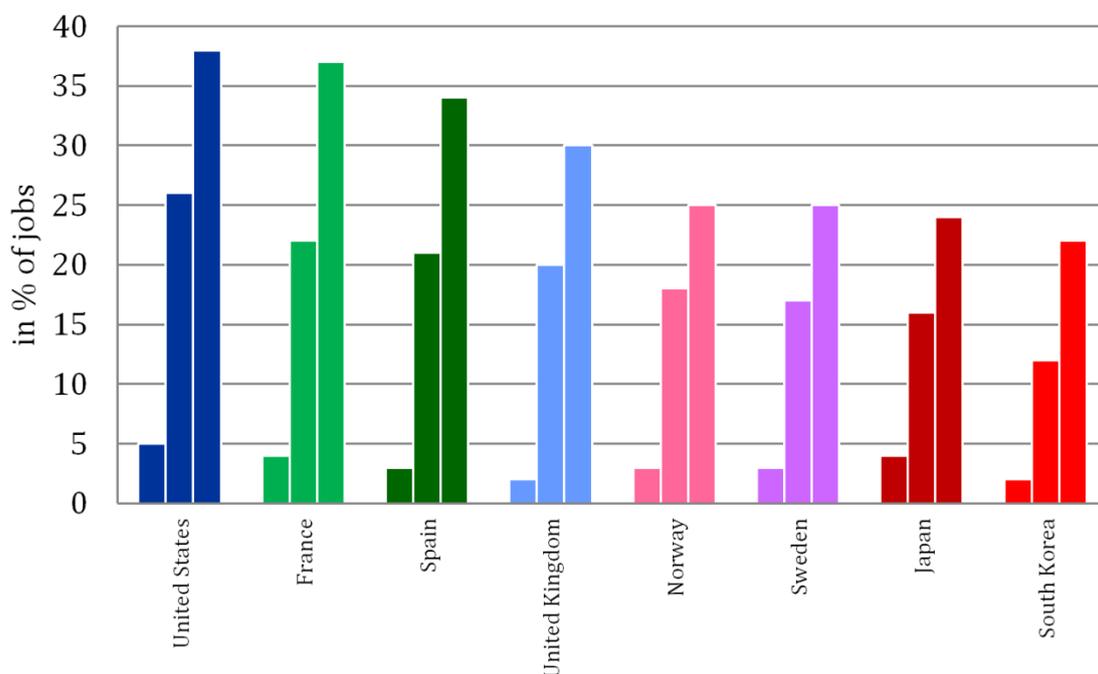


Figure 8. Estimated share of jobs at potential high risk of automation for each of the three waves³⁹. Figures are cumulative: the final column includes the hypothetical impacts of the previous ones.

In this case, the analysis of PWC has put Spain in the third place of the ranking of the studied countries, and the United States appear as the country with the greatest impact, at 38% of current jobs when all the three waves have manifested their effects. It shall be considered that these estimations are based on the technical feasibility of automation, but there are other factors that may limit its presumable implementation, like economic, legal and organisational constraints. *Ab initio*, Japan is the second country that experiences the largest impact of the «autonomy wave», but after this moment, a clear division among the four categories of countries is defined. Overall, it is expected that Asian advanced economies and European-Scandinavian countries could be less impacted by computerisation.

³⁷ In fact, between the final of 2007 and 2017, the Spanish banks had closed 39.6% of the existent offices and had reduced their workers in a proportion of 30.5%. *20 minutos* online newspaper [Last consultation in 30/08/2019]: <https://www.20minutos.es/noticia/3420854/0/bancos-despidos-trabajadores-crisis/>

³⁸ HAWKSWORTH, John; BERRIMAN, Richard; GOEL, Saloni (2018): *Will robots really steal our jobs? An international analysis of the potential long term impact of automation*. London, PricewaterhouseCoopers LLP, p. 6.

³⁹ Graph created by the author. Source of data:

HAWKSWORTH, John; BERRIMAN, Richard; GOEL, Saloni (2018): *Will robots really steal... (op. cit.)*, p. 16.

2.8. UNEMPLOYMENT RATE

The change in statistical definitions over years to count precisely the unemployment rate, affects the comparability of analysis during large periods. For example, in some cases individuals that are enrolled in studies are dropped from the unemployment count, and in previous analysis they were included. Moreover, the diffusion of part-time jobs is a way to redistribute labour hours among citizens. It is clear that those cannot be compared as full-time occupations, in terms of professional dedication and earnings, but individuals are equally qualified as «employed». In this sense, it could be estimated that using the previous methodology the unemployment rate would be at the present moment much higher than what statistics indicate. Here is used the current OECD definition⁴⁰.

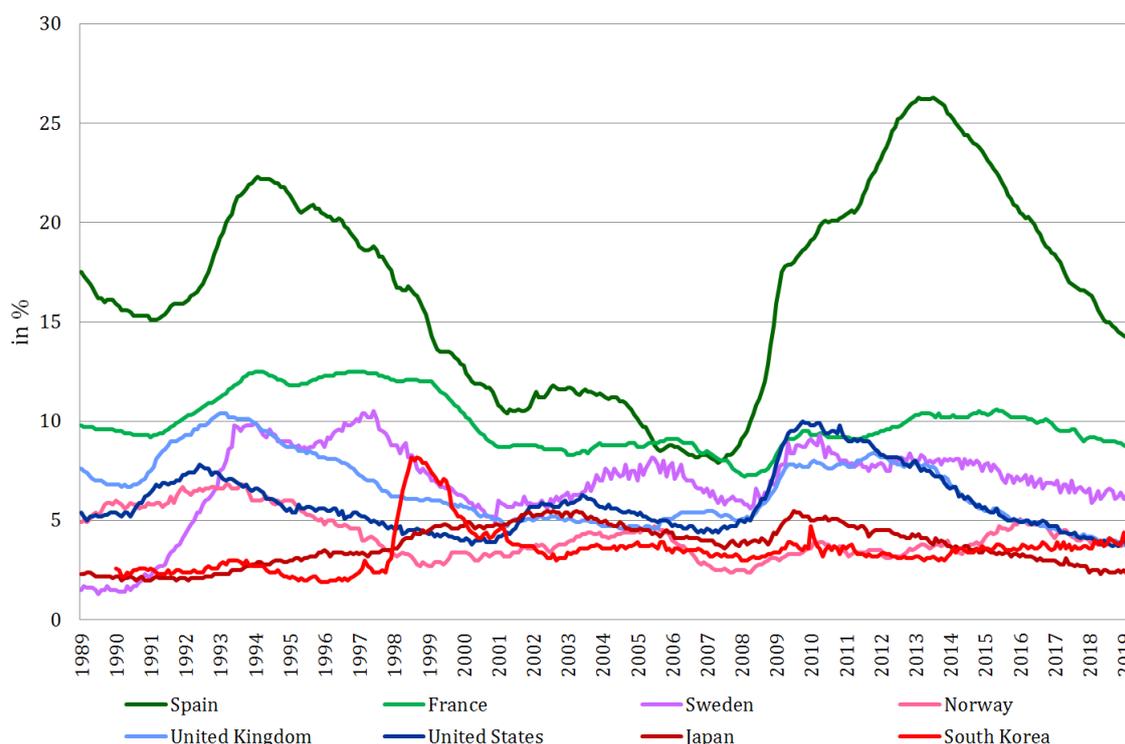


Figure 9. Monthly unemployment rate (January 1989 – April 2019)⁴¹.

The upper graph shows the fluctuation of the unemployment rate over the last three decades, on a monthly basis. There is one country that exceeds the normal parameters: Spain. In April 2019, the unemployment rate of Spain was of 14.20%, contrasting with Japan, where it is situated at 2.4%. Besides it is relevant to identify the peaks of unemployment over time. During the last international financial crisis in 2008, the United States, Sweden and Japan suffered their top unemployment levels in 2009-2010. Since 2012, the USA and the UK follow quite similar paths. In contrast, Spain and France experienced the highest level in 2013-2014, which is an indicator of other reasons behind (that is, the real estate bubble in Spain and the disappearance of the traditional credit institutions –with a social orientation–, the sovereign debt crisis and the high dependence of the employment generated by public administrations). Despite this, the discourse in Europe has centred mainly on transatlantic subprime mortgages. When considering the impact of automation, it is clear how countries in Continental Europe have a dangerous departing point.

⁴⁰ According to OECD, the *Harmonised Unemployment Rate* defines the unemployed as «people of working age who are without work, are available for work, and have taken specific states to find work».

⁴¹ Graph created by the author. Source of data:

OECD (2019): *Harmonised unemployment rate (HUR)* (indicator). DOI: 10.1787/52570002-en

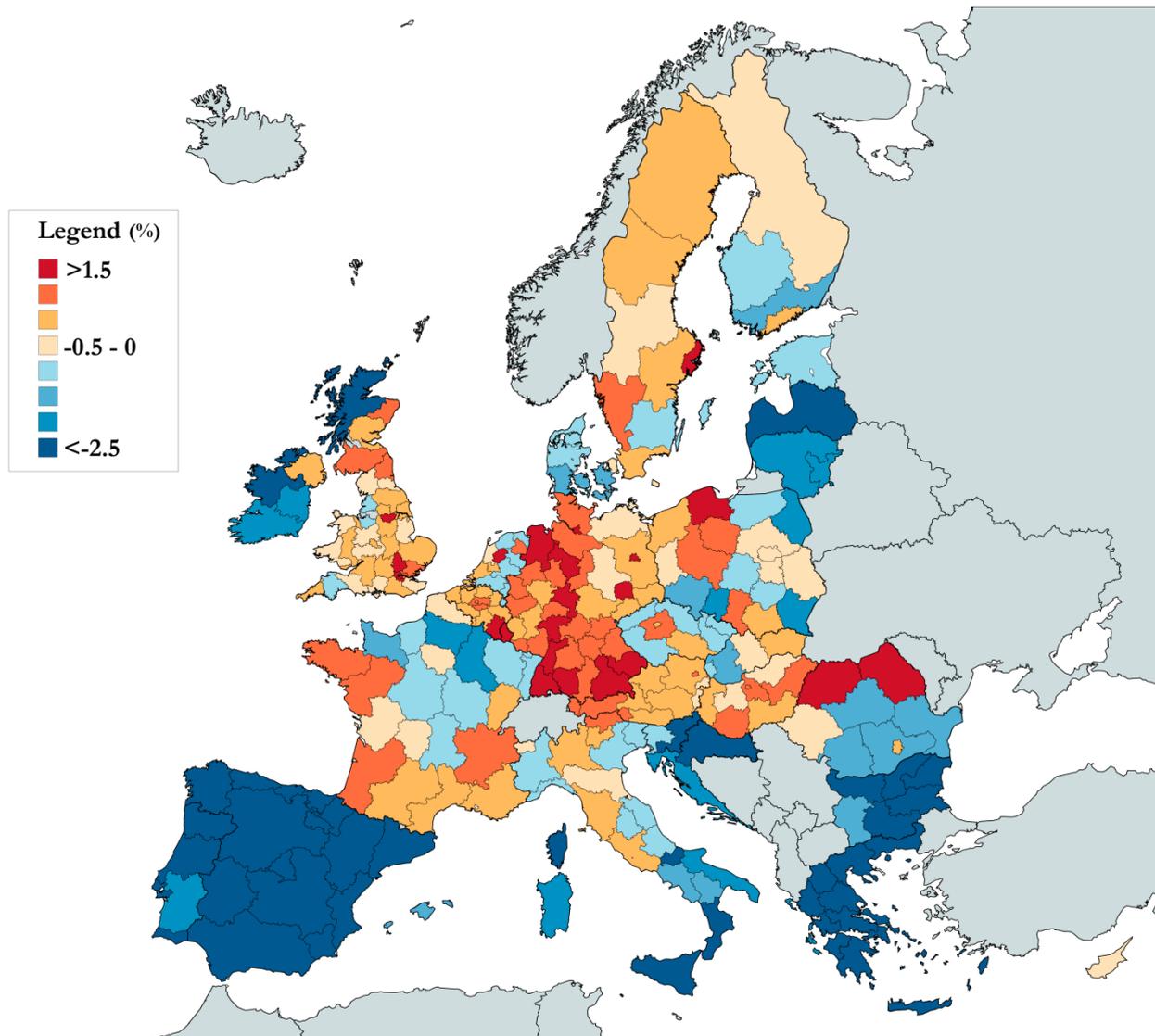


Figure 10. Average employment change, by NUTS 2 regions (2008-2013)⁴².

The previous figure comprehends a remarkable time lapse: 2008-2013. In 2008, began the international financial crisis, but in 2013 several countries had partially escaped from its effects and by then were recovering their employment levels, particularly Germany, Austria, Sweden and certain regions of Poland. Notwithstanding this fact, peripheral regions in Europe were severely affected and remained sunk for a long period of time: the private debt crisis turned into a sovereign debt crisis. These territories are represented by the Iberian Peninsula, Southern Italy, Greece, Ireland, Bulgaria, Romania and the Baltic States. In contrast with the dominant media discourse, this is not a simple North-South divide; it is clearly a core-periphery pattern⁴³, reinforced by the single currency. In this sense, the mentioned regions appear more vulnerable in the future scenery of the deployment of automation. It should be considered that the Slavic-Magyar States that entered in the EU at 2004, all of them with a sovereign currency, received more funding supports to help them converge to similar technological and living standards.

⁴² Graph created by the author using the software *mapchart.net*. Source of data:

STIERLE, Michael; STIERLE – VON SCHÜTZ, Ulrike; ROCHER, Stijn (2018): “How did Regional Economic Structure in the EU Change during the Economic Crisis?”. *European Economy Discussion Papers*, No. 88. Luxembourg, Publications Office of the European Union, p. 13.

⁴³ CRESCENZI, Riccardo; LUCA, Davide; MILIO, Simona (2015): “The geography of the economic crisis in Europe: national macroeconomic conditions, regional structural factors and short-term economic performance”. *Cambridge Journal of Regions, Economy and Society*, No. 9, pp. 27-28.

2.9. POPULATION WORKING IN THE INDUSTRIAL SECTOR

Advanced economies are often called to be «post-industrial» societies, considering the reduction of the weight of the industrial sector in the economy and the increase of the services. The present graph depicts the percentage of population between 15 and 64 years old (the working age range in most of the countries) that is employed in industry. In the case of Western countries, we can identify easily an important descent that is stabilised approximately in 2010. In contrast, Japan and South Korea exhibit a stable path during the period and maintain themselves at remarkable levels of employment at the present moment.

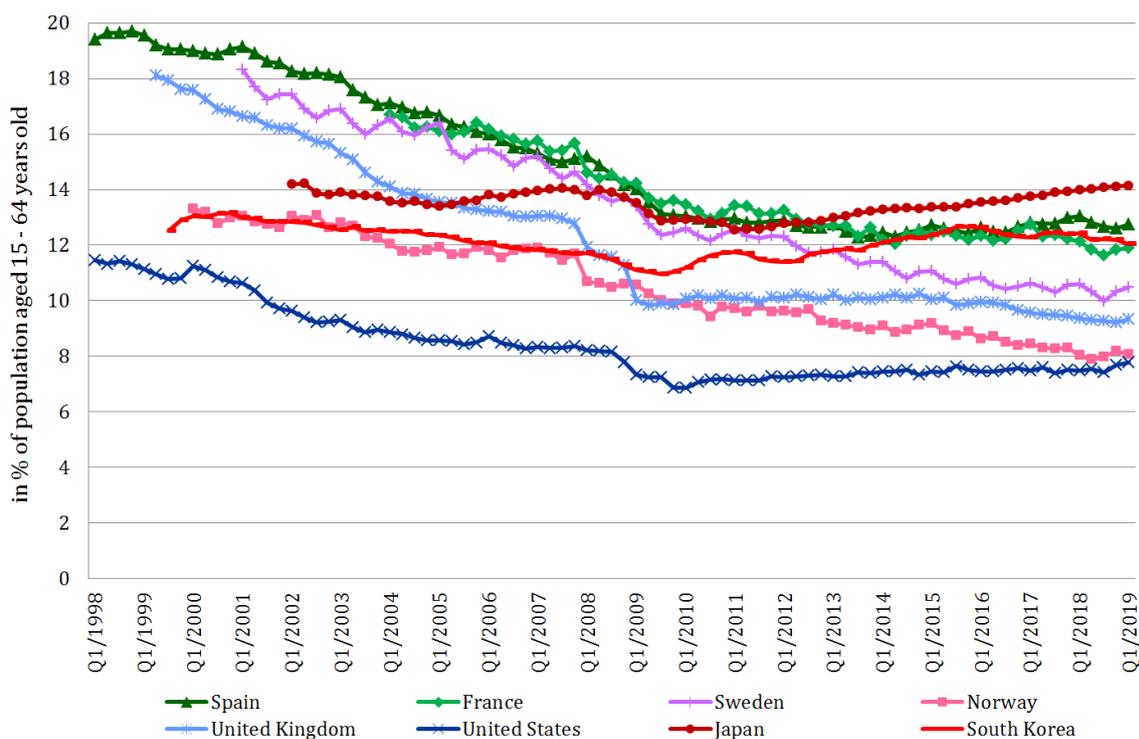


Figure 11. Percentage of population employed in the industrial sector, related to the population aged between 15 and 64 years old⁴⁴.

Having a national industrial policy that generates employment in the long run is fundamental to assure the relevance of the country tomorrow. This is a key issue that has been understood well by Japan and South Korea, but not in Europe⁴⁵ and North America. When factories close, the «know-how» of their workers is abandoned out of the system, and impoverishes the capacity of the country to innovate and sustain its competitive advantage. The abrupt descent over the last decades of the industrial population in Anglo-Saxon countries, analysed previously, has been one of the causes of the discontent of their citizens and the resulting political instability. Spain and France maintain better levels, but the irruption of another economic crisis would change the set.

⁴⁴ Graph created by the author. Source of data:

OECD (2019): *Employment by activity* (indicator). DOI: 10.1787/a258bb52-en

EUROSTAT (2019): *Quarterly population by sex, age, degree of urbanisation and labour status*.

Code: lfsq_pgauws. On line [Last consultation in 30/08/2019]:

https://ec.europa.eu/eurostat/web/products-datasets/product?code=lfsq_pgauws

FEDERAL RESERVE. BANK OF ST. LOUIS (2019): *Working Age Population: Aged 15-64*.

On line [Last consultation in 30/08/2019]. Codes:

LFWA64TTJPQ647S (Japan). <https://fred.stlouisfed.org/series/LFWA64TTJPQ647S>

LFWA64TTKRQ647S (South Korea): <https://fred.stlouisfed.org/series/LFWA64TTKRQ647S>

LFWA64TTUSQ647S (United States): <https://fred.stlouisfed.org/series/LFWA64TTUSQ647S>

⁴⁵ In a different sense, has been issued recently the Resolution of the EU Parliament of 12 February 2019, on a comprehensive European industrial policy on artificial intelligence and robotics (2018/2088 (INI)).

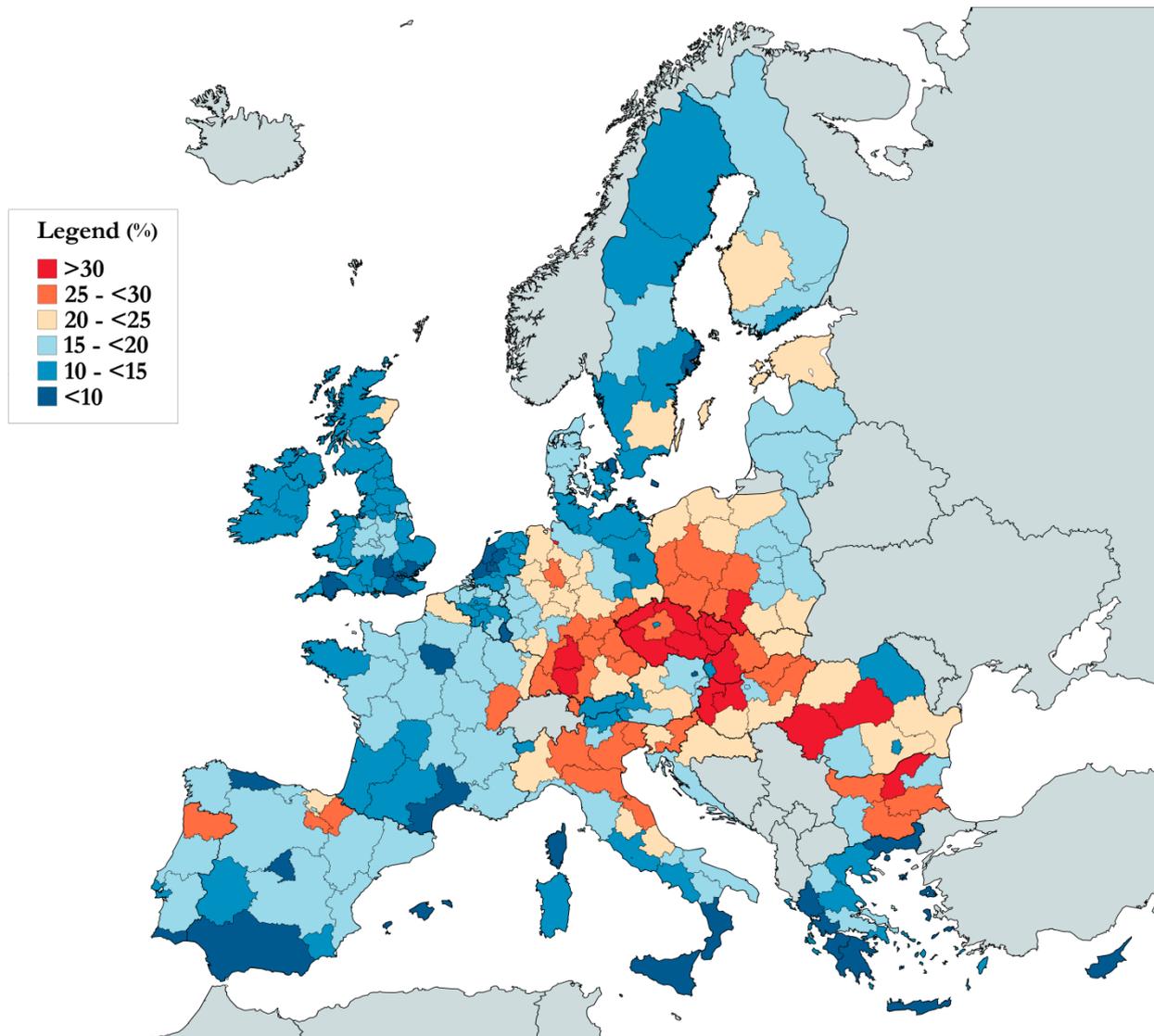


Figure 12. Share of industry in employment, by NUTS 2 regions (2013)⁴⁶.

As in the previous graph, it is quite astonishing to observe the United Kingdom, motherland of the industrial revolution and member of the G7, to be in such a low position of employment related to the secondary sector. Similar characteristics are found in France and Nordic States. In contrast, the regions situated in Southern Germany and newly incorporated States at the Union show a very different pattern. As an example, Czech Republic has indexes of industrial employment superior than 30%. The favourable trends of the currency and the lower salaries of qualified workers attract German investors. Moreover, environmental standards are lower than in other European States⁴⁷. Industrial occupations represent a favourable indicator at the short run, as employments are characterised by more stability in terms of salaries and working conditions, but at the long run, computerisation can suppose an important threat over these jobs, especially during the «augmentation wave». It is estimated that in Czech Republic the automation processes can put at high risk 40% of the current jobs when the «autonomy wave» has been deployed. In Slovenia and Lithuania the proportion is higher (42%). Slovakia has a risk estimated at 44%⁴⁸.

⁴⁶ Graph created by the author using the software *mapchart.net*. Source of data:

STIERLE, Michael; STIERLE – VON SCHÜTZ, Ulrike; ROCHER, Stijn (2018), *Op. cit.*, p. 29.

⁴⁷ The Interreg programme *Central Europe* covers an area of 76 NUTS 2 regions, integrated in nine EU Member States. With the financial support of the European Regional Development Fund, it aims the international cooperation to reduce high carbon emissions by increasing energy efficiency and renewable energy usage, among other goals.

⁴⁸ HAWKSWORTH, John; BERRIMAN, Richard; GOEL, Saloni (2018): *op. cit.*, p. 16.

2.10. GENERAL PUBLIC DEBT

Public expenditure can be financed by the emission of financial instruments by States and other administrations. Advanced economies have relied on them to maintain their spending capabilities, especially in moments of crisis. The following graph represents the ratio of public debt related to the gross domestic product of the country, that is, the value of all the output produced in a year related to the debt accumulated. This is a count that allows comparability among countries, but is not perfect, as the debt (in absolute values) can grow indefinitely without being well perceived.

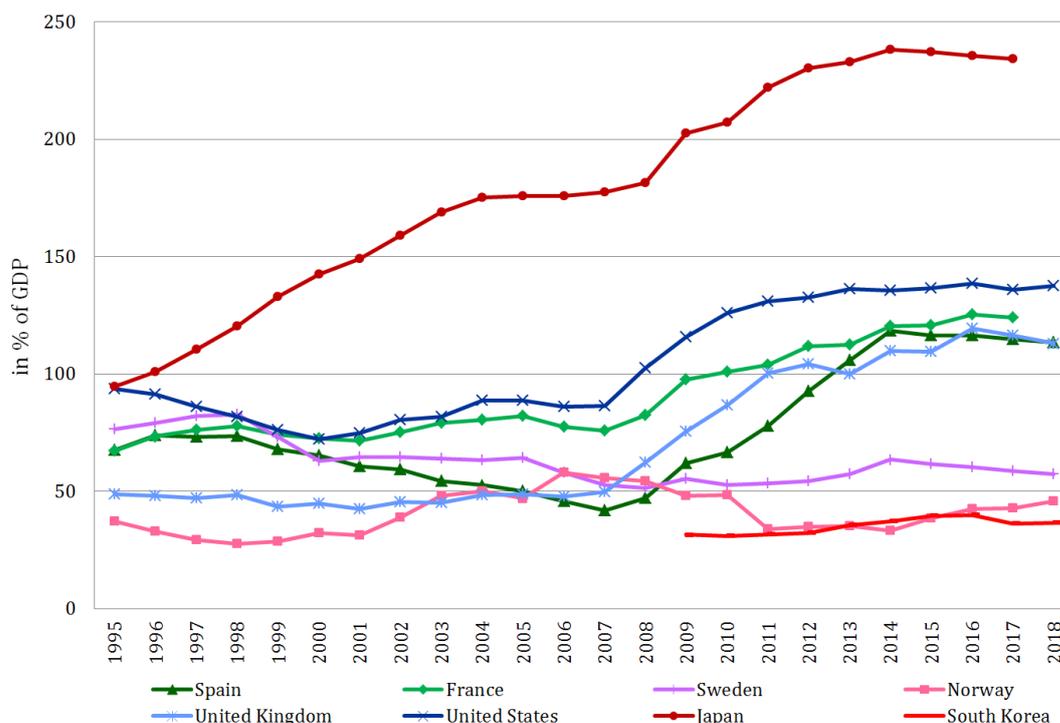


Figure 13. Gross debt of the general government as a percentage of GDP (1995 – 2018)⁴⁹.

As in the case of the elderly population, here appears a country that exceeds the values of most of the sample: Japan. In 1996, the ratio debt-GDP surpassed the 100% level and has continued to grow until 2014, when it has stabilised at approximately 235 points. When observing Western countries, the Anglo-Saxon and European-Continental groups have moved following similar patterns, and are now above the 100% level. In contrast, Scandinavian nations have opted for maintaining themselves near the 50% threshold, a policy that is considered also by South Korea, and the crisis that burst in 2008 apparently did not have incidence over its debt-GDP ratio.

Some experts consider the need of a basic income, so that every citizen can have a guaranteed payment that allows satisfying the basic needs, while having enough autonomy to decide the allocation of expenses. Even conservative economists have exposed this option, so as the services provided in the context of the welfare state can be substituted in its integrity by the private supply and paid with the funds of the basic income⁵⁰. The election of a social model is a decision of each State and its citizens, but it can be well inferred that in European-Continental countries the coexistence of a basic income with a decent network of public services is incompatible, at least with the current levels of taxation. European-Scandinavian countries show a different pattern.

⁴⁹ Graph created by the author. Source of data:

OECD (2019): *General government debt* (indicator). DOI: 10.1787/a0528cc2-en

⁵⁰ From the Chicago School of Economics, Milton Friedman was an important defender of the free market with minimal State intervention, and was also favourable to the implementation of the basic income.

2.11. INVESTMENT IN EDUCATION

The destiny of the world depends on the generations to come. Providing them with the best education possible will assure citizens concerned with civic values and adaptable to the coming challenges⁵¹. Moreover, lifelong learning will play an important role at the decades to come, assuring that skills demand is conveniently matched with labour supply⁵². An educated society will be capable to shape its own future, rather than resign to accept the desires of others. In several international databases, education is qualified as a «spending». The present study will use instead the term «investment», in order to assure that education is appropriately dignified.

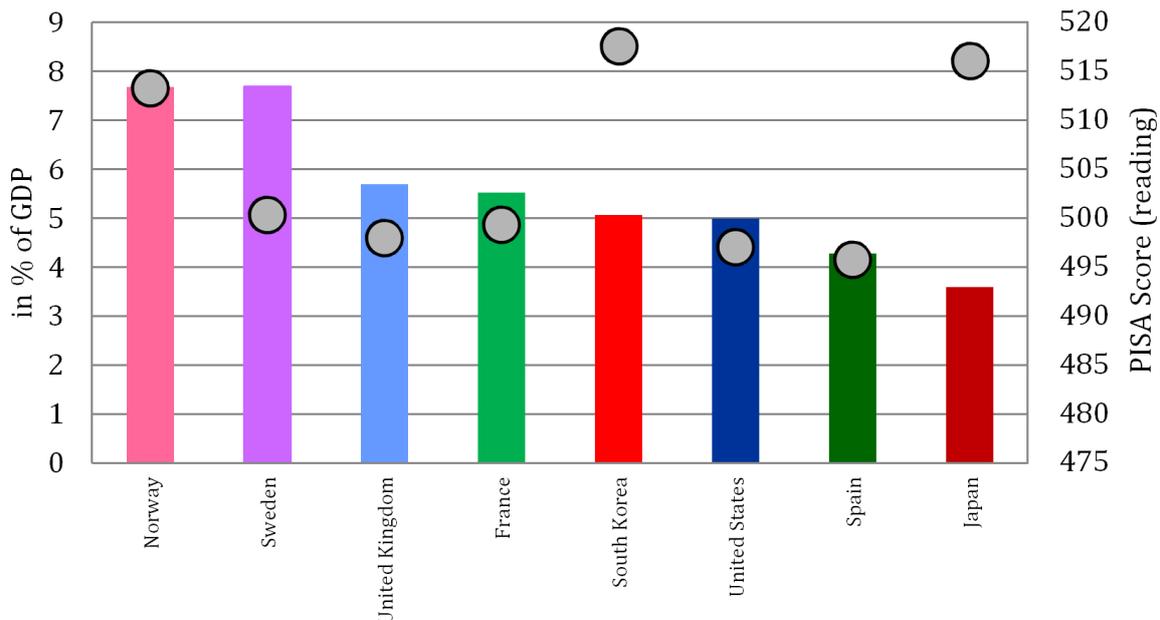


Figure 14. Investment in education, in % of GDP of 2014 (coloured bars). Mean performance in reading at PISA test score of 2015 (grey dots)^{53 54}.

In the previous graph, we can observe that in most of the cases a higher investment in education, in terms of the fraction of the gross domestic product invested in education, is translated into a better performance at PISA tests, considering the reading examinations at 15 year-old students. Rankings sound attractive, but are not the unique magnitudes. Here deserve special attention the cases of Japan and South Korea, offering outstanding qualifications despite not being at the top in terms of GDP destined to education. This fact can only be explained by cultural and civilizational factors. Scandinavian countries have considered education as one of national priorities, and regarding Norway, the results suit well to the deposited investment, being at the top of Western countries. But in the case of Sweden, performance remains relatively on the general average of 500. When observing Spain, results at reading capabilities appear correlated to the investment in education: more can be done. If Spain has invested only 4.28% of its GDP of 2014 to education, Costa Rica, in contrast, has opted for 6.86% and has become a reference in Latin America.

⁵¹ CONSEJO ECONÓMICO Y SOCIAL (2018): “El Futuro del Trabajo”. *Colección Informes*, No. 3. Madrid, Consejo Económico y Social, p. 46.

⁵² JANKOWSKA-ERIKSSON, Anna; ZAHIDI, Saadia (2017): *Accelerating Workforce Reskilling for the Fourth Industrial Revolution. An Agenda for Leaders to Shape the Future of Education, Gender and Work* (White Paper). Cologny and Geneva, World Economic Forum, p. 3.

⁵³ Graph created by the author. Source of data of investments in education (coloured bars):

United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics. Published by the World Bank (2018): *World Development Indicators*.

⁵⁴ Source of data of PISA score in reading (grey dots):

OECD Programme for International Student Assessment (PISA). Published by the World Bank (2018): *EdStats*.

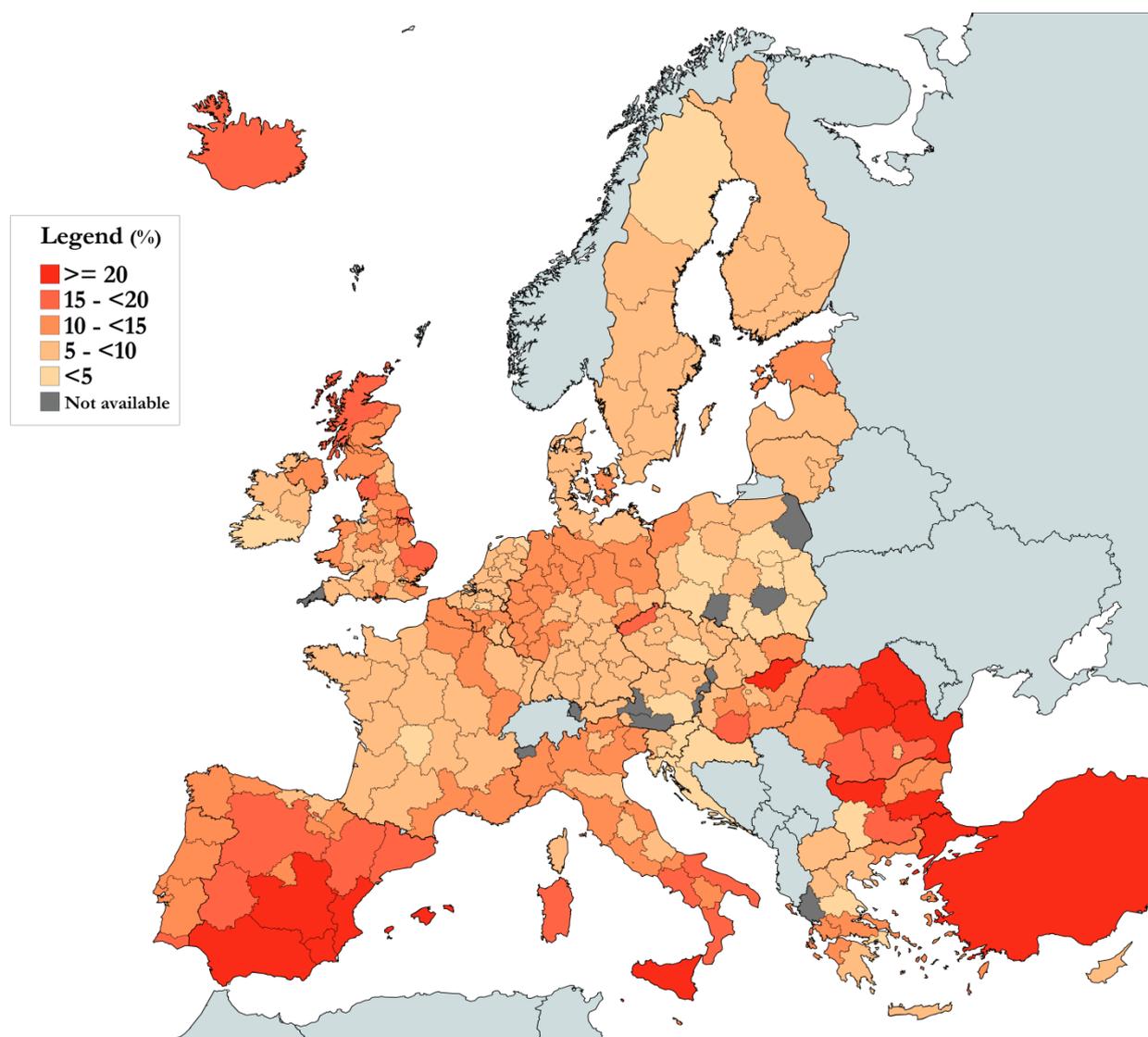


Figure 15. Early leavers from education and training, by NUTS 2 regions (2017). In % of population aged 18-24 years old⁵⁵.

The context of automation represents an important threat over non-qualified individuals. Early school leaving is statistically linked to unemployment, poverty and poor health, and this situation will cause social instability at the territories where it is more extended. On average across the EU, the percentage of early leavers descended from 13.4% in 2011 to 10.6% in 2017. The target is to attain the 10% level by 2020, a relatively plausible goal. But there are countries with extremely high rates, which are set very far from the objective: Malta (18.6%), Spain (18.3%) and Romania (18.1%). The former two have done remarkable progresses since 2011, but the latter remains stagnant⁵⁶. Southern Italy has also important difficulties in this issue, and non-educated youth is highly vulnerable to join mafias and criminal organisations. Overall in Europe, the lowest level of early leavers is located in the Czech capital city region of Praha (only 1.6%). In the Iberian Peninsula, the lowest rate of early leavers is in Euskadi, at 7.0%. Catalonia is slightly below the Spanish average, at 17.0%, and the highest rates are encountered at the Balearic Islands (26.5%) and Melilla (27.5%). Living in peripheral regions increases in most of the cases the ratio.

⁵⁵ Graph created by the author using the software *mapchart.net*. Source of data: EUROSTAT (2019): *Education and training statistics at regional level*. Code: edat_lfse_16 (*Early leavers from education and training*).

⁵⁶ EUROPEAN COMMISSION (2018): *Education and Training Monitor 2018*. Luxembourg, Publications Office of the European Union. DOI: 10.2766/28521, pp. 28-32.

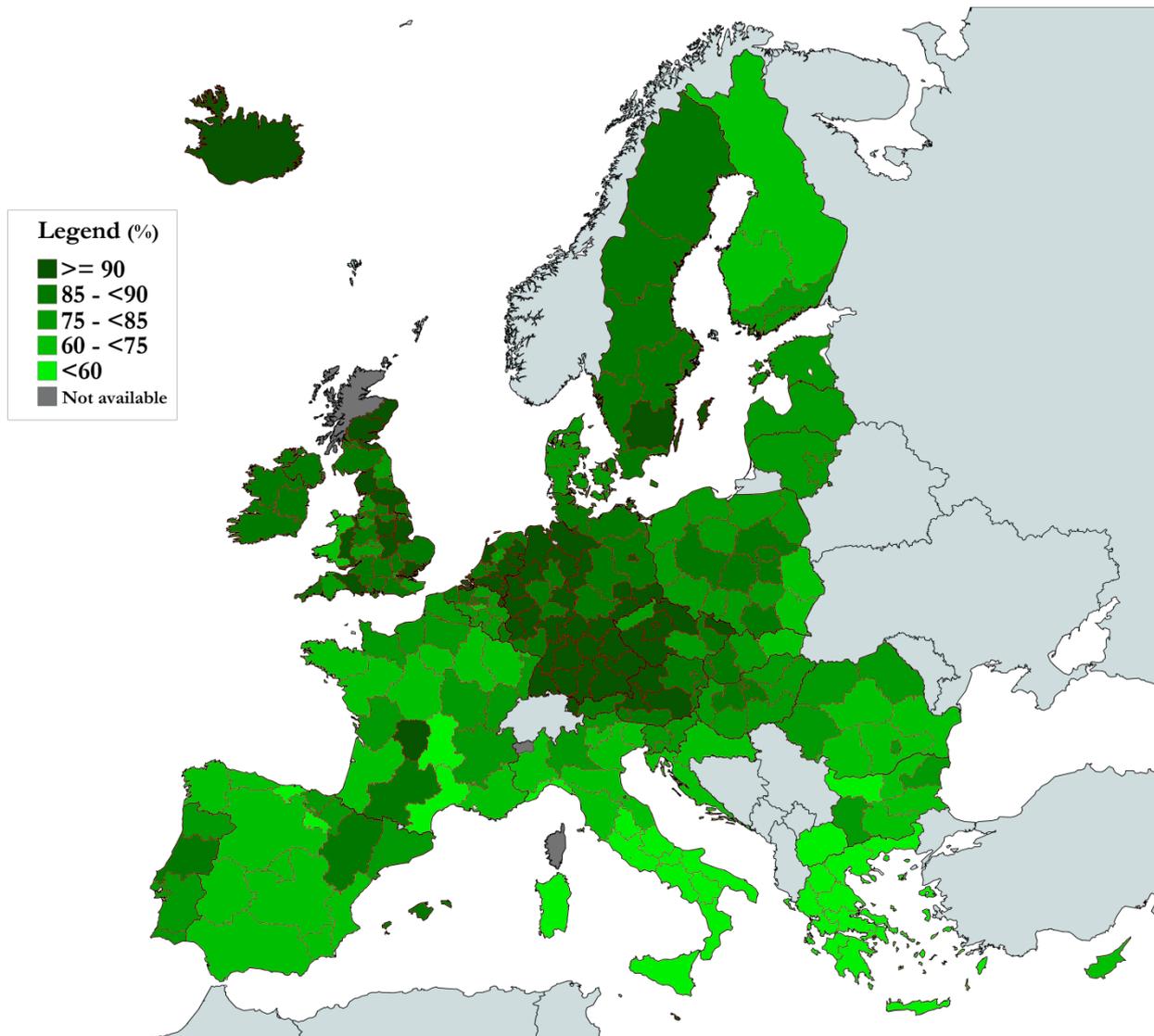


Figure 16. Employment rate of recent graduates⁵⁷, by NUTS 2 regions (2017)⁵⁸.

After having studied early leavers, it is quite reasonable to think that a greater employability of university or professional graduates will foster the interest of young students to pursue their education at the tertiary levels or vocational specialisations. This could be like a «virtuous cycle» of education and employment. The EU has established the goal that 82% of recent young graduates should be in employment by 2020, having reached in 2017 the level of 80.2%. The highest rates were concentrated in most of the regions of Germany, the Netherlands, Sweden, Austria, the Czech Republic and the United Kingdom (where North Eastern Scotland and Cumbria reached the 100% level). In contrast, the lowest rates are situated in Southern Italy: Campania (36.4%), Sicily (32.2%) and Calabria (28.3%). Certain regions in Greece attain also very low levels of employability. In the case of the Iberian Peninsula, the territories that have more favourable ratios are located in Portugal and at the Southern slope of Pyrenees. Catalonia has the same level of Euskadi, at 75.4%, but the best ratios are located in Aragon (87.7%) and the Balearic Islands (89.0%), where tourism is an important economic activity.

⁵⁷ In percentage of share of population aged 20-34 years old, with at least an upper secondary level of education attainment and not in any further education or training, having successfully completed their education within the previous 1 to 3 years.

⁵⁸ Graph created by the author using the software *mapchart.net*. Source of data: EUROSTAT (2019): *Education and training statistics at regional level*. Code: edat_lfse_33 (*Employment rates of recent graduates*).

2.12. INVESTMENT IN RESEARCH AND DEVELOPMENT

The same argument mentioned in the section of education can be applied to research and development: shall not be qualified as a common spending, and assume that is an investment, with positive outcomes at the long run for society. As can be identified in the graph, Spain remains at the lowest level in the investment in research and development since 1981. Most of the countries have assumed that this is a key magnitude to assure the future welfare and have maintained (and even increased) the fraction of GDP destined to it over the four decades.

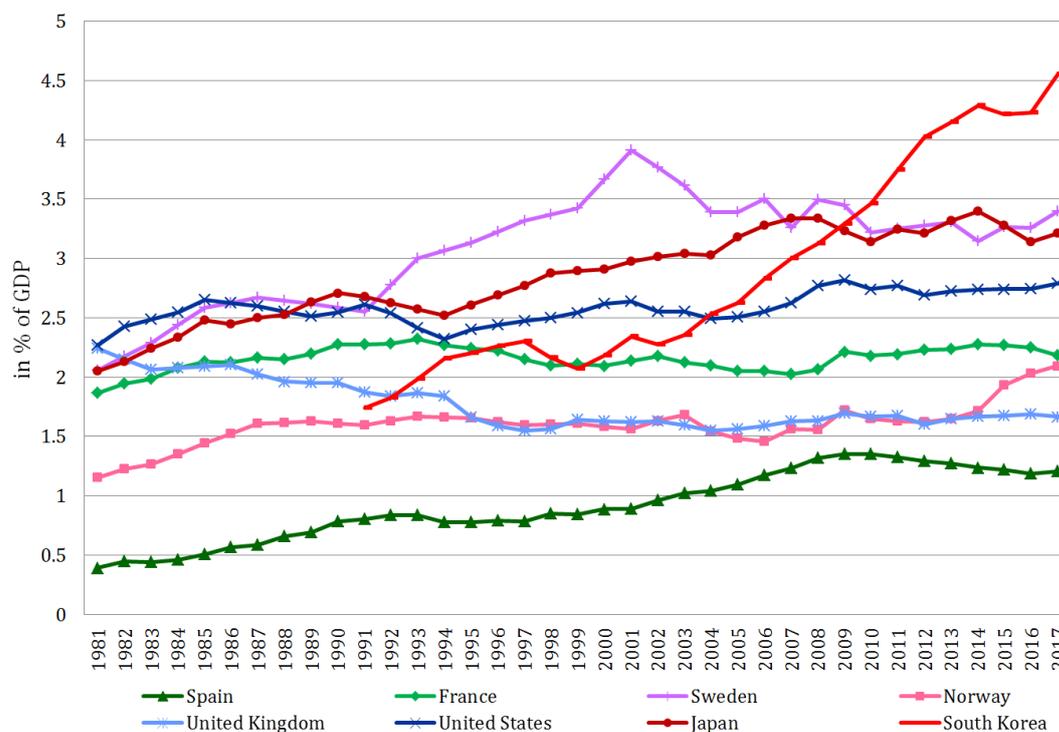


Figure 17. Investment in research and development, in % of annual GDP (1981 – 2017)⁵⁹.

In the case of Spain, where an important part of the research and development is linked to the public budget, the arrival of the crisis was translated into a sustained decrease of such investment, thus reinforcing the «brain drain» of scientists and engineers to the countries of Central and Northern Europe. The divergence between the centre and the periphery in Europe has been accentuated in the last years and will have consequences at the long run, as richer economies benefit from the arrival of qualified professionals, and the sender countries (at South and East) experience a greater settlement of extra-EU migrants, that are generally less skilled than intra-EU migrants⁶⁰. The case of South Korea, at the other side, explains a very different picture, called popularly as the «miracle of the Han-Gang»⁶¹. The departing point was clearly far superior to that of Spain, despite the harsh conditions of permanent conflict with the North (nevertheless, probably this is a stimulus), and this divergence has been expanded over time, becoming the country with the highest portion of GDP destined to R&D, followed only by Sweden and Japan.

⁵⁹ Graph created by the author. Source of data:

OECD (2018): *Gross domestic spending on R&D* (indicator). DOI: 10.1787/d8b068b4-en

⁶⁰ DEMERTZIS, Maria; SAPIR, André; WOLFF, Guntram (2019): «Promoting sustainable and inclusive growth and convergence in the European Union». *Policy Contribution*, Issue N. 7, Bruegel Institute, pp. 14-15.

⁶¹ The Han river crosses Seoul, the capital of the country and important metropolis, symbol of the exceptional economic growth of Korea in the recent decades, based fundamentally on new technologies. But this prosperity is at the expense of extraordinary efforts. In February 2018 the National Assembly approved an amendment of the Labour Standards Act to establish a maximum level of working hours at 52 per week, and 40 for young employees.

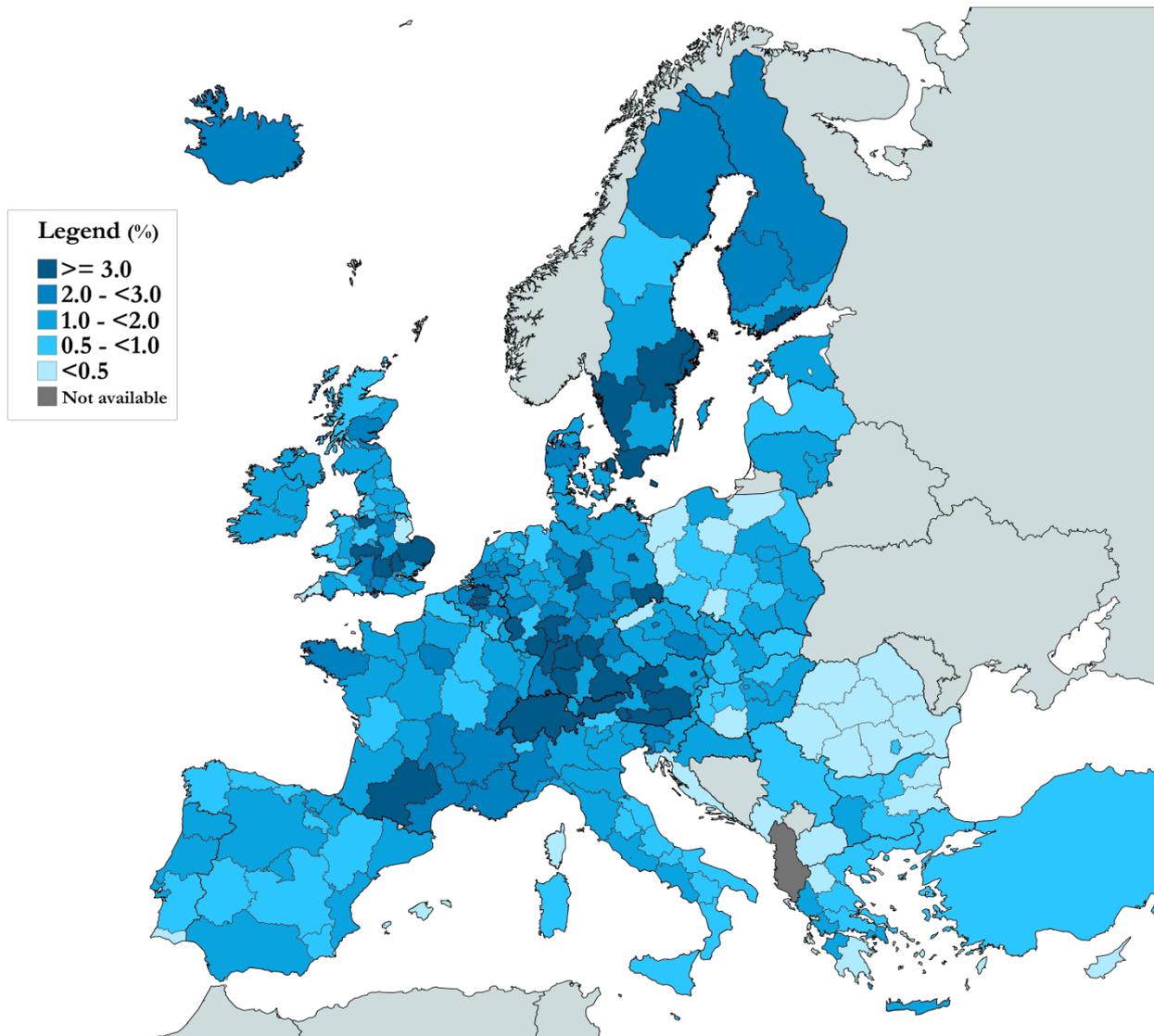


Figure 18. R&D investments relative to the GDP, by NUTS 2 regions (2015)⁶².

When observing the European regional map, it is clear that the weight of research and development has important concentrations in the transalpine area (Switzerland, Austria and Southern landers of Germany). Certain areas in Sweden, England and Belgium have also important levels. Approximately one third of all EU regions where R&D investment was greater than 3% were situated in Germany, reaching high ratios Braunschweig (at the top with 9.5% of its GDP) and Stuttgart (6.2%). Between them, the Belgian region of Brabant Wallon reached the second highest level of intensity, at 6.54%. The Department of Midi-Pyrénées attained 4.75% of the GDP (the sixth in the ranking, according to data of 2013), thanks to the important research in aeronautics and aerospace. In the Iberian Peninsula, Euskadi was the autonomous community with the top investment, at 1.91%. Follow the list the region of Madrid (1.72%), Navarra (1.62%) and Catalonia (1.52%), which hosts important infrastructures like ALBA Synchrotron light source. The metropolitan region of Lisboa was next in the list, at only 1.51%. The lowest levels of R&D intensity were principally situated at Eastern and Southern regions of the EU, including the Romanian territories (with the exception of the capital city region of Bucuresti-Ilfov), five regions from Poland, and the insular territories of the Iberian States, with Ceuta and Melilla at the bottom of the ranking. The average of all regions is at 1.59%, far from the 3% target of the EU.

⁶² Graph created by the author using the software *mapchart.net*. Source of data: EUROSTAT (2019): *Research and innovation statistics at regional level*. Code: rd_e_gerdreg (*Research and development expenditure*).



Chapter III / Research hypotheses

3. RESEARCH HYPOTHESES

The volume of data gathered is sufficient to articulate an econometric model that evaluates the characteristics of individuals that are determinant for having a positive or negative opinion about robots and artificial intelligence, regarding the impact over employment in a time interval of twenty years. This will be the dependent variable of the ordinary least squares (OLS) regression, evaluated according to a Likert-type scale with negative/positive values separated by a zero frontier, with the goal to attain symmetry and balance. Evaluations are transformed to a 0-10 points grade when deploying the model. Regarding the independent variables, fourteen of them will be used to verify the hypotheses that will be described in the following section, and the rest will be taken as control variables, in order to articulate a more precise study. At Chapter 5 will be developed in detail the empirical analysis and confirmed or rejected the hypotheses shown *infra*.

3.1. TERRITORIAL HYPOTHESES

Metropolitan area

Living in a metropolitan area is normally linked with having a greater access over services. Thus, it is supposed that technologies are going to be more spread in spaces where urban density is higher. The concept of «smart cities» has been diffused over the last decade, increasing the awareness of a community that self-regulates thanks to information and communication advancements. In the case of Catalonia, Barcelona's metropolitan area produces a large fraction of the gross domestic product of the country⁶³, hosting most of the industrial tissue, where robots are spreading. Also, the metropolitan area is an important deposit of employments related to the third sector. For the exposed reasons, could be expected that metropolitan citizens are going to be more receptive towards innovations at the workplace. As commented in the section dedicated to the methodology, the present study uses an «expanded» notion of the Metropolitan concept in Barcelona province.

Hypothesis 1. *Living in the metropolitan area is positively related with a more favourable opinion of the incidence of robots and AI over employment.*

Capital of the county

Catalonia has the province as the political and electoral circumscription inside the territory. Nevertheless, the so-called «comarques», which could be assimilated as the existent counties in Anglo-Saxon countries, have an important tradition in sociological terms. «Comarques» have evolved from the ancient counties of the Middle Ages, with at least an important urban centre that has the function of economic and administrative pole of the territory⁶⁴. Considering that employment opportunities and more stable jobs in public offices can be placed in the capital of the county, the present hypothesis considers that citizens that live in the exposed towns may have a more positive opinion towards the impact of new technologies over employment.

Hypothesis 2. *Living in a municipality that is the capital of the county is positively related with a more favourable opinion of the incidence of robots and AI over employment.*

⁶³ According to IERMB (Institut d'Estudis Regionals i Metropolitans de Barcelona), the GDP produced in 2016 in Barcelona and its 33 adjacent municipalities of AMB (only considering towns with more than 5.000 inhabitants) was that of 53.06% of the GDP of Catalonia and 10.15% of Spain. On line [Last consultation in 30/08/2019]: https://iermbdb.uab.cat/index.php?ap=0&id_cat=301

⁶⁴ In the project of the territorial division of Catalonia was decisive the contribution of Pau Vila i Dinarès (1881-1980), an academic and geographer that also did a founding task in Colombia and Venezuela during the exile period.

Urban density

In indirect factor to assess the income of participants is the urban density of their own residence. This characteristic has been evaluated with four variables at the questionnaire, appropriately described: high urban density (concentrated and tall flats, without green areas), medium urban density (flats with green areas or public spaces), low urban density (leaned or neighbouring houses) and rural density (separated houses, with land around). A compressed living space is an indicator of less wealth. However, having residence in a large city may have higher costs associated, reserving only to the top incomes the areas with less density. For this reason, this variable alone would be incomplete and had been established the metropolitan and municipal disposable income per capita variables, in order to isolate better the measure. Less economic resources is associated to reduced living spaces and higher urban densities, and probably the perception that robots and algorithms could be that of a substitution entity, rather than a tool.

Hypothesis 3. *Living in an area of higher urban density is negatively related with a more favourable opinion of the incidence of robots and AI over employment.*

Income per capita

The Ministry of Finance and Public Administration of Spain has a database that classifies municipalities according to the average disposable income per capita of their residents⁶⁵. This interesting information is an indirect indicator of the economic capacity of the surveyed citizens. Individuals who are proprietary of production factors will tend to live in wealthier municipalities, incrementing the average measure of their towns. For them, innovation could be viewed as a source to increment productivity and by these means the output and benefits generated, not representing a threat over them and by extension over employment in general.

Hypothesis 4. *Living in a municipality of higher disposable income per capita is positively related with a more favourable opinion of the incidence of robots and AI over employment.*

Local unemployment rate

The Department of Employment, Social Affairs and Families of the Government of Catalonia publishes periodically the unemployment rates of all municipalities⁶⁶. The present value is obtained every month, considering the data recorded at the public registries the last day of each period. This methodology differs from the unemployment rate diffused by the State Administration, published quarterly and based mainly with the data related to the Social Security affiliation. We could expect that in municipalities where unemployment rates are high, citizens will consider robots and algorithms as a threat over jobs. In contrast, towns with low unemployment rates could be more favourable to new technologies, placing them as productivity boosters. In the present case, the hypothesis is verified using the month of March, which provides a better measure because is less affected by seasonality.

Hypothesis 5. *Living in a municipality with a higher unemployment rate is negatively related with a more favourable opinion of the incidence of robots and AI over employment.*

⁶⁵ AGENCIA TRIBUTARIA (2018): *Estadística de los declarantes del IRPF por municipios. Detalle de los municipios con más de 1.000 habitantes* (Data of 2016 year). On line [Last consultation in 30/08/2019]:

https://www.agenciatributaria.es/AEAT/Contenidos_Comunes/La_Agencia_Tributaria/Estadisticas/Publicaciones/sites/irpfmunicipios/2016/jrubik1ef468a251d390b847ce88908aaafc743028fb8d.html

⁶⁶ OBSERVATORI DEL TREBALL I MODEL PRODUCTIU (2019): *Atur per comarques i municipis* (Data of March 2019). On line [Last consultation in 30/08/2019]:

<https://govern.cat/govern/docs/2019/05/06/12/26/085a1643-113b-43bd-8f44-fe367a218f57.pdf>

3.2. TECHNOLOGICAL HYPOTHESES

Smartphone applications

Having a greater interaction with mobile devices would suppose a greater affection to new technologies, and could be translated to a favourable opinion regarding robots and algorithms. The questionnaire identified several categories of applications, showing some examples of each one to orient adequately participants. For example: messenger apps, purchasing apps, video and audio apps, bank apps, etc. At the survey could be ticked several options, and the count of the selected categories became the indicator of use⁶⁷. As in the case of urban density, the existence of the control variable «age» allows to evaluate appropriately different generations, which have different intensities of use of smartphone devices. At Chapter 4, dedicated to the descriptive analysis, the patterns of consumption indicated by citizens will be analysed in full detail.

Hypothesis 6. *Using a greater number of mobile phone applications is positively related with a more favourable opinion of the incidence of robots and AI over employment.*

Robot at home / workplace

Catalonia and Spain are losing industrial weight, compared to the other sectors. This conclusion can be extracted from statistics about the number of persons employed at the secondary sector. From 2001 to 2018, Catalonia has lost 35.19% of the proportion of employed citizens at the industrial sector. At the same period, Spain has registered a decrease in 28.78%. In contrast, services had incremented the quota and absorbed all the mentioned losses, providing less stable jobs, but at the same time with less dreariness and physical efforts. The competitive nature of industry offers the opportunity to interact with robots and new technologies, and this is the aspect evaluated in the present hypothesis.

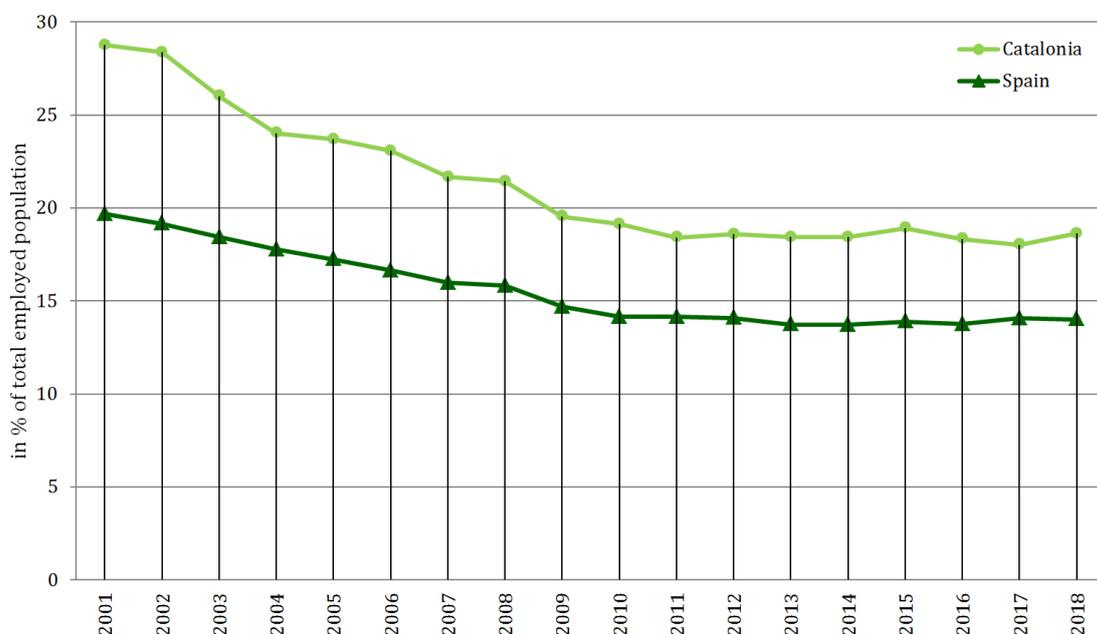


Figure 19. Population employed in the industrial sector. Catalonia and Spain⁶⁸.

⁶⁷ For example, a participant that uses two real-time messenger apps is indicated as only one category user (the «messenger» category). But in the case he/she uses three different social nets, depending on the functions, would be a user of three differentiated groups («messenger», «social network of short text» and «social network of images»).

⁶⁸ Graph created by the author. Source of data:

IDESCAT (2019): *Població ocupada. Per sectors d'activitat i sexe. Catalunya i Espanya.*

Despite this, the use of robots and other technical devices at home or at work could encourage the perception that they «help» humans in their daily lives. In this sense, for example, an automatic vacuum cleaner would be viewed as a technology that cleans more easily and supposes less effort, leaving free time to concentrate on other more valuable tasks. The same argument could be translated to factories: the dominant thesis states that employees will devote to activities which provide greater value added and leave the routines to «collaborative» robots⁶⁹.

Hypothesis 7. *Using a robot at home or at the workplace is positively related with a more favourable opinion of the incidence of robots and AI over employment.*

Robots / AI arriving at the economic sector

The questionnaire established several time lapses to indicate an estimated massive arrival of robots and artificial intelligence at the sector in which the citizen had indicated previously the affiliation. The first option is that robots are present now, and the following ones show a sequence of five, ten, twenty and more than twenty years. A short time span of arrival, that is, of five and ten years, is a beacon that the «danger» over labour posts is approaching, possibly including the job of the respondent, and thus the surveyed citizen could have a remarkable propensity to consider a negative opinion.

Hypothesis 8. *Having an expectation that robots/AI will arrive soon at the economic sector is negatively related with a more favourable opinion of the incidence of robots and AI over employment.*

Risk of substitution

Considering that robots and automation processes would substitute the surveyed individual at work, or if the interviewed person does not work then new technologies would execute the job that the person was doing previously, could be linked to a negative opinion about robotisation. The questionnaire presented different options if the substitution case was considered plausible: the surveyed citizen would find another job quite easily, the respondent would have to study or acquire a specific knowledge to find another employment, and finally the surveyed person would have important difficulties to find a job. The exposed three possibilities were shown to illustrate better different hypothetical paths after substitution, avoiding by these means that participants reduce a rising cognitive dissonance by denying categorically the substitution at work scenery.

Hypothesis 9. *Having an expectation that robots/AI will substitute the surveyed individual at work is negatively related with a more favourable opinion of the incidence of robots and AI over employment.*

3.3. EDUCATIONAL HYPOTHESES

Educational attainment

In general, more educated individuals have more employment possibilities thanks to their qualifications, or simply their own personal discipline allows them to adapt better to the changes of the labour market.

On line [Last consultation in 30/08/2019]:

<https://www.idescat.cat/indicadors/?id=anuals&n=10387&t=201800&col=1>

⁶⁹ During the survey, the author was able to talk to several workers of two important car manufacturing plants, and they transmitted, quite surprisingly, a positive opinion regarding new processes implemented at the factories. Such innovations implied less efforts (and backaches) to carry automobile components into the assembly line.

Probably, a qualified individual would consider that no matter that technologies substitute him/her at the workplace: according to the dominant discourse, new employment opportunities would emerge and could be reached having the appropriate educational background. In contrast, a person with the minimum studies could feel more exposed to the perils of automation. This evaluation can be inferred when studying the unemployment rate in Spain:

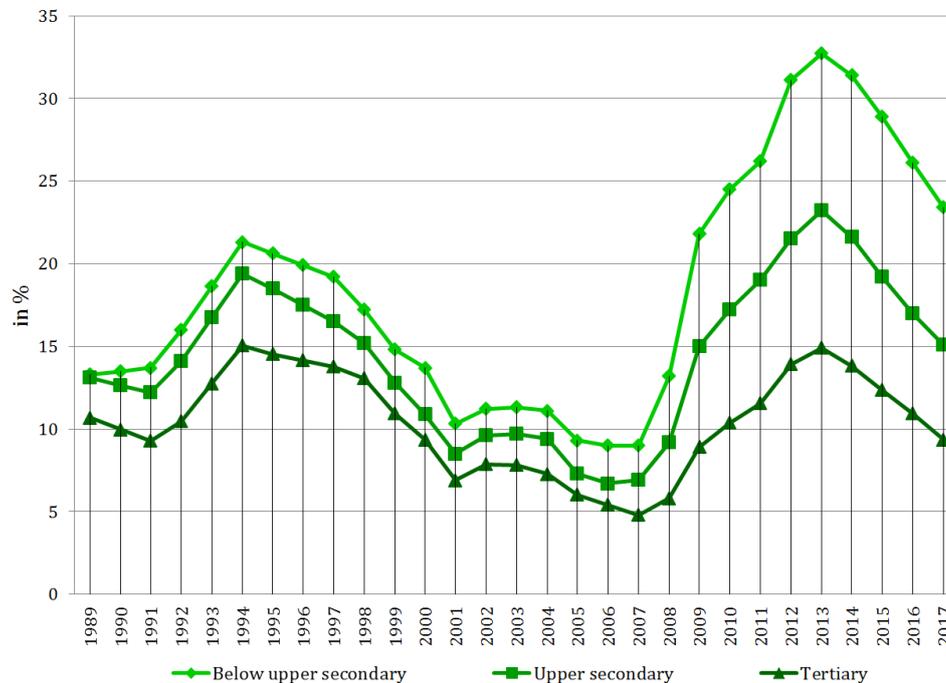


Figure 20. Unemployment rate according to the educational attainment⁷⁰.

The previous graph illustrates an increasing gap among different educational levels. During the «post-Olympics» crisis, unemployment rates differed between non-qualified citizens and the ones with tertiary education in only six points (the maximum was reached in 1994, at 6.26 points). But after 2008, the commented space tripled, arriving at 17.8 points in 2013. Individuals that possess university studies seem to have an unemployment rate ceiling at 15% in the case of Spain. This should be a magnitude of concern, still very high, and does not reflect the «brain drain» experienced over decades, which has obviously reduced the rate. For the quality of the regression model, age has been placed as a control variable. By these means can be differentiated better students that have not finished superior education with adults with a low educational attainment.

Hypothesis 10. Possessing a greater educational attainment is positively related with a more favourable opinion of the incidence of robots and AI over employment.

Education in technology and experimental sciences

Traditionally, teaching subjects had been classified according to a static double scheme: sciences or humanities. We could expect that a person with a high educational background in technology or experimental sciences would adopt a more favourable orientation towards new technologies, compared to a citizen educated in social and humanistic matters, or that has received instruction with a generalist academic orientation only.

Hypothesis 11. Having a specialised education in technology or natural sciences is positively related with a more favourable opinion of the incidence of robots and AI over employment.

⁷⁰ Graph created by the author. Source of data: OECD (2019): *Unemployment rates by education level* (indicator). DOI: 10.1787/6183d527-en

3.4. PUBLIC POLICIES HYPOTHESES

Preferred public policies

The survey presented six different possibilities to address a situation of substitution in employment by robots or algorithms: the unemployment benefit (a measure that is currently in force at the country), a guaranteed basic income, free vocational or university education, a stable work offered by the State, redistribution of hours among citizens to allow that employment and free time combine better, and other options not covering the previous measures (generally, citizens had indicated «reinvent oneself», in close accordance with the dominant discourse of entrepreneurship at mass media). Choosing the options of free education, the unemployment benefit or «other measures», could be associated with a «soft» vision of automation. In this sense, a participant that opts for such measures may consider other employment possibilities after substitution, and elects public policies that suppose a minimal cost for the public budget.

Hypothesis 12. *Choosing «soft» public policies for the case of labour substitution is positively related with a more favourable opinion of the incidence of robots and AI over employment.*

Global public regulators

Citizens were able to choose among six different regulators for technological matters, or by another way to decide not to regulate the issue. The opinions that had been favourable to global public regulators, like the multilateral frameworks that represent the United Nations and the OECD, could be from citizens highly concerned about the impact of robots and algorithms over employment, who preferred a planetary regulation in order to increment effectiveness levels at the long run in an interdependent world.

Hypothesis 13. *Choosing a global public regulator for robots and automation matters is negatively related with a more favourable opinion of the incidence of robots and AI over employment.*

European Union's social policies

The last question presented at the survey showed a scale and asked citizens to indicate their evaluation regarding European Union's social policies. Relatively recently, the European Commission has promoted the awareness of the «Social Pillar»⁷¹ and is increasing the resources of the European Social Fund, among other instruments⁷². Despite the economic and social crisis and the «Brexit» scenery, the European Union «seems» to represent the future of the continent as an integrated political and economic area. A negative evaluation of the Union regarding its social policies could be related to a negative opinion towards the future of work, as the EU would be considered incapable to attend the present needs⁷³ and thus would not be prepared to affront the social challenges that will appear in the next decade by the incidence of automation.

Hypothesis 14. *Evaluating more positively the European Union's social policies is positively related with a more favourable opinion of the incidence of robots and AI over employment.*

⁷¹ EUROPEAN COMMISSION (2017): *Establishing a European Pillar of Social Rights*. Brussels, Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM (2017) 250 final. The *Social Pillar* was object of a joint proclamation at the Social Summit for Fair Jobs and Growth, celebrated in Gothenburg on 17 November 2017.

⁷² These programmes are the European Structural and Investment Funds, the Youth Employment Initiative, Erasmus+, the European Globalisation Adjustment Fund and the Fund for European Aid to the Most Deprived.

⁷³ In June 2019, after decades of free circulation of workers, was officially created the European Labour Authority.



Chapter IV / Descriptive analysis

4. DESCRIPTIVE ANALYSIS

4.1. HOW WILL BE THE FUTURE OF WORK AFTER TWENTY YEARS?

When estimating the future of employment in the country, twenty years from now⁷⁴, opinions depict a quite equilibrated scenario. The questionnaire was designed to offer twelve different options in a Likert-type scale, from minus five to plus five passing through zero, in order to allow precise indications by the surveyed citizens, also with the possibility to tick «do not know». Thus, the possible answers were classified into six distinct categories, accompanied with a brief description: very negative, negative, neutral, positive, very positive and «do not know».

As is illustrated in Figure 16, the option of neutrality (35.16%) is the preferred one (oscillating from -1 to +1), followed by the negative opinion (33.02%) and the positive one (28.40%). The percentage of surveyed citizens who consider that do not know the appropriate answer is marginal (3.42%). The mentioned opinions will articulate the dependent variable side in the econometric model, which is going to be mathematically formulated in the next Chapter.

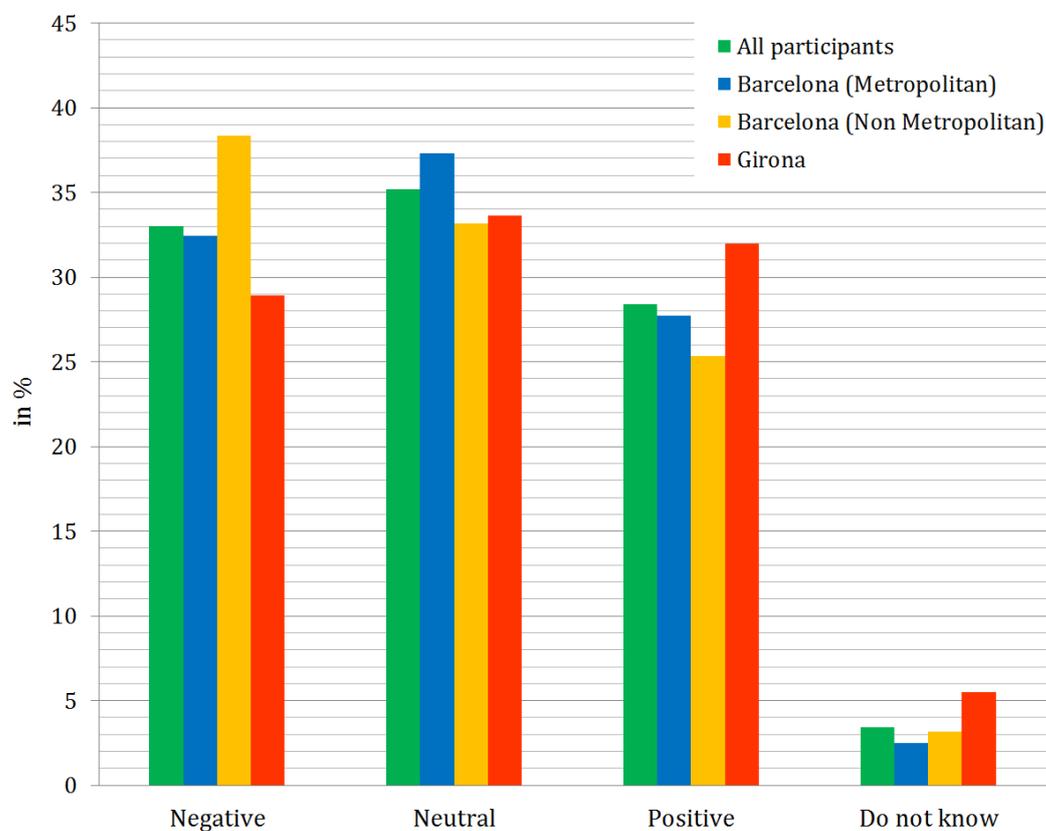


Figure 21. Opinions regarding the impact of robots and AI over employment, by territory.

Regarding territorial differences, the inhabitants of Barcelona's metropolitan area show a greater orientation towards neutrality, while the citizens that live in Barcelona province but not in the metropolitan space exhibit a higher negative opinion, as a consequence of the historical deindustrialisation trend of the textile sector there. In Girona province, in contrast, opinions have moved towards the neutral and positive sides. Here the loss of operating factories has been compensated by the services sector, with tourism at the front line.

⁷⁴ From a commercial perspective, Barcelona hosts every year the event «Four Years From Now», integrated inside the Mobile World Congress and important reference of the sector for the diffusion of new technologies.

Figure 22 classifies the opinions of citizens according to their educational attainment. In this case, more education is translated into a less negative opinion for the future of work. Consider the vision of citizens that have received basic instruction or do not have studies: 43.68% of them evaluate employment possibilities by 2040 year in a negative manner, while individuals that have obtained a Master or a Doctorate consider the negative scenario only in 22.08% of the cases. Also, there is a slight difference in the case of citizens that possess a vocational training, that tend to be more pessimists in comparison with the other educational neighbouring categories, but this fact obeys mainly to the practical experience in the industrial sector of the participants.

The fact that more educated people tend to have a more positive view for the future of employment⁷⁵ could have important consequences regarding the adequate design of public policies. Agents in charge of them (politicians, civil servants, experts... who are qualified individuals generally) could be overoptimistic about labour possibilities⁷⁶, and thus more distant to the reality of a large fraction of the population, that would easily be «substituted» by new technologies and excluded from most of employment opportunities. Considering that the impact of artificial intelligence is not defined yet and probably will suppose an important threat over high-skilled workers, the negative consequences of robotisation could be amplified.

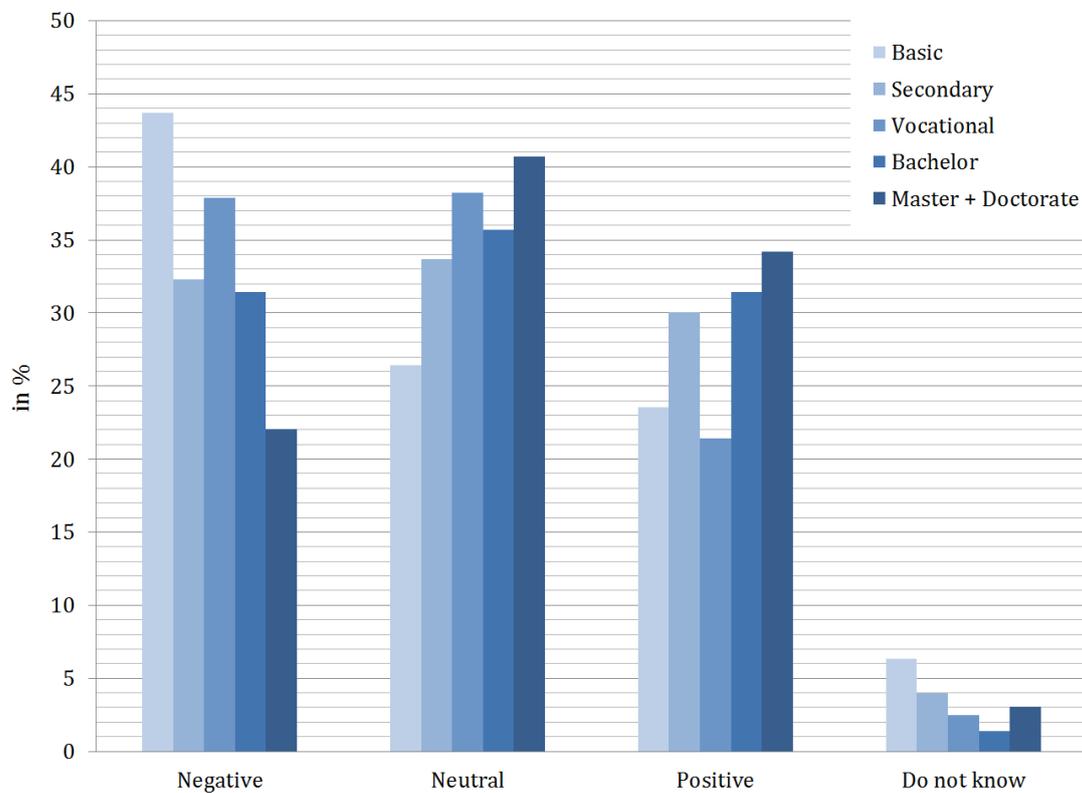


Figure 22. Opinions regarding the impact of robots and AI over employment, by educational attainment.

If we consider the differences among eight different counties in Catalonia, Figure 23 illustrates that only two of them have a positive vision of the future of employment in a twenty years' time lapse. In this case had been converted the qualifications of the Likert-type scale, with negative and positive values, to a scale over ten points, being 5 equal to the previous zero: employment levels analogous as the present. Baix Llobregat is located West of Barcelona, inside the metropolitan area, and Gironès represents the more dynamic area of Girona province.

⁷⁵ This finding is also encountered at KOLKO, Jed (2019): *Who's Afraid of Automation?* Indeed Hiring Lab. On line [Last consultation in 30/08/2019]: <https://www.hiringlab.org/2019/01/10/automation-ai-fears-jobs/>

⁷⁶ Another issue is that the stability in employment of public agents in charge of social policies contrasts with the emerging «precarariat» condition for most of the citizens.

At the other side, the counties with the lowest grades for the future are located in the metropolitan region and in Bages. In this last «comarca», mining still represents an important activity and generates well-paid employments, but inhabitants in the area are concerned that automation processes and the closure of exploitations may determine a different future for them, when minerals' extraction becomes less profitable. Overall, shall be observed that the evaluation of the future moves between 4.4 points and 5.4 points over ten, and in this sense the average scenery would be characterised by «neutrality»: the future of work would have strong similarities with the present, in terms of employment levels and properties of the labour market. Extreme opinions appear thus compensated.

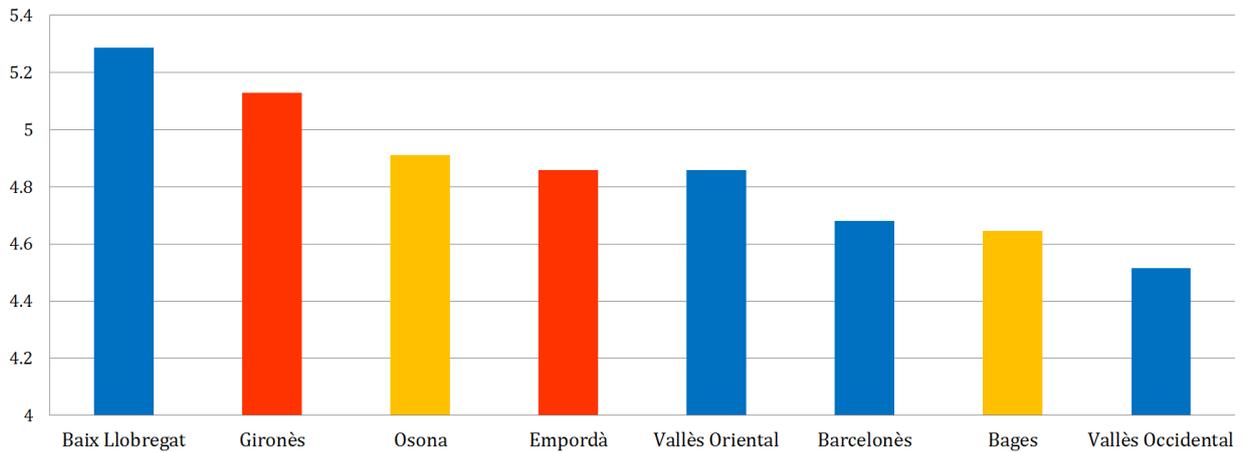


Figure 23. Opinions regarding the future of work over ten points, by county of residence.

In participants that indicated that do not knew the evaluation of the future of work, their answer has been converted into a neutral response (0 in the initial scale, or 5 five over 10 points after), in order to allow the comparability of data. When considering the aggregate of participants in the study, the average evaluation is summarised in 4.872 points, indicating a slight orientation of Catalans towards predicting a darker future. The following graph illustrates a Kernel density⁷⁷ of the expected impact of automation of all participants, and we can identify that extreme opinions appear marginal, with an important concentration at the neutral and central sides.

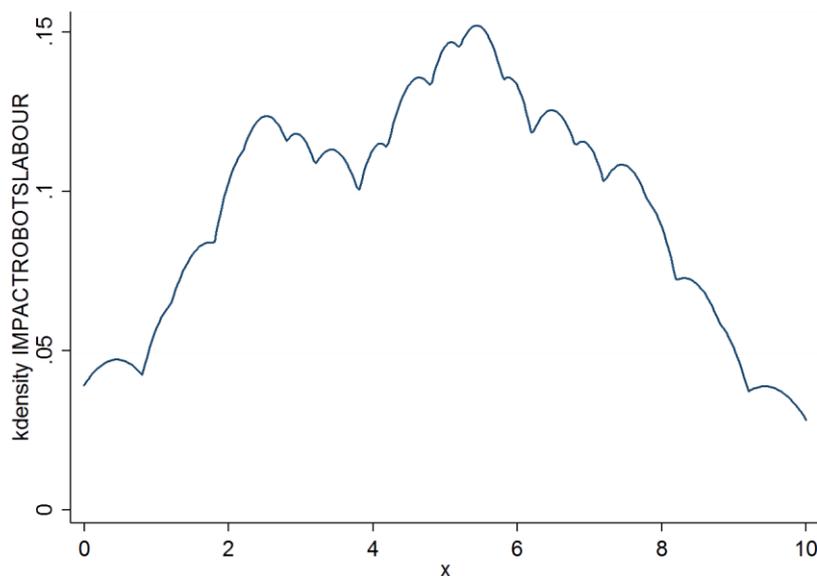


Figure 24. Kernel density of the expected impact of robots and automation, over ten points.

⁷⁷ With a shape also remembering Montserrat mountain range in Catalonia.

The analysis attains as greater precision when studying the differences among sectors of the economy. As commented previously, it shall be noted that participants are not all employed at the moment. The questionnaire was answered by students and pensioners, among other collectives. Citizens had been asked to consider the sector at which they felt more identified, in terms of current, past, or potential area of employment. Like in Figure 22, participants that manifested that did not know the answer had been placed at the neutral level of evaluation to count the average.

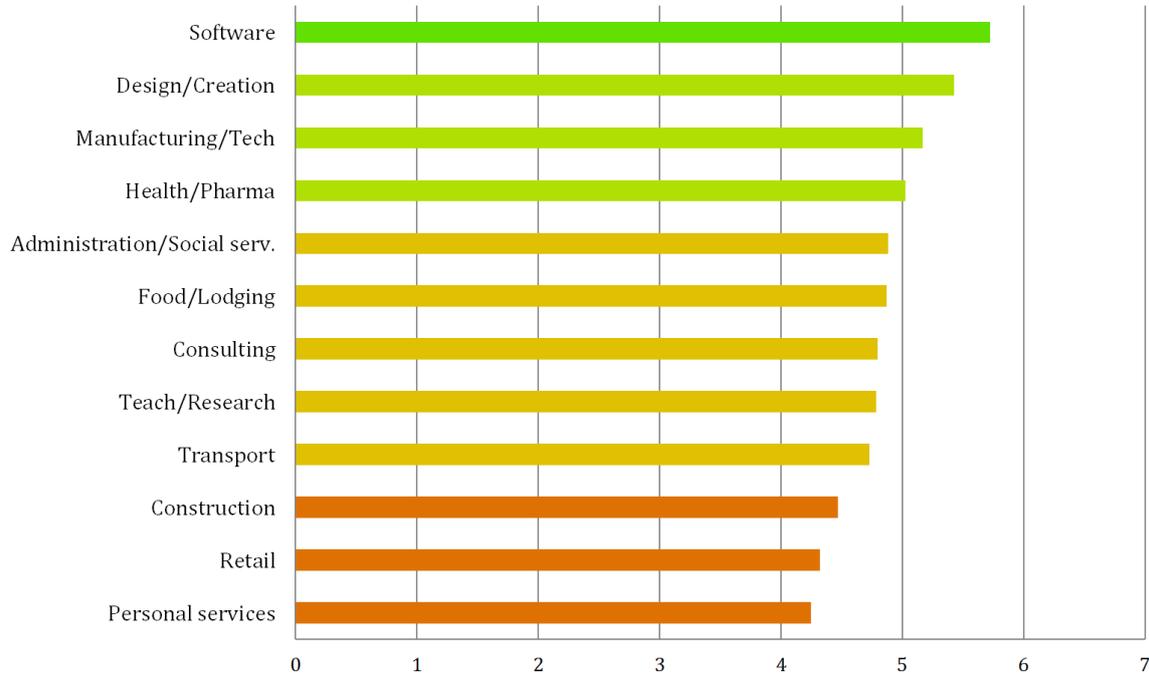


Figure 25. Evaluation of the future of work, over ten points and by sector of personal identification.

As Figure 25 shows well, four sectors are placed in the «optimistic» side for the future of employment, and «software» leads the group, at 5.72 points. A quite logic finding, as it is the sector more related to technological advancements in ICTs. The list is followed by «design and creation» (5.43 points). This fact can be attributed by the dominant discourse in entrepreneurship and the promotion of the «creative class» status, despite the high economic vulnerability of a large fraction of its members⁷⁸. Next, comes «manufacturing and technology» (5.17 points) and «health and pharmaceuticals» (5.02 points), which are sectors with high investments in fixed assets (buildings and sophisticated machinery, among others).

The rest of the sectors are classified at the negative side, being «personal services» at the bottom, with only 4.25 points. This position can be attributed to the strong competitiveness among professionals that pushes the benefits downwards at the long run, and the nature of manual work (for example, the tasks effectuated by a hairdresser)⁷⁹. Then comes «retail» (4.32 points), where employed citizens may perceive that costumers use the physical shop to decide the next purchasing orders at online shopping platforms. At a better position is placed «construction» (4.47 points), a sector that experiences important oscillations over large cycles in the country, going from extraordinary speculative benefits to catastrophic losses. As has been stated in the previous observations, the circumstances of the sector of personal identification can determine remarkably the evaluation of the future of the whole labour market at a twenty years' time lapse.

⁷⁸ MOULD, Oli (2018): *Against Creativity*. London and New York, Verso. For the Castilian edition (2019): *Contra la creatividad. Capitalismo y domesticación del talento*. Madrid, Alfabeto Editorial, pp. 42-50.

⁷⁹ This finding is consistent with the analysis of PEW RESEARCH CENTER (2016): *Public Predictions for the Future of Workforce Automation*, p. 6. On line [Last consultation in 30/08/2019]: <https://www.pewinternet.org/2016/03/10/public-predictions-for-the-future-of-workforce-automation/>

4.2. WHAT IS THE BEST GOVERNANCE LEVEL TO REGULATE ROBOTS AND ARTIFICIAL INTELLIGENCE?

This is a question⁸⁰ that does not have a unique answer, as the coordination of different levels of governance can foster the effectiveness of public policies. Catalonia is integrated inside Spain and the European Union, and thus competences are distributed among different public administrations, including also provinces and local entities. This complex nature can also be a problem to articulate an efficient response, as happened during the crisis of Syrian refugees and continues today with the current migration policies. At the survey, citizens were asked to choose only one regulatory level among six possibilities, if they considered that robots and artificial intelligence had to be regulated, or by the other way to reject any possible normative framework.

As is illustrated in Figure 26, the United Nations (35.59%) is the preferred option, followed by the European Union (23.27%) and the rejection of any forms of regulation (10.04%). Quite surprisingly, more people consider preferable that companies self-regulate themselves with «soft law» (9.18%), rather than exists a regulation deployed by the State (8.75%). Finally, appear the normative frameworks elaborated by developed countries (7.61%) and regions (5.55%).

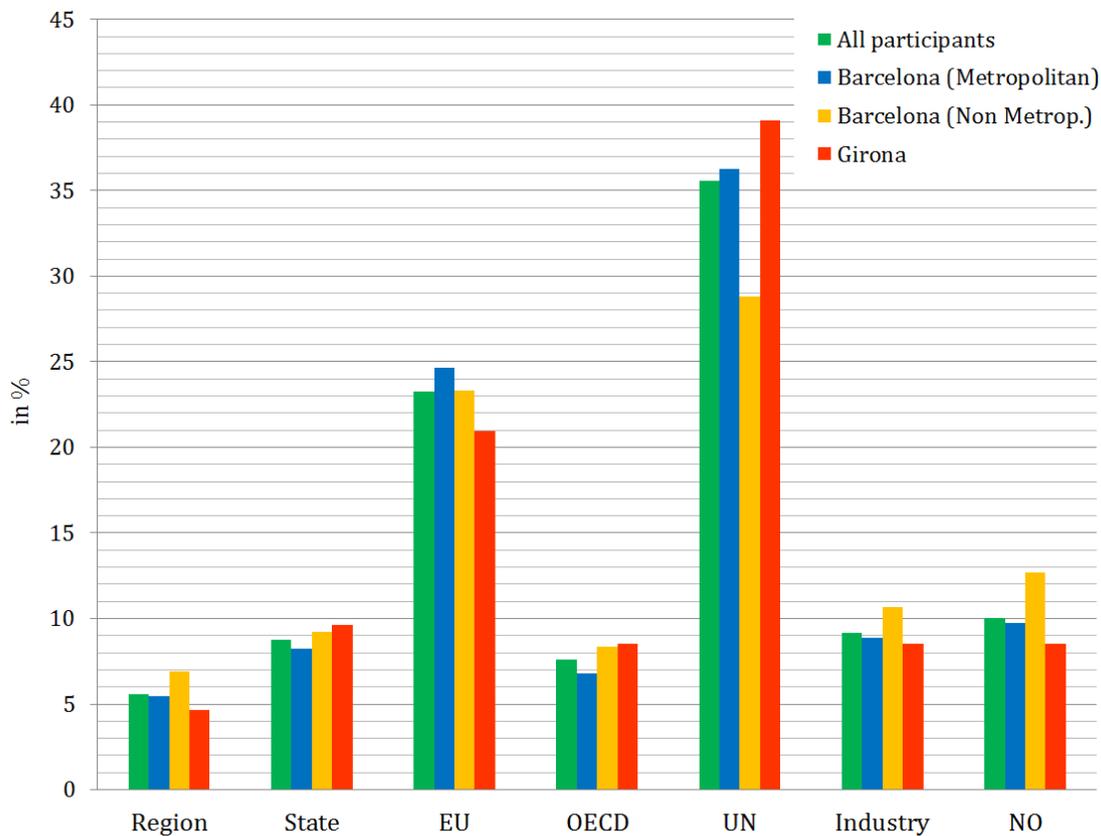


Figure 26. Opinions regarding the desired regulator of robots and AI, by territory.

When assessing territorial differences, opinions are relatively similar among provinces, but we can identify a greater propensity towards the EU in Barcelona's metropolitan area and a large trend favourable to the UN in Girona. Citizens that live in Barcelona province and outside the metropolitan area have shown a higher inclination over non-regulation and also auto-regulation by the industry herself. Such are options that could be qualified as «wrong», as naturally is very difficult that companies would judge favourably new taxes over robots to finance Social Security.

⁸⁰ At the survey of the EU Parliament the question was articulated in these terms: «Generally speaking, do you think it is necessary to regulate developments in the robotics and AI area?». Possible responses had been improved.

Figure 27 classifies the results according to the educational attainment of the surveyed citizens. A trend can be well traced: more education is related with a greater acceptability of the international level to regulate robots and AI (the European Union and the United Nations). In contrast, less educated persons show more preferences towards non-regulation, and also over the normative frameworks elaborated by the State, regions and even corporations. In other words, persons who are more vulnerable to automation, show more propensities to non-regulate the issue and thus would amplify the negative consequences that could arise over them in a near future. This property can be well extrapolated to elections, as less educated voters would favour candidates of the extremist and deregulatory side, not precisely benefiting the citizens that have opted for them at the polls⁸¹.

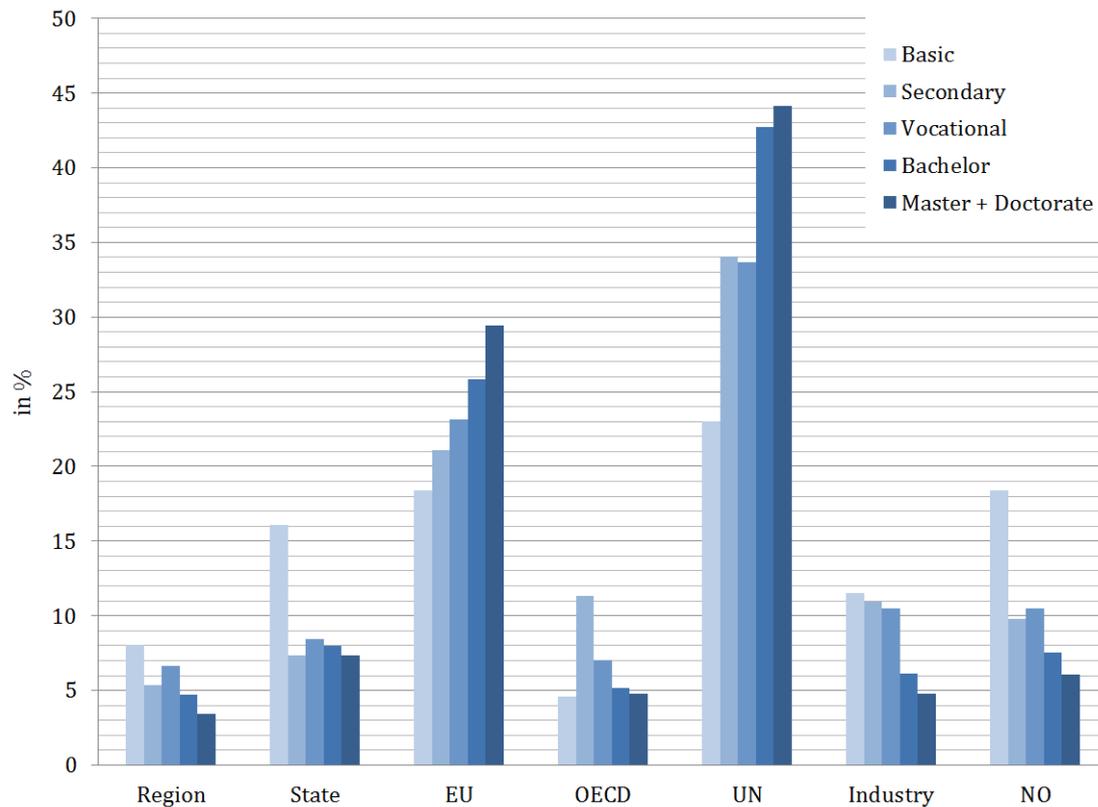


Figure 27. Opinions regarding the desired regulator of robots and AI, by educational attainment.

To sum up, the United Nations appear as the preferred normative framework to cover future regulations regarding robotics and AI. In other words, citizens consider the need of a global solution when affronting a global challenge. Then, the European Union is considered as a «second best» possibility. Naturally, future regulations may cover different levels of governance in order to be more effective, and this should be our desired normative goal. Possible measures and citizens' preferences will be analysed at the section dedicated to public policies to counteract the negative effects of automation. We cannot neglect that the State and autonomous communities have to play an important role to attend the needs of the population and assure their protection, in spite of the limited opinions in favour of these possibilities shown in the inquiry, that were even more powerful towards the regulations elaborated by the industries themselves.

⁸¹ Several analyses have covered the educational attainment of citizens related to their possible extremist vote in elections, and more will arrive soon, considering the current political scenery in Europe. Among them, it is interesting the work elaborated by HAKHVERDIAN, Armen; VAN ELSAS, Erika; VAN DER BRUG, Wouter; KUHN, Theresa (2013): "Euroscepticism and education: A longitudinal study of twelve EU member states, 1973-2010". *GINI Discussion Paper*, No. 92. Amsterdam Institute for Advanced Labour Studies (AIAS).

It is an interesting exercise to assess the preferences of regulators while evaluating simultaneously the sector of personal identification. At Figure 28 had been represented the sectors with more participants, classified by the proportions favourable to the eventual normative framework created by the United Nations. «Consulting» obtains the highest rate for the global legislation at 57.5% of the respondents, and this is the unique case where an option has obtained the absolute majority. In contrast, regulations favourable to industry and autonomous communities appear here at the lowest level possible.

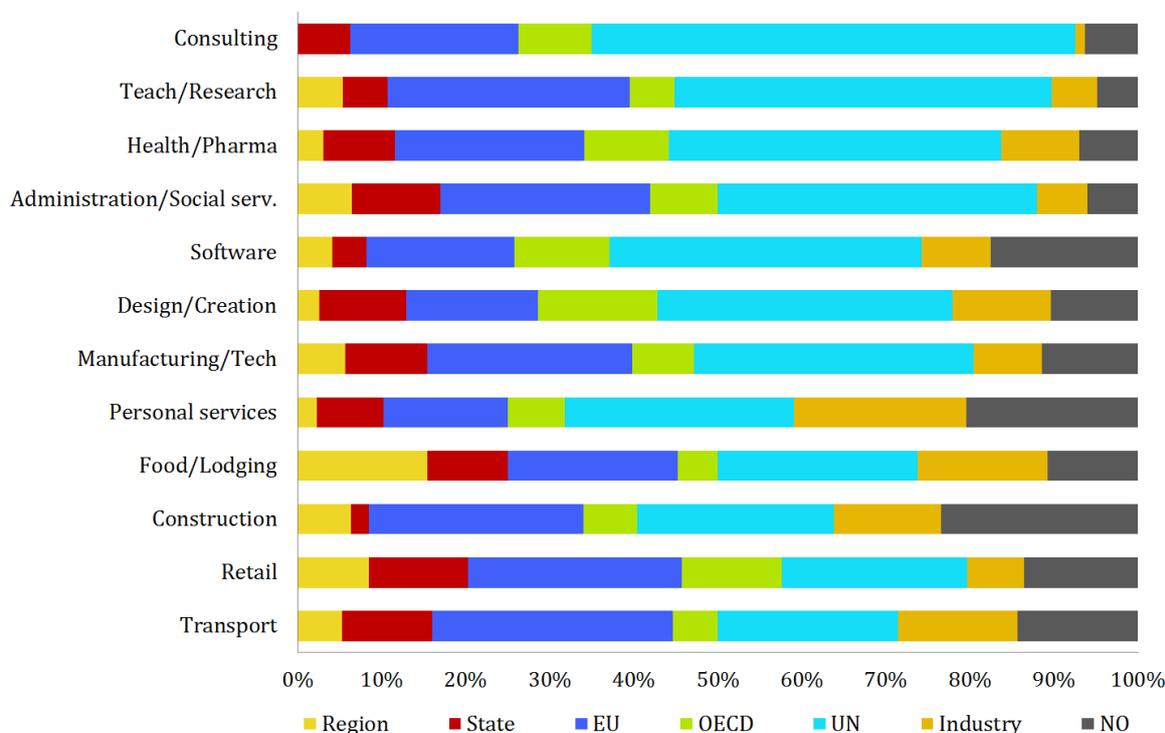


Figure 28. Opinions regarding the desired regulator for robots and AI, by sector of personal identification.

When observing the highest category of respondents favourable to the European Union's norms, appear two clear sectors: «teach and research» (28.78%) and «transport» (28.57%). Such answers can be attributed to the international mobility of university students and researchers, and the free circulation of goods around the Schengen Area. The top opinion rate to allow industries to self-regulate themselves is located at the «personal services» sector (20.45%), probably by the more pro-firm point of view of the entrepreneurs that operate here. «Design and creation» has established a greater attention towards the State (10.39%), while «food and lodging» has adopted a vision closer to the citizen, opting more for autonomous communities (15.47%). The sector that has shown a greater rejection over regulation is, not surprisingly, «construction» (23.40%).

This question of the survey was partially extracted from the inquiry of the European Parliament on *Civil Law Rules on Robotics*. This questionnaire did not include the regional level and indicated the possibility of an «international» level, not mentioning directly the United Nations or developed countries. The terms «Member State» and «EU» were used, thus creating a favourable bias over the European Union. Despite this, when first results were published in July 2017 the EU and international categories were grouped together⁸², in an intentional attempt to cover the importance of the global regulation⁸³.

⁸² EVAS, Tatjana (2017): *Public consultation on robotics and Artificial Intelligence. First (preliminary) results of public consultation*. Brussels and Strasbourg, European Parliamentary Research Service.

⁸³ When definitive results of the individual responses were published, the EU joint regulation attained 45% of the answers, while the «international» regulation arrived to 42%. This document is no longer available at EU website.

4.3. ARE ROBOTS OR ALGORITHMS POSSIBLE SUBSTITUTES AT ONE’S EMPLOYMENT?

Asking a person if he/she believes that a robot or algorithm may be a substitute at work is not always a comfortable question. For this reason, the survey was designed to allow different options to be selected, avoiding an «all or nothing» dilemma of substitution:

1. *Yes, but I will find another job, with the current knowledge and abilities.*
2. *Yes, but I will find another job, having more studies and/or acquiring other abilities.*
3. *Yes, and it would be very difficult to find another job.*
4. *No, it will not happen in any case.*
5. *Other opinion* [with the possibility to write it down].

In the case that the surveyed individual was not working at the moment, an alternative point of view was proposed verbally in case of doubts. For the case of pensioners and unemployed citizens, they had to think in their previous employments. And regarding students who have not entered in the labour market yet, they were asked to consider potential jobs for them.

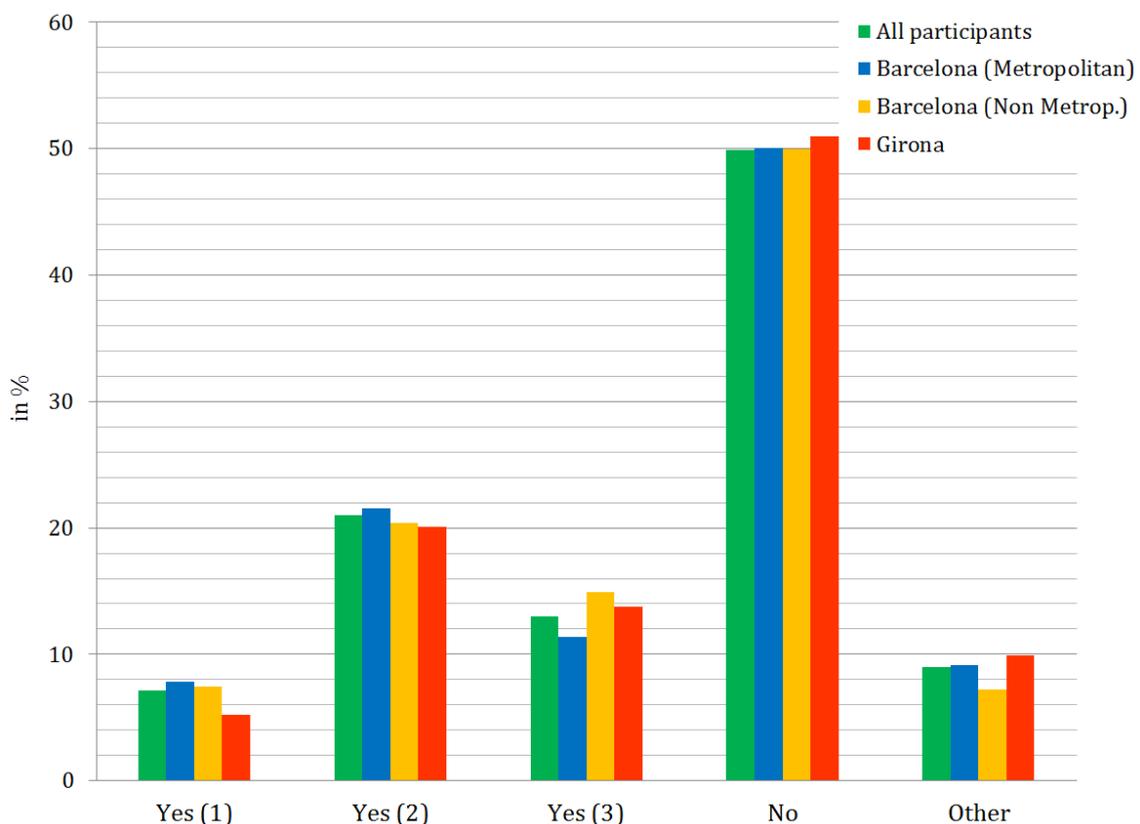


Figure 29. Opinions regarding the possible substitution by a robot or algorithm at work.

As is shown in the previous Figure, approximately half of the surveyed citizens consider that a robot or algorithm cannot be a substitute of them at the workplace. And territorially do not appear significant differences, only a slight increase of the proportion in Girona province, where are more services and tourism. When analysing the affirmative opinion regarding the possible substitution, in 20% (and more) with respect to the total answers, citizens had opted for considering a re-entry at a new job after a period of study, acquiring new capabilities and knowledge. The scenery of having important difficulties to find a job has been indicated in a less proportion (13.02%), and citizens that had opted for this choice are characterised by more age, having also more conscience of the discriminations that very sadly strike in the labour market.

When considering all the affirmative options of substitution, with independence of the possibilities to find another employment in the future, the average is situated at 41.14% of the total respondents. Below the measure appears the province of Girona (39.12%) and Metropolitan Barcelona (40.77%). In contrast, citizens of Barcelona that have residence outside the metropolitan area are slightly situated above the general value (42.82%).

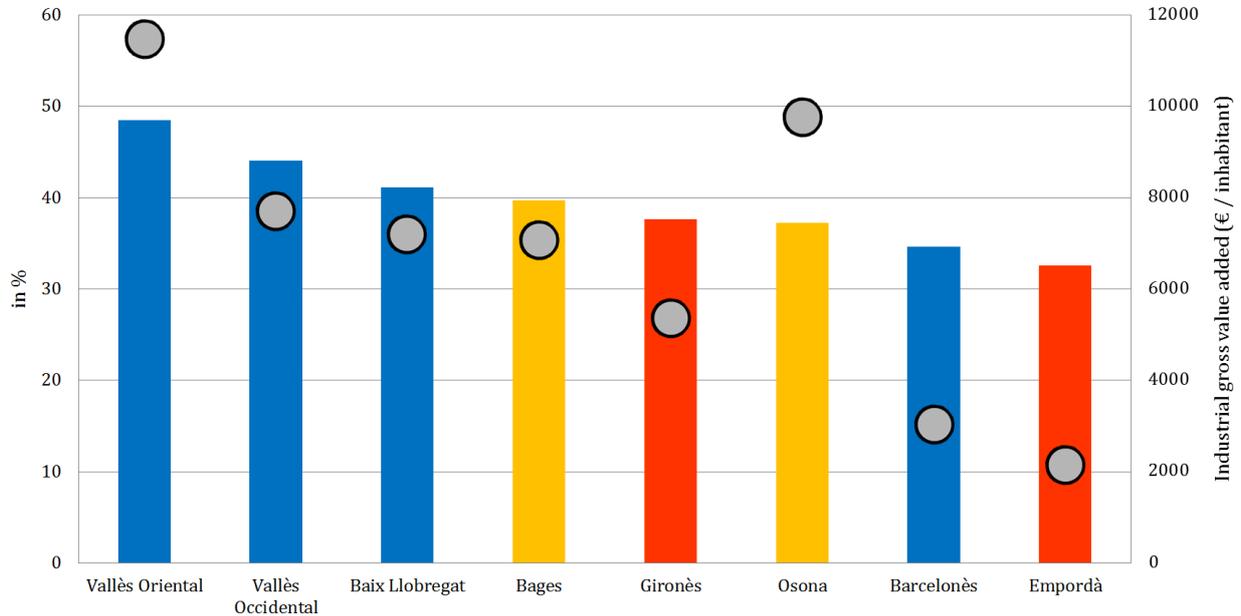


Figure 30. Opinions considering the possible substitution by a robot or algorithm at work, by county of residence (coloured bars). Industrial gross value added (grey dots)⁸⁴.

When analysing Figure 30, which distinguishes the «comarques» with more participants, it is clear that the counties that surround Barcelonès and configure the Metropolitan Area register the highest indexes of expectations of substitution, over 40% of the surveyed citizens in each space, clearly influenced by the industrial characteristics of the territory. By contrast, Barcelonès and Empordà counties, characterised by services (having tourism as a paradigmatic example), have lower rates. Counties in Central Catalonia adopt an intermediate position.

The graph also indicates the gross value added of industry, in euros per inhabitant (grey dots). This is a measure of the value added in the production of manufactured goods, but also covers extractive activities, management of water and waste, textile, chemicals, wood processing and food elaboration, among others. In this sense, it is shown that, with the exception of Osona county, a greater industrial added value per inhabitant is related with a reinforced perception that substitution at work is more plausible. As examples, Vallès Oriental has an industrial gross value of 11,456.40 euros per inhabitant and an opinion of substitution by new technologies of 48.48%; instead, Barcelonès county (which hosts the heart of the metropolitan sector), has an industrial value added of 3,031.21 euros per inhabitant and a qualification of substitution of merely 34.59%. The lowest case appears at Empordà⁸⁵, with an industrial value of only 2,137.72 euros per inhabitant and an opinion regarding substitution of solely 32.61%.

⁸⁴ Graph and calculations elaborated by the author. Source of data regarding the industrial gross value added: IDESCAT (Institut d'Estadística de Catalunya, 2019): *Població empadronada (2018). Per grandària del municipi. Comarques i Aran, àmbits i províncies*. On line [Last consultation in 30/08/2019]: <https://www.idescat.cat/pub/?id=aec&n=248>

IDESCAT (2019): *Valor afegit brut de la indústria (2016). Per branques d'activitat. Comarques i Aran*. On line [Last consultation in 30/08/2019]: <https://www.idescat.cat/pub/?id=aec&n=360>

⁸⁵ At Empordà had been grouped the gross value added of industry, the population, and the opinions of participants of the two counties that constitute this historical territory: Alt Empordà and Baix Empordà.

It is also very interesting to develop an analysis of the opinions of possible substitution at work considering the sector at which the respondent is more identified. As commented previously, it shall be noted that participants are not all employed at the moment, as have answered the survey students and pensioners, among other collectives. For this reason, individuals had been asked to consider the sector at which they felt more identified, in terms of current, past, or even potential area of employment.

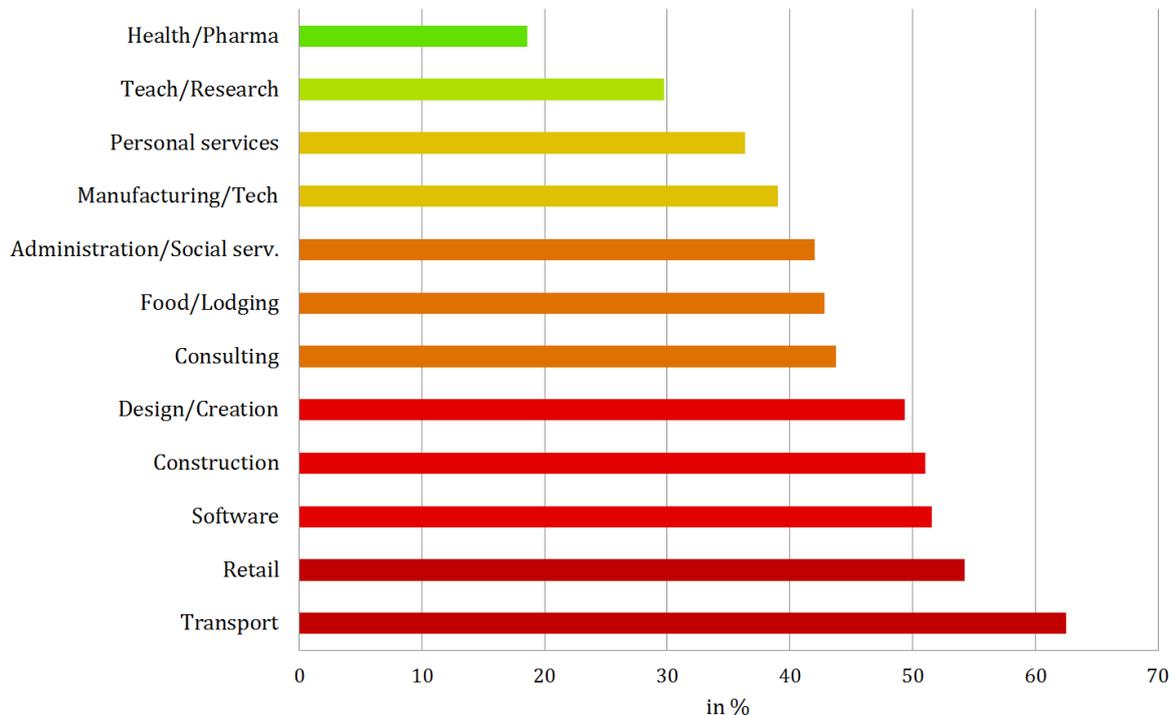


Figure 31. Opinions considering the possible substitution by a robot or algorithm at work, in percentage and by sector of personal identification.

When observing the graph, respondents that have felt more identified by the sector of «health and pharmaceuticals» have opted by a reduced response ratio of acceptance of the substitution scenery, only reaching 18.60% of the participants. The second sector is represented by «teaching and research»⁸⁶ (grouped inside the same category because of the strong relatedness of both in universities), at 29.76%. Next, follow the list «personal services» (36.36%), quite normal because of the tasks developed, and very surprisingly, «manufacturing and technology» (39.02%). This situation can be explained by the traditional stability of the employment generated in this sector, partially thanks to the organised movement of unions. Despite this, the advancements in industrial robotics and computer science will make a different picture in the next decade.

The sector at which citizens feel more in danger to be substituted is «transport», at 62.5% of respondents. This rate can only be explained by the influence of mass media in recent years, where autonomous cars appear with certain frequency at news and television programmes. The next sector with the highest ratio is «retail» (54.24%), as citizens may be consumers of online shopping platforms and thus they recognise that their job can be easily substituted. Follow the list «software» (51.55%), quite reasonable as programming advancements allow to automate more computer processes, and «construction» (51.06%). This last sector groups professionals of heterogeneous qualifications, and reveals the high standardisation in materials and techniques.

⁸⁶ This finding is consistent with the analysis of PEW RESEARCH CENTER (2016): *Public Predictions for the Future of Workforce Automation*, p. 3. According to this study, government, education and non-profit workers are slightly more sceptical about the likelihood of widespread automation. On line [Last consultation in 30/08/2019]: <https://www.pewinternet.org/2016/03/10/public-predictions-for-the-future-of-workforce-automation/>

The analysis of the possibilities of automation and the sectors can go further, when assessing the specific options selected by citizens in case of admitting the hypothetical substitution at work. Three options were available: at first, another job was possible to be obtained; secondly, the next job will be possible but only after a period of training or acquiring more education; and finally, the possibilities to be hired in another job were remote. In this last case, the respondent did not have to indicate the cause of the impossibility (for example, could be by age discrimination).

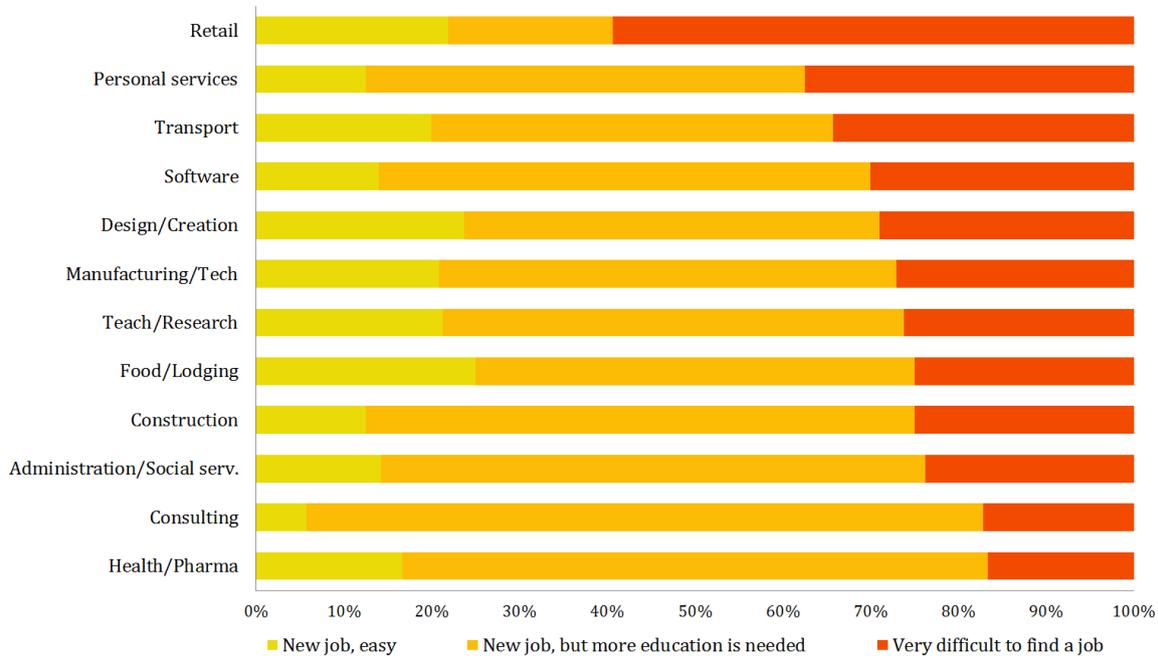


Figure 32. Possibilities in case of affirming a possible substitution by a robot or algorithm, by sector of personal identification.

The sector where respondents consider that they will find another job without problems at a highest rate is «food and lodging», at 25%⁸⁷. Probably, the reason for this is found in the stunning temporality of the jobs generated and the strict seasonality of tourism. Follow the list «design and creation» (23.68%), influenced by the project nature, and «retail» (21.87%), another sector where short contracts are much extended. The lowest rate is encountered in «consulting», with only 5.71% of respondents.

In this case, «white collar» jobs are translated into a greater acceptance of acquiring other abilities or knowledge to find a new job. Precisely in «consulting» appears the highest indicator, at 77.14% of participants. The list is followed than by «health and pharmaceuticals» (66.66%), where qualified professionals are relatively extended, and «construction» (62.5%), having suffered the burst of the real estate bubble in 2008 and thus needing to adapt to other jobs after a period of training. The lowest rate of acceptance of acquiring new abilities and/or studies with the expectancy to find another job is found in «retail» (18.75%).

Finally, the sector at which citizens have thought that would be very difficult to find a job after a substitution at work is also found in «retail» (at 59.37%), thus considering that when technology replaces the human contact in sales it is extremely difficult to integrate the worker inside a labour niche of other sectors. The next area is «personal services» (37.5%), for the same reasons, and the lower ratios are found in «consulting» (17.14%), where the «re-invent» rhetoric is highly extended, and «health and pharmaceuticals» (16.66%).

⁸⁷ Notice that the present graph is elaborated considering as the reference the affirmative respondents of substitution at work (the previous figure), and not all the participants of the study that are identified in a specific sector.

4.4. WHAT MEASURES ARE PREFERABLE, IN CASE OF TECHNOLOGICAL UNEMPLOYMENT?

In front of the hypothesis of critical unemployment levels in the future caused by new technologies, it is fundamental to consider the preferences of citizens about public policies that could be implemented in developed countries. Some of them are the following ones:

- 1) *Basic Income*. A guaranteed payment could be useful to maintain the consumption capabilities of citizens and their families, redistributing the wealth among them.
- 2) *Public employment*. The mentioned income, instead of being a right without any duties, would be conditioned to the effectuation of tasks destined to the general social welfare.
- 3) *Redistribution of labour time*. The increment in productivity allows employers to hire fewer workers. In this sense, a progressive reduction of maximum working hours, while increasing the legal minimum salary, could maintain employment rates and purchasing power of citizens.
- 4) *Free education*. If knowledge is more accessible to all, an educated society will be more suitable to adapt to the technological transition.
- 5) *Unemployment benefit*. Nothing changes in the current framework.

The following Figure illustrates the distribution of preferences indicated by citizens. Two options are remarkable: free education (28.11%) and redistribution of working hours (27.11%). Then, follow the list public employment (22.49%), a basic income (14.73%), the unemployment benefit (4.55%) and other possibilities (2.99%). In this sense, a basic income is not a measure that the population supports extensively, considering other options with less impact for the public budget.

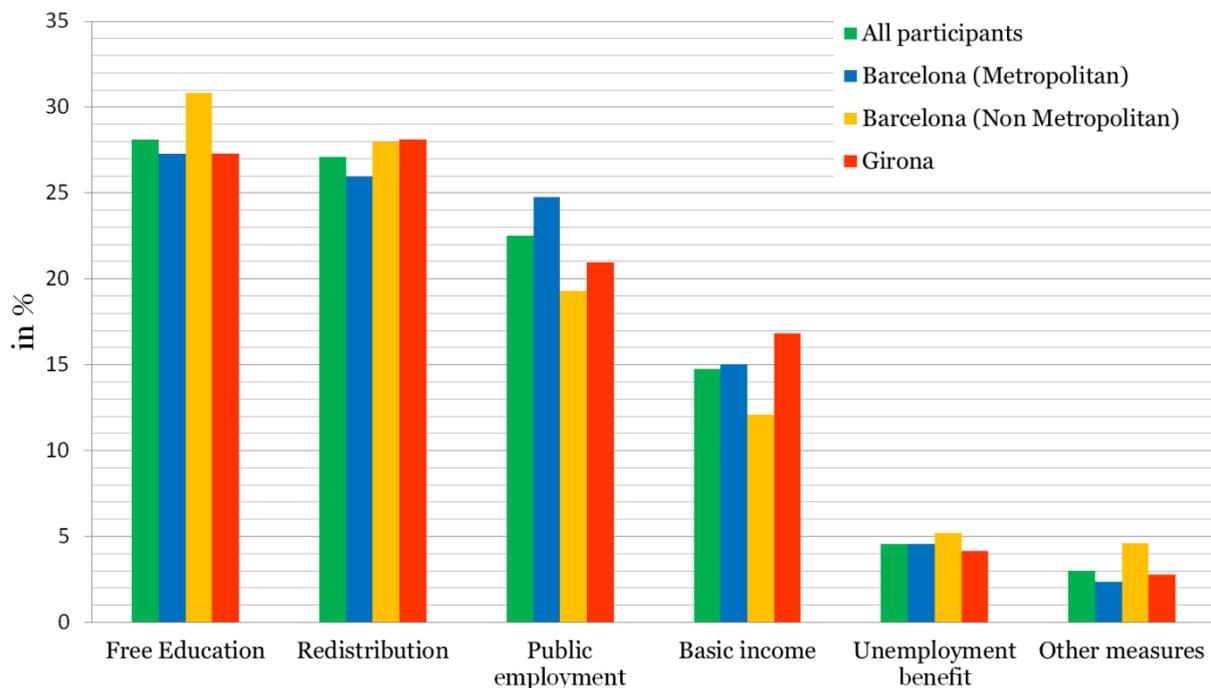


Figure 33. Preferences regarding assistance measures in case of substitution at work.

Of course, choosing the option of free education indicates a will of the individual to «recycle» him/her, which is quite positive, but raises several questions of importance (and remarkable concerns about techno-optimism). First of all, how will affront the person his/her basic needs while being in the process of being educated? Families are not perpetual institutions. And afterwards, what will happen if education becomes a mere «badge» in a time where robots and algorithms substitute high-skilled jobs? The respective answers are not easy to express.

The option of redistributing working hours appears thus as more plausible, also considering the country analysis deployed at Chapter 2, where it is estimated that working hours had been reduced over time. The so-called «four working days» campaign is an interesting initiative, but shall be considered that the exposed decrease in labour hours could be explained partially as a consequence of international trade, as more goods are shipped from emerging economies whilst the European industrial muscle cannot compete against cheap imports and «social dumping».

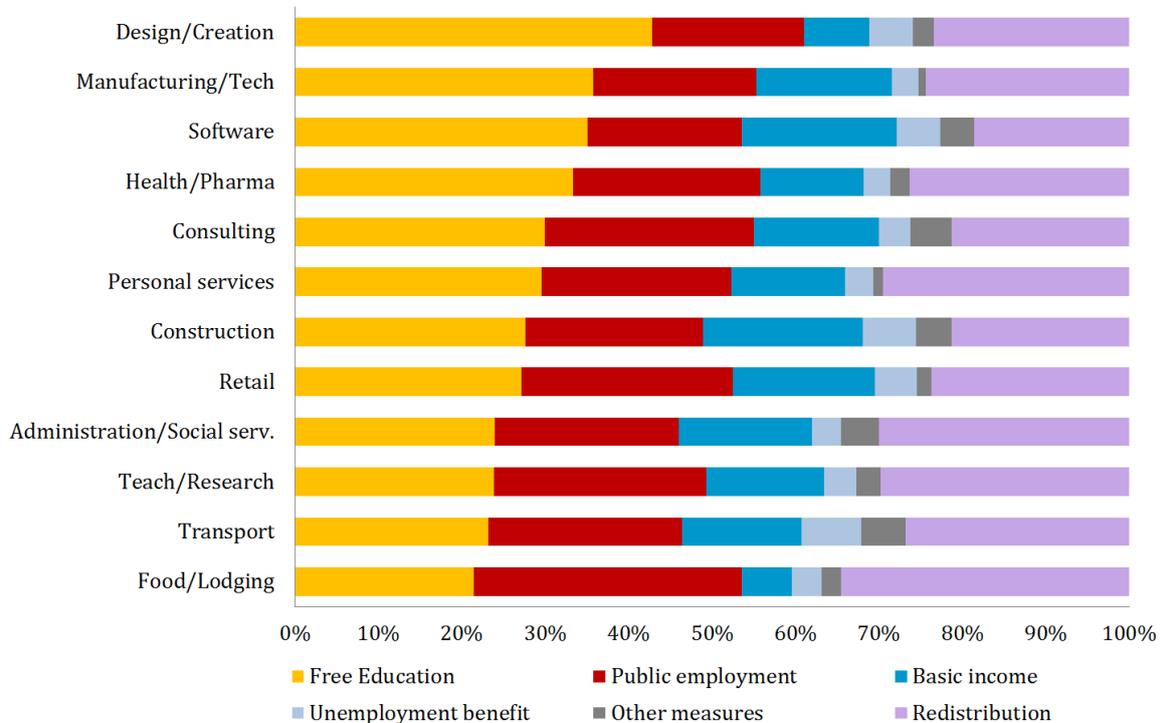


Figure 34. Preferences regarding assistance measures in case of substitution at work, by sector of personal identification.

The classification of answers considering the sector of personal identification of the respondents allows articulating a better overview. The category that has expressed a greater will to acquire other abilities and knowledge to find another job after substitution, without considering other measures more favourable to maintain income levels, is «design and creation» (42.86%). This response rate could be explained in terms of the romantic or bohemian context of the profession, more keen to obtain a greater status with new qualifications and thus become able to find another employment. The other possible explanation is that the options of public employment, basic income, or redistribution of hours are perceived as constraints to creativity, with the dangers that such conception implies. It should be considered that the next sector that puts at first place solely education is «manufacturing and technology» (35.77%). With the spread all over the world of 99% automated factories, choosing an option that does not provide economic security at the long run would be an important mistake for the affected workers.

The other side of the coin, represented by redistribution of working hours, is evaluated at first place by «food and lodging» (34.52%). This is also the sector that prefers the most the option of public employment (32.14%), probably as a consequence of the widespread instability that the sector suffers. We can conclude that basic income has been rejected⁸⁸, and the sector that has shown a greater acceptance of it is «construction» (19.15%), a quite logic outcome.

⁸⁸ In a similar sense, the first referendum in the world to establish a basic income was decided in Switzerland in April 2016 and only 23.1% of the valid votes accepted the proposal. Thus, the project to modify the article 110a) of the Federal Constitution was rejected. CHANCELLERIE FÉDÉRALE (2016): *Votation No. 601. Tableau récapitulatif*. On line [Last consultation in 30/08/2019]: <https://www.bk.admin.ch/ch/f/pore/va/20160605/det601.html>

4.5. WHAT IS THE DEGREE OF USE OF SMARTPHONE APPS?

In order to analyse the future impact of robots and automation processes, it is of interest to understand better the interactions of humans with new technologies. Smartphones have become a paradigmatic example: with a little screen and having a tiny computer inside, citizens are becoming more dependent on them to communicate to other persons in multiple forms, to contract services, to entertain themselves with videos and games...

Figure 35 shows the average degree of use of smartphone apps, which has been obtained by classifying applications into fifteen different categories according to their functionalities and asking citizens to tick the options that used more during a single week. The generation that has between 26 and 35 years old exhibits a greater propensity to use apps in their daily lives, a finding that is coherent with other research conducted previously in the Iberian Peninsula⁸⁹.

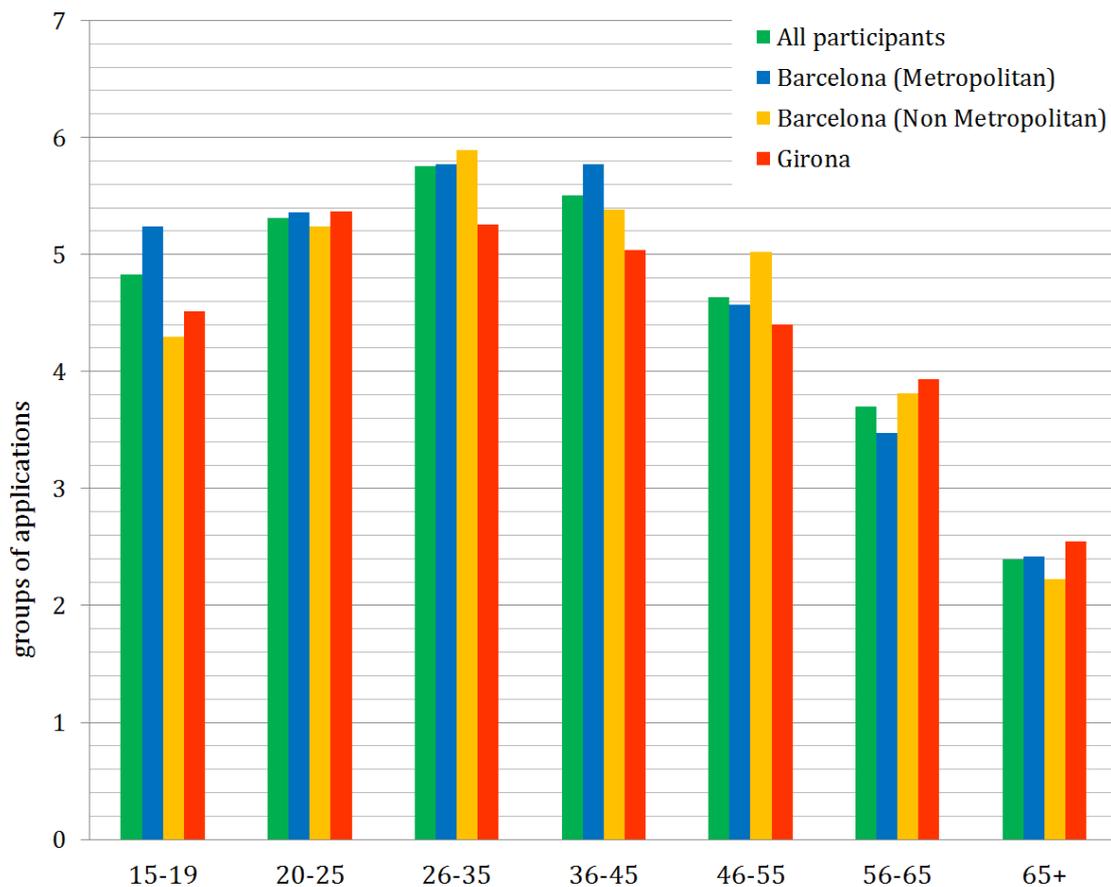


Figure 35. Average use of different categories of smartphone apps, by age and territory.

On average, Catalans use 4.71 different groups of phone apps on a weekly basis. The next section will delimit what smartphone apps are more popular considering the mentioned categories, which were designed to avoid repetitions of similar functionalities, and also not to write the original commercial names to protect intellectual property⁹⁰.

⁸⁹ EMMA (2015): *Penetración y uso de Apps en el Smartphone en España*, p. 14. The study has been elaborated by a private business intelligence company, with a sample of 530 interviews obtained in September 2015.

On line [Last consultation in 30/08/2019]:

<https://emma.io/lp-files/penetracion-uso-app/EMMA-Study-1-Penetracion-y-uso-de-apps-en-Smartphone.pdf>

⁹⁰ And naturally, the author is not paid by such companies to promote their own brands. Despite this, at the questionnaire were put some examples at each category, in order to help respondents fill the survey better.

A curious picture is obtained when analysing the use of smartphone apps considering the sector of personal identification of participants. The areas at which more groups of apps are used are «software» and «administration and social services», at 5.28 and 5.26 groups on average, respectively. In the case of software, it is quite expectable that employees will have an intensive use of new technologies both at work and at home, but regarding the workers at public administration or NGOs, this finding probably reveals a use of mobile phones destined to scape over well-defined labour routines at office.

The list is followed by «consulting» (5.02 groups), «health and pharmaceuticals» (4.98 groups) and «teach and research» (4.86 groups). All of them could be qualified as «white collar» jobs, so we could estimate that workplace conditions in an office and lower physical effort will determine a greater use of the smartphone device. Another possible explanation would be that more qualified individuals tend to have a more diversified use of mobile functionalities, and by extension to different applications⁹¹.

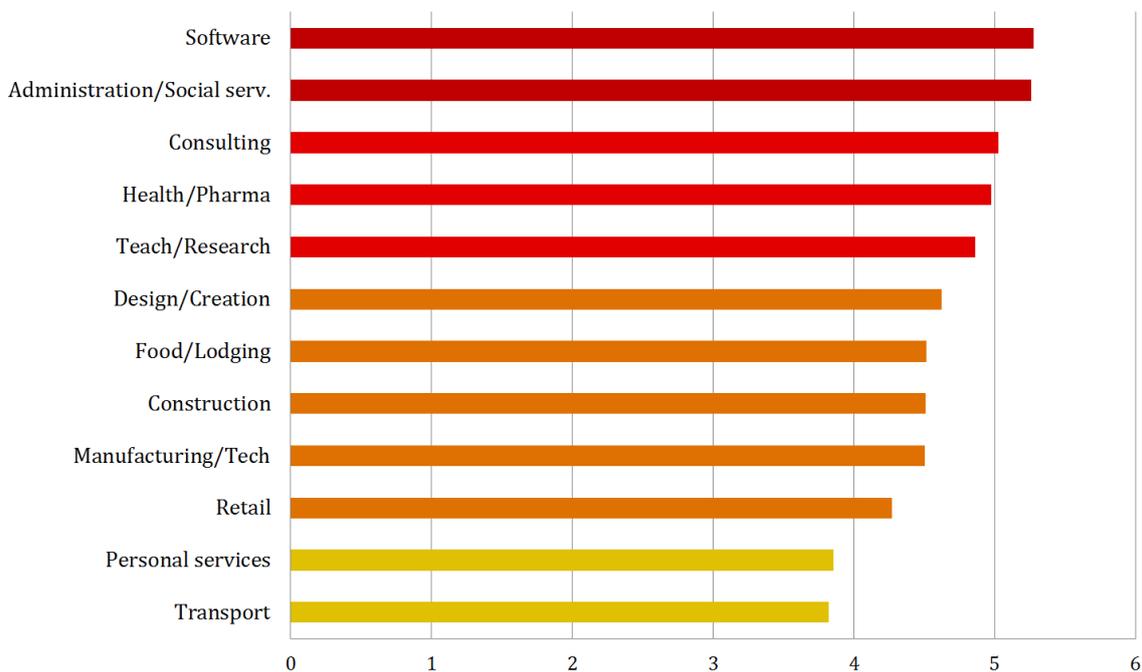


Figure 36. Average use of different categories of smartphone apps, by sector of personal identification.

The next sectors represented in the graph are characterised by manual dexterity or abilities that require concentrating in one specific task, and thus do not allow a prolonged use of smartphones. The categories where are recorded the lowest number of groups of applications are «transport» (3.82 groups) and «personal services» (3.85 groups). For obvious reasons, driving a vehicle requires a specific concentration on this task and limits the freedom of movements of the individual, not being able to use a mobile phone whenever considers it. The same situation happens in personal services: in the case of a hairdresser, for example, his/her continuous manual work reduces the opportunities to use a digital device. The list continues with «retail» (4.27 groups) and «manufacturing and technology» (4.50 groups), sectors at which is experienced a similar dedication of professionals over a concrete task.

⁹¹ This possibility could be set aside in a few years, when children «born digital» arrive to the adult age and is appropriately analysed the incidence of new technologies over psychological disorders (among them, attention deficit). Very probably, students with a limited use of mobile devices during the day will be able to concentrate more on a specific task, and thus improve their qualifications and general educational attainment. This is an important issue for the future of the country that should be placed immediately at the public debate and parliamentary arena.

4.6. WHAT SMARTPHONE APPS ARE MORE POPULAR?

Figure 37 illustrates the degree of use of the main categories of smartphone apps, on a weekly basis. First of all, we can appreciate the dominant presence of messenger applications (94.95%), which have replaced the original use of SMS texting. Secondly, the use of video and audio apps is very extended (70.89%). At third place, social networks that have strong image contents have become very popular in all geographical distributions (52.31%), and have displaced social networks of short text to the seventh position (28.11%).

The next categories are occupied by purchases (40.93%), bank services (40.07%) and travel (30.46%, not to be confused with transport apps, a different category). These last three apps suppose a real impact to the familiar budget, compared to the initial categories, and their use is an indicator of how the economy is transforming to the virtual arena, where costs and prices tend to hyper-efficiency. It is quite surprising to observe travel apps having such a continuous use over the year, and a possible explanation is that consumers would be waiting patiently to promotional prices and discounts, in order to contract the desired trips at the minimum costs: a new habit.

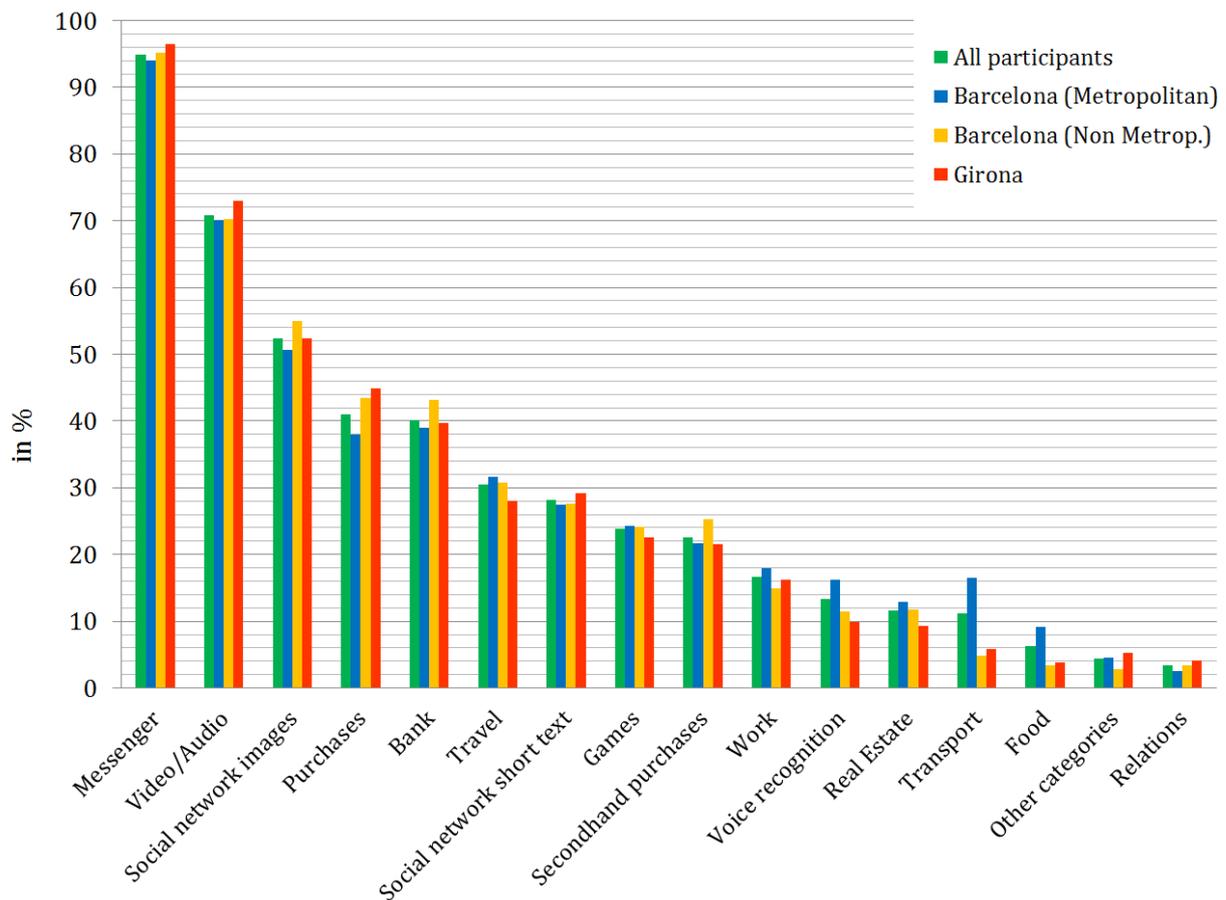


Figure 37. Average use of different categories of smartphone apps, by territory.

The types of applications that follow the list have in some cases territorial specificities. Transport apps, for example, appear to be highly extended in metropolitan Barcelona (16.51%, compared to approximately 5% at the other cases), and the same argument applies to food applications. The higher urban density and the greater availability of means of transport are key factors to make the difference. Real Estate applications were suspicious to have a large incidence in the metropolitan area, but the analysis has shown that the impact is quite low. Regarding apps of relationships (a sensitive matter), the rate has been extremely low and possibly is not adjusted to the real use.

4.7. HOW ARE EVALUATED THE SOCIAL POLICIES DEPLOYED BY THE EUROPEAN UNION?

One of the reasons that have been determinant to shorten the period of data gathering in the survey has been the arrival of the EU Parliament’s elections in May 2019. The quality of the research would have been affected, considering also the willingness of citizens to participate in the study. As the graph inserted below shows, a large proportion of respondents opted to evaluate negatively the social policies developed by the European Union. Moreover, an important fraction of the surveyed inhabitants affirm not to know what the indicated policies are, which is also bad news for the EU, as an organization that affirms to be in search of greater social acceptability.

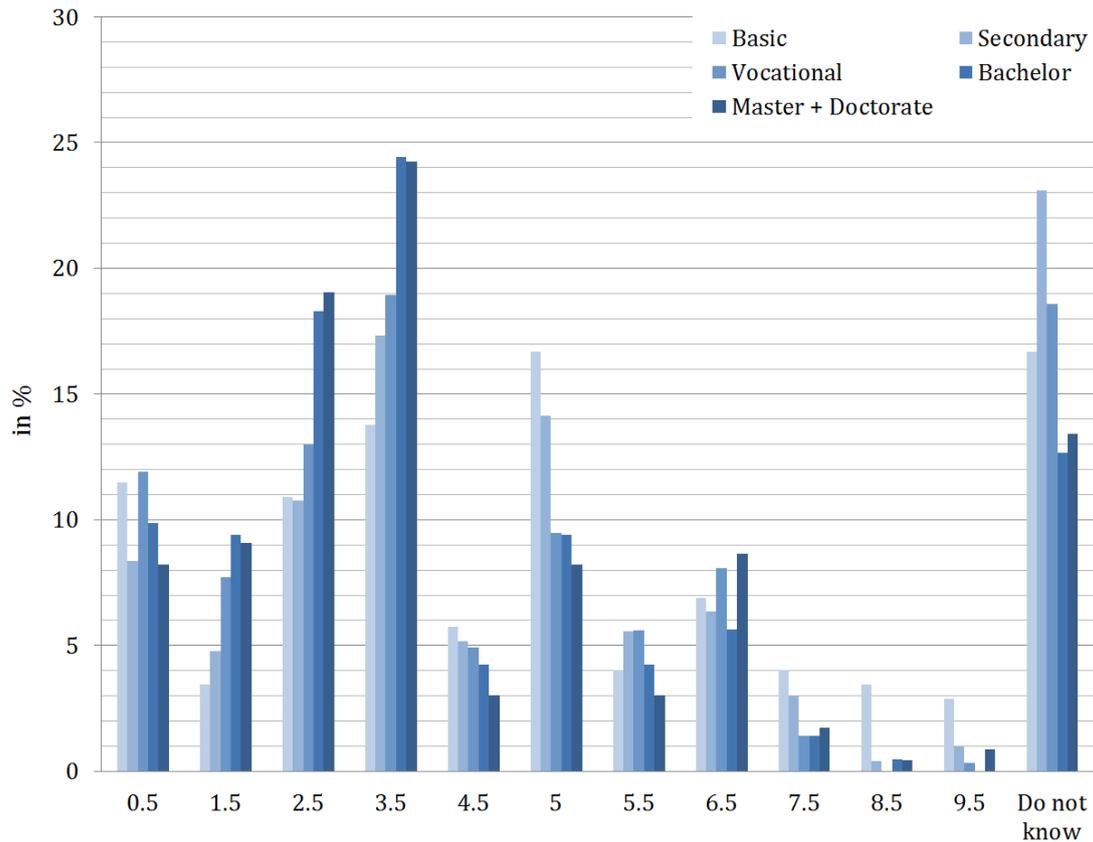


Figure 38. Evaluation of European Union’s social policies, by educational attainment.

The graph illustrates well how more educated citizens tend to evaluate more negatively, in general, the EU’s social policies, reaching an important concentration at 3.5 points over 10. Another form to analyse citizens’ opinions is by classifying the answers according to the origin of respondents. Europeans (considering the member States of the EU and the countries of the European economic space only) evaluate more as «failed» EU’s social policies (57.29%). By contrast, respondents that have origin outside the continent (in a restricted sense), approve such policies in 41.38%, superior than that of failing (38.36%). This may be because of the lack of a Welfare State in their countries of provenance and harsh living conditions. In contrast, Europeans that had approved EU’s social policies are only 24.89%.

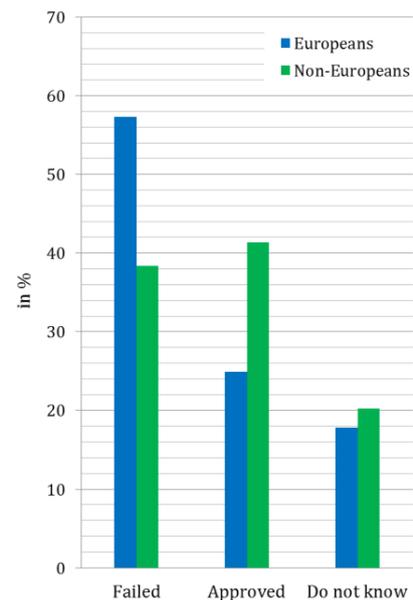


Figure 39. Evaluation of EU’s social policies, by origin.

The same analysis can be deployed observing the sector of personal identification of respondents. Notwithstanding this different perspective, none of the studied sectors has moved inside the approval area. Figure 40 illustrates the results. The sector where was detected a greater will to non-regulate robots and automation, «construction», here reaches the higher level in terms of acceptance of EU social policies (42.55%). The logics behind this vote remain unclear for the author. It is followed by «software» (40.21%) and «transport» (37.5). In such cases, the participants integrated at the first sector may be impressed by the current deployment of the GDPR⁹², and this fact may have increased their positive vote. Curiously, this is the sector with the highest rate of «do not know» responses about the EU's policies, and more positive evaluations about the future of work in general. Regarding «transport», it is well-known the original objective of the European Communities to eliminate border controls and promote the free circulation of goods inside the territory of the Member States, thus becoming the professionals of the sector more keen to approve the tasks of the EU in matter of social policies.

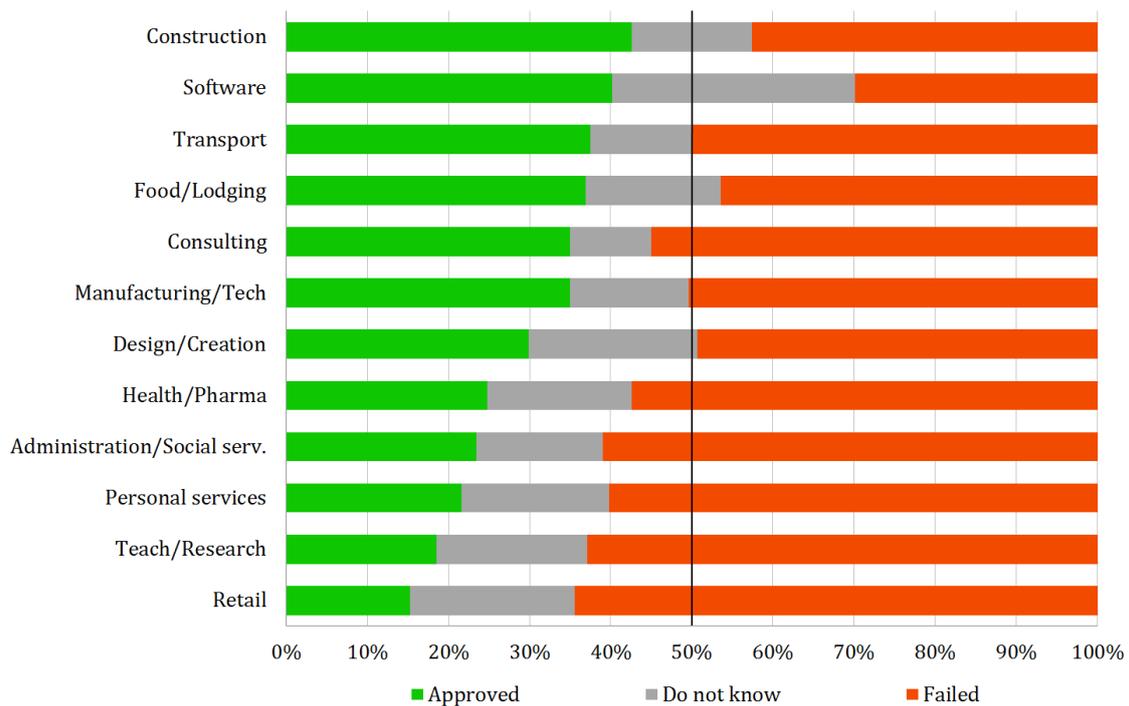


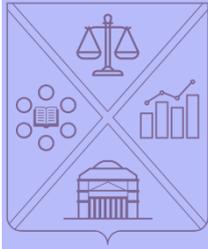
Figure 40. Evaluation of European Union's social policies, by sector of personal identification.

At the other side, «retail» is the sector that has shown a greater dissatisfaction for the social policies of the EU: 64.41% of the respondents have selected negative values. A possible explanation could be the interest of the EU to promote deregulation pleading the competition of electronic commerce⁹³, which could affect negatively small shopkeepers. Also, large companies establish their domiciles in Member States where tax privileges are the norm⁹⁴, whilst little retailers are physically constrained and cannot compete in reduced margins. The second sector that has expressed more disapproval of EU's social policies is «teach and research» (62.93%). Mobility programmes like «Erasmus» have seen their prestige descent over years, as most of the students do not take them seriously. Also, the objective to make compatible the curriculums among European universities and the «3+2» progressive harmonisation of plans has reduced the deepness and general quality of the contents that are taught, whilst increasing the costs of tuition.

⁹² General Data Protection Regulation (Regulation (EU) 2016/679). It is considered to be an international reference.

⁹³ EUROPEAN COMMISSION (2018): *A European retail sector fit for the 21st century*. Brussels, Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM (2018) 219 final, p. 10. Spain is considered to establish «restrictive rules on retail operations».

⁹⁴ At the very recent G7 summit in Biarritz, France and Germany have refused to enter the tax discussion at the agenda of the Union, and have moved the issue to the OECD, where is even more difficult to reach a consensus.



Chapter V / Empirical analysis

5. EMPIRICAL ANALYSIS

5.1. ECONOMETRIC MODEL OF THE FUTURE OF WORK

The present econometric model defines as the dependent variable the evaluation of the future of work in twenty years' time, over ten points (in other words, this is the regressand of the model). This variable is associated with 18 independent variables, which are shown at the table below. Most of them are based in the binary pattern, also called «dummy» variables, and will be fundamental to assess the 14 hypotheses presented at Chapter 2, at the following Section.

Definition of independent variables	
Territorial variables:	
01-Ter:METROPOL-AREA	1 if the surveyed citizen has residence in the Metropolitan area of Barcelona ⁹⁵ , and 0 otherwise.
02-Ter:CAPITAL-COUNTY	1 if the surveyed citizen has residence in the capital of the county, and 0 otherwise.
03-Ter:HIGH-URBAN-DENSITY	1 if the surveyed citizen has residence in an area of high and medium urban density (flats with or without public spaces or gardens), and 0 otherwise.
04-Ter:DISPOSABLE-INCOME	Disposable income of the municipality of residence, according to the Ministry of Finance and Public Administration of Spain. Data of 2016 year average (last available), converted to thousands of euros.
05-Ter:UNEMPLOYMENT-RATE	Registry unemployment rate of the municipality of residence, according to the Department of Employment, Social Affairs and Families of the Government of Catalonia. Data of March 2019 year.
Technological variables:	
06-Tech:APPS-USE	Number of groups of smartphone applications used by the surveyed citizen, on a weekly basis.
07-Tech:ROBOTS-USE	1 if the surveyed citizen has ever used a robot at home, at work or in both places, and 0 otherwise.
08-Tech:ROBOTS-APPROACH	1 if the surveyed citizen estimates that robots and/or artificial intelligence will arrive at his/her labour sector in the next 5 and 10 years, and 0 otherwise.
09-Tech:SUBSTITUTION	1 if the surveyed citizen considers that robots and/or artificial intelligence could substitute him/her at the current work ⁹⁶ , and 0 otherwise.
Educational variables:	
10-Educ:EDUC-ATTAINMENT	1 if the surveyed citizen possesses university studies (bachelor, master and doctorate), and 0 otherwise.
11-Educ:TECH-SCIENCE	1 if the surveyed citizen has an educational specialisation in technology or experimental sciences, and 0 otherwise.
Public policies variables:	
12-PubPol: MEASURE-SOFT	1 if the surveyed citizen prefers for him/her, in case of technological unemployment, public policies of free education, the current unemployment benefit or «other measures», and 0 otherwise.

⁹⁵ Considering as municipalities integrated inside the Metropolitan Area of Barcelona the Catalan towns and cities located inside the Zone 3 of the public transportation system. *Vid.* Annex I for more details.

⁹⁶ In case of being unemployed or pensioner, the expectancy of substitution is related to the previous employment. And in case of being student, the expectancy of substitution is associated to a potential job in the future.

13-PubPol:UN-OECD	1 if the surveyed citizen prefers regulations for robots and artificial intelligence deployed by global public regulators (United Nations and OECD), and 0 otherwise.
14-PubPol:EU-SOCIAL-POL	The evaluation of the European Union’s social policies indicated by the surveyed citizen, in a scale of 10 points, considering halves ⁹⁷ .
Control variables:	
Ctrl:GENDER	1 if the surveyed citizen is a woman, and 0 if is a man.
Ctrl:AGE	The category of age selected by the surveyed citizen, transformed according to certain parameters ⁹⁸ .
Ctrl:ORIGIN	1 if the surveyed citizen was born, or considers having origin in the Iberian Peninsula, and 0 otherwise.
Ctrl:OCCUPATION	1 if the surveyed citizen is currently working (as employee, public official or entrepreneur), and 0 otherwise.

By using the previous independent variables, the following equation summarises the econometric model that will be developed at the present Chapter, with the aim to answer appropriately the initial hypotheses:

$$FW_i = \alpha + \sum_{j=1}^5 \beta_j \sum_{j=1}^5 Ter_i^j + \sum_{k=1}^4 \gamma_k \sum_{k=1}^4 Tech_i^k + \sum_{l=1}^2 \delta_l \sum_{l=1}^2 Educ_i^l + \sum_{m=1}^3 \zeta_m \sum_{m=1}^3 PubPol_i^m + \sum_{o=1}^4 \eta_o \sum_{o=1}^4 Ctrl_i^o + \varepsilon$$

Where:

$$1 \leq i \leq 1405 \quad 1 \leq j \leq 5 \quad 1 \leq k \leq 4 \quad 1 \leq l \leq 2 \quad 1 \leq m \leq 3 \quad 1 \leq o \leq 4$$

Definition of the elements of the equation	
FW_i	<i>Future of Work</i> , the evaluation of the employment levels and labour market in a twenty years’ time, after the presumable impact of new technologies. Data in a scale over ten points, transformed from the original data based on a Likert-type scale with negative and positive values, having 0 as the neutral point.
α	Constant of the regression.
β_j	Coefficient related to a regressor of the territorial hypotheses.
Ter_i^j	Regressors of each of the territorial hypotheses (5).
γ_k	Coefficient related to a regressor of the technological hypotheses.
$Tech_i^k$	Regressors of each of the technological hypotheses (4).
δ_l	Coefficient related to a regressor of the educational hypotheses.
$Educ_i^l$	Regressors of each of the educational hypotheses (2).
ζ_m	Coefficient related to a regressor of the public policies hypotheses.
$PubPol_i^m$	Regressors of each of the public policies hypotheses (3).
η_o	Coefficient related to a regressor of the control variables.
$Ctrl_i^o$	Regressors of each of the control variables (4).
ε	Error term or disturbance.

⁹⁷ The opinions of citizens that did not know the social policies of the EU had been transformed, at the evaluation, to five points over ten, as a limited degree of approval. Otherwise, a remarkable sample would have been discarded.

⁹⁸ Regarding the variable of age: 17 points (citizen selected an age between 15 and 19 years old), 23 points (20 – 25 years old), 30 points (26 – 35 years old), 40 points (36 – 45 years old), 50 points (46 – 55 years old), 60 points (56 – 65 years old), 70 points (66 – 75 years old) and 80 points (more than 75 years old). This classification of ages was created with two main purposes: first of all, it is more practical to control the quality of the sample and the comparability among territories while the questionnaires are being gathered; and secondly, citizens feel more comfortable to indicate an age category (which is not cut at every decade), and have fewer propensities to lie.

5.2. ESTIMATION AN RESULTS

In Annex III is detailed the output obtained of the previous regression, using the software Stata 14.1. In order to be more didactic and comprehensive, every hypothesis will be commented after indicating the specific results of each variable; confidence intervals are saved at the mentioned Annex. The coefficient of determination obtained in the regression is relatively low, at 0.1024. This value is accepted in the context of social sciences, where analysis experience important levels of «noise». Moreover, as econometricists know well, shall be considered that the grade of the R^2 is not a perfect and unique measure of the quality of the econometric model.

5.2.1. TERRITORIAL HYPOTHESES

Hypothesis 1. <i>Living in the metropolitan area is positively related with a more favourable opinion of the incidence of robots and AI over employment.</i>			NOT SIGNIFICANT
Coefficient	Standard Error	<i>t</i>	$P > t $
-0.0381558	0.158427	-0.24	0.810

At the beginning, we could consider that the relationship among living at the metropolitan area and having a favourable opinion about the incidence of robots and artificial intelligence over employment is positive. However, the present analysis surpasses the minimum level of precision of 10% (it appears at 81%) and we cannot reach significant conclusions about this variable. In this sense, we can only affirm that living in the metropolitan area is not proven to be related with having a favourable opinion of the incidence of new technologies over labour.

Hypothesis 2. <i>Living in a municipality that is the capital of the county is positively related with a more favourable opinion of the incidence of robots and AI over employment.</i>			NOT SIGNIFICANT
Coefficient	Standard Error	<i>t</i>	$P > t $
0.2043297	0.1390813	1.47	0.142

Initially, we could infer that living in a municipality that is the county's capital is related with having a favourable opinion of the impact of robots and artificial intelligence over employment. Despite this, the current analysis surpasses the established minimum level of precision at 10% (in this case, is at 14.2%), and we cannot reach significant conclusions regarding this variable. In this sense, we can only affirm that living in the capital of the county is not proven to be related with a favourable opinion about the impact of new technologies over employment levels.

Hypothesis 3. <i>Living in an area of higher urban density is negatively related with a more favourable opinion of the incidence of robots and AI over employment.</i>			NOT SIGNIFICANT
Coefficient	Standard Error	<i>t</i>	$P > t $
-0.1045017	0.1598949	-0.65	0.514

At first sight, we could consider that the relationship between the urban density of the residence and the opinion about robots and automation over employment is even negative, but the present analysis surpasses notably our minimum level of precision of 10% (reaches 51.4%). We cannot obtain significant conclusions about the influence of this variable. Thus, we can only affirm that living in an area of higher urban density is not proven to be related with having a positive opinion about the impact of robotics and artificial intelligence over employment.

Notwithstanding this fact, if we represent graphically the municipalities with the highest number of participants considering their levels of urban density⁹⁹ and the average opinion about the future of work, we can discover a convex curve which will not suit to the characteristics of a linear regression, but still has the power to introduce interesting observations, despite the reduced size of the municipal sample.

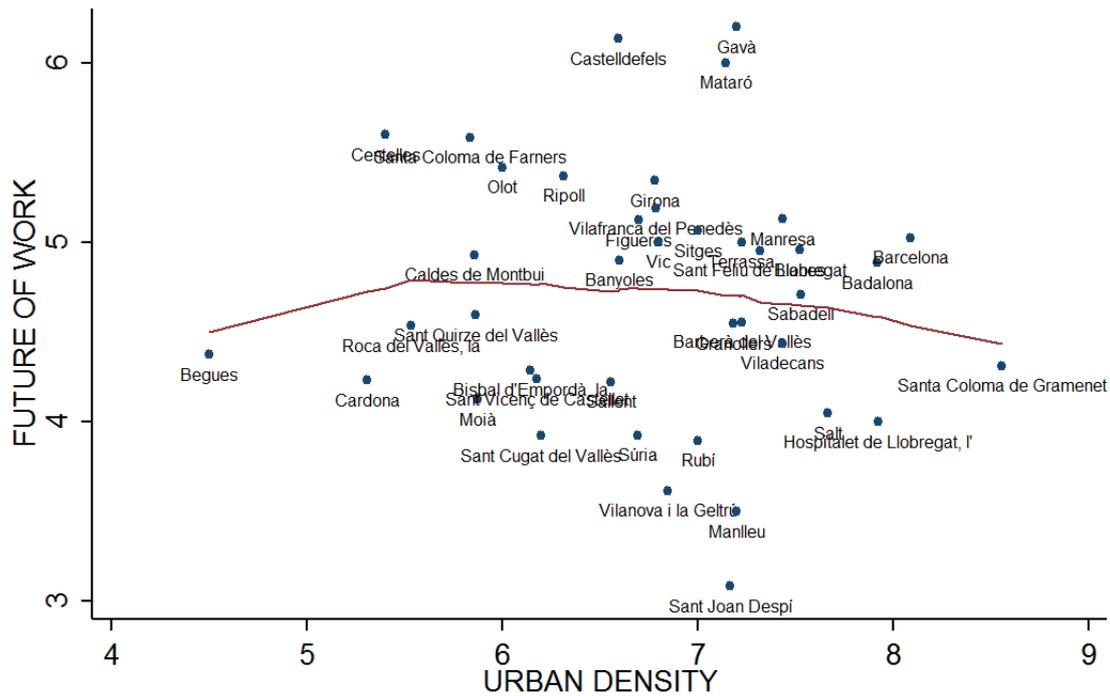


Figure 41. Locally weighted regression of the urban density index and the average opinions about the future of work. Municipalities with the greatest number of participants.

At low levels of urban density (isolated and neighbouring houses), the expectations for the future of work are quite low, but then increment progressively, and follow a stable course until arriving at the density of flats with public spaces (level 7). There commences a descent until the extreme levels of urban density in the metropolitan area. Thus, the convex curve is an indicator of an optimal level of urban density (between neighbouring houses and flats with green areas), where the opinion about the future of work tends to be more positive.

Hypothesis 4. <i>Living in a municipality of higher disposable income per capita is positively related with a more favourable opinion of the incidence of robots and AI over employment.</i>			NOT SIGNIFICANT
Coefficient	Standard Error	<i>t</i>	$P > t $
0.0032241	0.0217644	0.15	0.882

Initially, we could infer that the relationship among living in a municipality with higher disposable income per capita and the opinion of the incidence of robots and AI over employment is even positive, but the current analysis surpasses our minimum level of precision of 10% (reaches 76.7%), and we cannot reach significant conclusions about this variable.

⁹⁹ To depict Figure 41 had been transformed the opinions of citizens into a numerical scale: 9 points for high urban densities (flats with no green areas), 7 points for medium urban densities (flats with public spaces), 5 points for low urban densities (houses with neighbouring walls) and 3 points for rural densities. The average value of the urban density is thus a less extreme indicator than the data provided from official statistics, allowing better graphical representations and reflecting the living reality of the surveyed citizens, that is the main objective of this research. Also, there could be towns with large municipal surfaces but strong urban concentrations in this vast area, inducing to a very different count of urban density.

By these means, we can only affirm that living in a municipality where the average disposable income is high is not proven to be related with a favourable opinion of the impact of new technologies over employment levels. However, like in the case of the previous variable, we can illustrate a locally weighted regression combining the local disposable income and the average opinion for the future of work, covering the municipalities with more participants in the study. Naturally, the reduced size of the sample, especially regarding the affluent towns, limits the quality of the research, but we can introduce a point of view useful for future investigations.

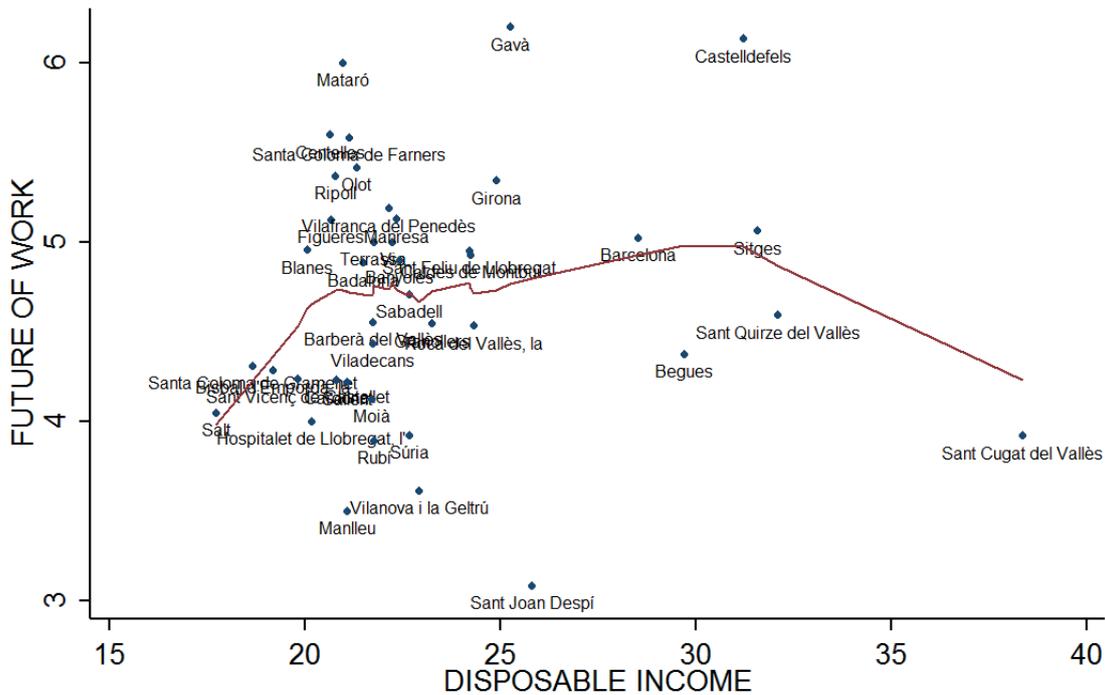


Figure 42. Locally weighted regression of the municipal disposable income and the average opinions about the future of work. Municipalities with the greatest number of participants.

At low levels of disposable income, the average opinion regarding the future of work appears to be low. However, after the threshold of 20,000 euros per inhabitant, the values tend to flatten. Between 25,000 and 30,000 euros of disposable income, the average opinion experiences a positive trend and reaches the maximum level. After that, commences a linear descent¹⁰⁰, leaving the optimal point at approximately 30.000 euros per inhabitant and in an evaluation very near from five over ten points, literally «passing the exam» of the future of work.

Hypothesis 5. <i>Living in a municipality with a higher unemployment rate is negatively related with a more favourable opinion of the incidence of robots and AI over employment.</i>			NOT SIGNIFICANT
Coefficient	Standard Error	<i>t</i>	<i>P</i> > <i>t</i>
-0.0271541	0.0310024	-0.88	0.381

At the beginning, we could consider that the relationship among living in a municipality with a higher unemployment rate is negatively related with a favourable opinion of the impact of new technologies over employment. However, the current analysis surpasses our minimum level of precision of 10% (in this case, at 40.8%) and we cannot reach significant conclusions about the influence of the variable. Considering the linear regression principles, we can sentence only that a higher unemployment municipal rate is not proven to be related with an increased evaluation of the future of work.

¹⁰⁰ This descent is explained by the lack of municipalities in the high income level. A greater sample is needed.

Despite this, and also like in the previous territorial variables, it is very interesting to consider a graphical representation of the relationship between the unemployment rate and the average opinion for the future of labour of the municipalities with the highest number of participants. Considering a locally weighted regression or «smooth line», we can identify convex and concave sceneries, with an inflexion point at 11% of the unemployment rate, and maximum levels at 9% and 16% of the unemployment indicator. Thus, between 9% and 13%, appears that a higher unemployment rate decreases the positive perceptions for the future of work. But after the 13% level, opinions differ and on average tend to reach the same levels presented in the 9% scenery, thus mitigating the negative opinion of the outcomes of robots and automation processes.

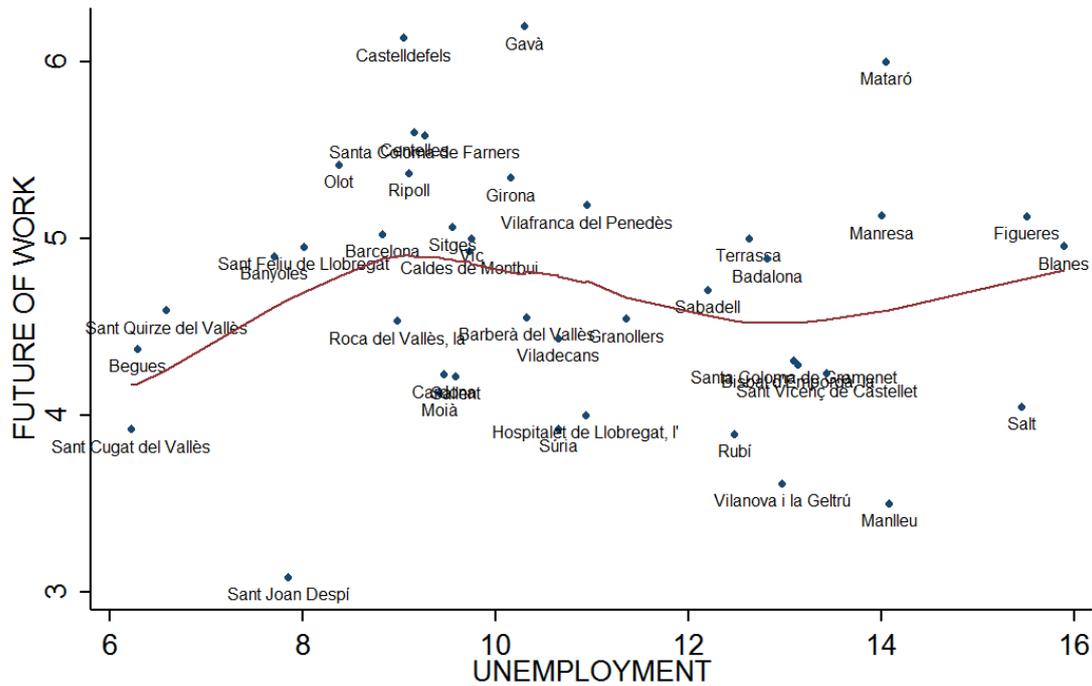


Figure 43. Locally weighted regression of the local unemployment rate and the average opinions about the future of work. Municipalities with the greatest number of participants.

5.2.2. TECHNOLOGICAL HYPOTHESES

Hypothesis 6. Using a greater number of mobile phone applications is positively related with a more favourable opinion of the incidence of robots and AI over employment.			ACCEPTED
Coefficient	Standard Error	t	P > t
0.0493097	0.0265332	1.86	0.063

In effect, using more smartphone applications is linked with having a more positive vision for the future of work. At a significance level of 10%, we can affirm that using another group more of apps (considering the categories designed in the study, as mentioned in Chapter 4.6), adds to the evaluation of the future of labour 0.044 points more, on average.

Hypothesis 7. Using a robot at home or at the workplace is positively related with a more favourable opinion of the incidence of robots and AI over employment.			ACCEPTED
Coefficient	Standard Error	t	P > t
0.4943210	0.1388380	3.56	0.000

Figure 44 illustrates well the conclusion obtained. The opinions of citizens regarding possible substitution by robots or algorithms had been converted into a numerical scale¹⁰¹, in order to elaborate a municipal index of substitution¹⁰². The linear relationship, summarised in an analysis of the residuals of the regression, appears thus clearer with a negative slope. Santa Coloma de Farners (in Girona province) is the town where citizens think that new technologies could have less impact over their own employments, while participants living in Viladecans (inside the Metropolitan Area) are pronounced in the opposite sense.

5.2.3. EDUCATIONAL HYPOTHESES

Hypothesis 10. <i>Possessing a greater educational attainment is positively related with a more favourable opinion of the incidence of robots and AI over employment.</i>			ACCEPTED
Coefficient	Standard Error	<i>t</i>	<i>P</i> > <i>t</i>
0.3761132	0.1552162	2.42	0.016

In accordance with the discoveries shown at the descriptive analysis, having a greater educational attainment is associated with having a more positive opinion about the future of work. This estimation is significant at a 5% level. On average, possessing university studies adds to the evaluation of the general employment levels in a twenty years' time lapse 0.271 points.

Hypothesis 11. <i>Having a specialised education in technology or natural sciences is positively related with a more favourable opinion of the incidence of robots and AI over employment.</i>			ACCEPTED
Coefficient	Standard Error	<i>t</i>	<i>P</i> > <i>t</i>
0.2951279	0.1624238	1.82	0.069

Moreover, considering the field of knowledge of the education attained by the surveyed citizens, having specialised studies in technology or experimental sciences is positively related with the evaluation of the future of labour, confirming the initial hypothesis. This estimation is significant at a 10% level. In this aspect, on average, possessing the mentioned specialisations adds to the opinion of the future of work 0.355 points, which is an important magnitude.

5.2.4. PUBLIC POLICIES HYPOTHESES

Hypothesis 12. <i>Choosing «soft» public policies for the case of labour substitution is positively related with a more favourable opinion of the incidence of robots and AI over employment.</i>			ACCEPTED
Coefficient	Standard Error	<i>t</i>	<i>P</i> > <i>t</i>
0.5744630	0.1364556	4.21	0.000

In effect, the fact that the surveyed individual has chosen public policies that not suppose an important expense for the public budget (free education, the current unemployment measures, or other possibilities), is associated with a more positive opinion about the future of employment.

¹⁰¹ The index depicted in Figure 44 is elaborated according to the following criteria. If the respondent indicated that substitution was possible, were awarded different grades: very difficult to find a job (10 points), new job but requiring more education or abilities (6 points), partial substitution (this was the highest response at the «other» category, 4 points), and new job found quite easy (3 points). If the participant considered that substitution was not possible in any case, 0 points. Responses are calculated on average for each of the local entities.

¹⁰² *Vid.* Annex II for the detailed list of municipalities with their respective indexes.

At a significance level of 1%, which is a considerable level of precision, we can affirm that the exposed election of public policies add to our model, on average, 0.425 points. This is the hypothesis that increases the greatest proportion in the evaluation of the future of work.

Hypothesis 13. <i>Choosing a global regulator for robots and automation matters is negatively related with a more favourable opinion of the incidence of robots and AI over employment.</i>			NOT SIGNIFICANT
Coefficient	Standard Error	<i>t</i>	$P > t $
0.1617546	0.1326715	1.22	0.223

Ab initio, we could think that it appears a positive relationship among both variables. Nevertheless, it is important to assess the significance level of the study, and in this case surpasses our minimum level of precision, fixed at 10% (now at 52.7%). We cannot reach significant conclusions about this variable. Only, we can sentence that choosing a global regulator for new technologies is not proven to be related with a more favourable opinion about the incidence of robots and new technologies over employment levels.

Hypothesis 14. <i>Evaluating positively European Union’s social policies is positively related with a more favourable opinion of the incidence of robots and AI over employment.</i>			ACCEPTED
Coefficient	Standard Error	<i>t</i>	$P > t $
0.2716078	0.0357058	7.61	0.000

The hypothesis is confirmed at a significance level of 1%, which is a remarkable level of precision. In this case, the positive evaluation of the European Union’s social policies is positively related with a favourable opinion of the future of employment in a twenty years’ time span. On average, the positive qualification of EU’s public policies adds to the model 0.233 points. The municipal averages of the main local entities of the present research can be represented in the following graph, which shows also a positive linear relationship.

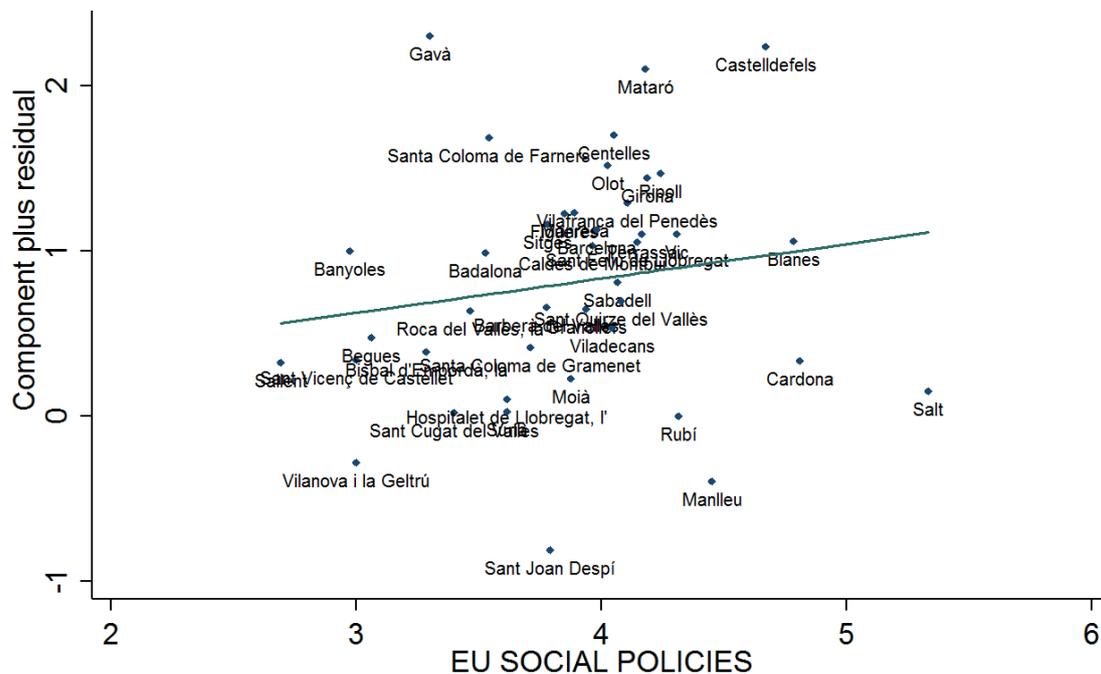


Figure 45. Linear regression of the evaluation of EU social policies and the residuals of the estimation of the future of work. Municipalities with the greatest number of participants.



Chapter VI / Conclusions

6. CONCLUSIONS

The present analysis has provided interesting insights about the future trends related to the impact of robots and automation over society. Historically, the economic dominant theory has sustained that new jobs are created during the process of «creative destruction», but at the present moment the expectations for the future remain uncertain. Since the seminal paper of Carl Benedikt Frey and Michael Osborne in 2013, published during the toughest period of the economic and social crisis in Catalonia, the public debate regarding this issue has been strongly reactivated.

6.1. INTERNATIONAL ANALYSIS

The international analysis, centred in four different social models but in advanced economies, has shown that the impact of automation will vary across the globe. Spain has been selected, among other countries, because the Iberian dynamics are very similar to those of Catalonia and large volumes of data in international organisations are available. The latter is more industrialised and has a lower unemployment rate than the former, but in general the evolution of the economy follows quite similar patterns, explained in part because Catalonia accounts the highest contribution to the GDP of Spain and is considered to be right now its economic locomotive.

Spain will be one of the developed countries with the highest impact of automation, considering the selected sample, being it estimated in the disappearance of 12 and 34% of the total employment. In this country, the unemployment rate suffers extremist variations in crisis moments, only is surpassed by Greece in the context of the OECD, and this fact raises concerns about the correct management of the expansion of automation when economic and social difficulties appear. Some studies, in several cases, try to release the worries of readers by indicating that other jobs will appear for sure in new sectors, compensating the losses, but this is only a hope without a clear numerical translation at the present moment.

Moreover, the low investment in education and the «easy» employment in routine tasks in the case of Spain, which do not stimulate enough the learning process of some of the employed citizens, represent an important obstacle to the re-skilling process. An important fraction of the substituted individuals will not be able to adapt in the new context, whilst employment opportunities may be exploited in countries where population is more qualified, thanks to the globalised information and telecommunications network.

As has been analysed in the NUTS 2 graphs, the youth in the Mediterranean countries is suffering from an important lack of employment, and the effects of automation will amplify this problematic. When a young professional begins his/her career, works at the positions where tasks are more simple and have an important degree of routine (for example, in a law firm the apprentice investigates legislation and jurisprudence to resolve the cases)¹⁰³. Robots and algorithms could be able to do such tasks with higher precision, so graduated students could find themselves into a dangerous trap: incapable to find a job that is related to their current qualifications, they have to listen how institutions explain them the virtues of having a greater education attainment to foster they employability. And thus, probably will enrol to more university studies with the expectancy that the desired job will arrive. Here is the risk that the greater demand of university studies transforms these institutions to a mere post-secondary, where degrees explode into a commercial variety of names that are more related to collecting «badges» rather than real acquisition of skills and knowledge. In some countries, the cost of such symbols for the labour market is exorbitant and represents a debt for the rest of the life.

¹⁰³ NEDELKOSKA, Ljubica; QUINTINI, Glenda (2018): “Automation, skills use and training”. *OECD Social, Employment and Migration Working Papers*, No. 202. Paris, OECD Publishing, pp. 8-9.

However, the analysis has shown how Asian countries, and specially Japan and South Korea, are investing remarkably in human capital and in research and development. And this investment surpasses the level of the «badge» commented before: these countries are operating with high quality educational standards, as has been shown in the PISA scores. Also and very curiously, those are the OECD States where more industrial robots are sold. It would seem a contradictory picture, but not. Not just they are absorbing the global demand of goods and ICTs related services: they are becoming the winners of the global value chain.

China has decided to follow their leaps too, and since the burst of the financial crisis in 2008 has expanded the investment in industrial robots. But China is not an ordinary «follower», the main objective of the country is to become the global leader. For this reason, the «Made in China 2025» programme will open the country to the global trade and foreign manufacturers, until the domestic production has attained the maximum standards possible. The following graph shows the estimated sales of industrial robots, and in this case China accounts a large fraction of the Asian count. The important population of the country and the expansion of its technological capabilities illustrate how the «Triad» is being replaced by a multipolar world order, with a gravity centre at the Asia-Pacific region.

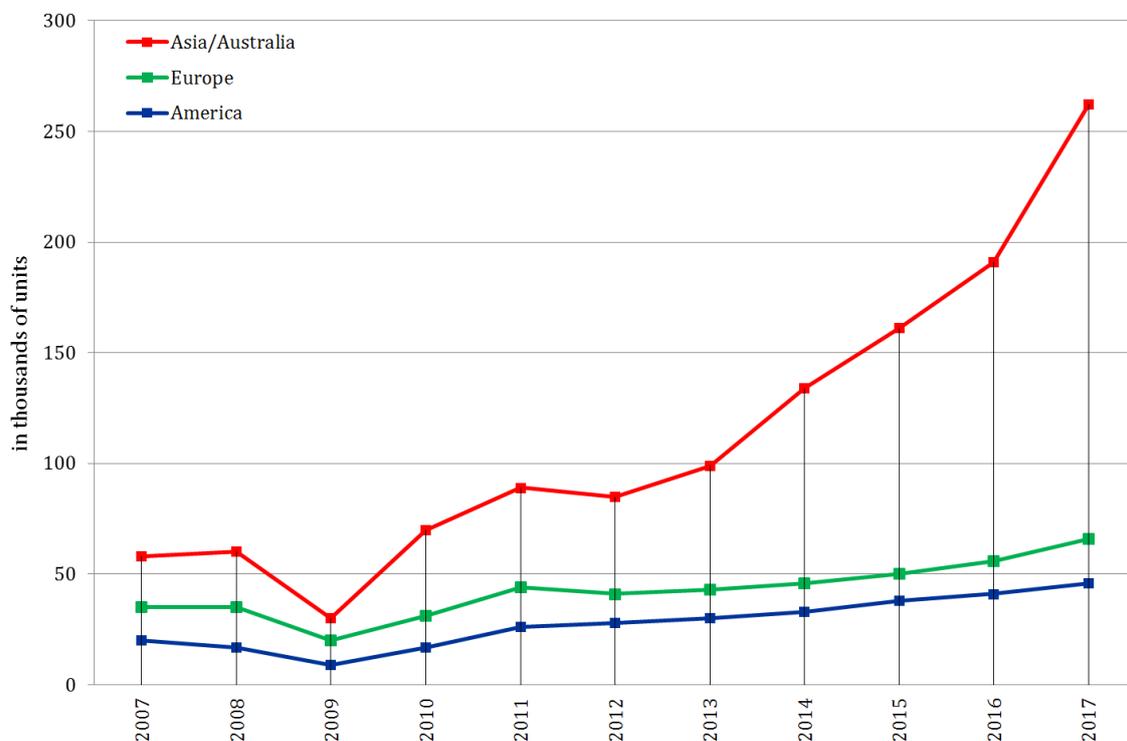


Figure 46. Estimated annual sales of industrial robots, by macroregions¹⁰⁴.

Despite the conclusions obtained for the mentioned economies, it is important to acknowledge that emerging countries in Latin America, Africa and Southern Asia, which concentrate the majority of the global population, deserve more studies that cover their territorial specificities and encourage attending appropriately their needs, in a time where future challenges shall be addressed from the international arena. Production processes have become a matter of international coordination, and for this reason, redistribution of work hours needs a UN coverage.

¹⁰⁴ Graph created by the author. Source of data:

INTERNATIONAL FEDERATION OF ROBOTICS (2018): *World Robotics 2018. Industrial Robots*. Executive Summary, p. 13. On line [Last consultation in 30/08/2019]:

https://ifr.org/downloads/press2018/Executive_Summary_WR_2018_Industrial_Robots.pdf

And what happens in Europe? The divergence among richer regions and powerful States is increasing. Since the approval of the single currency and the entry of the Eastern States at the beginning of the millennium, the Southern countries have observed their transformation into «periphery». This phenomenon has been expanded during the crisis and will continue with the deployment of the automation processes.

Germany, a republic with an ageing labour force, is accumulating an important stock of operational robots in its factories, contrasting with the other European States like France and the United Kingdom, and this means that the terms of trade will not be favourable to the «periphery», that could be enlarged. Manufactured goods could be traded from the central and rich regions to the surrounding markets, concentrating the production at the «hi-tech» nucleus for more efficiency. Processes that create more pollution would continue to be placed out of the dominant core, as is happening in Eastern countries at the present moment.

It should not be hidden that one of the key markets for Germany is China. Europe exports goods of more value added and imports manufactured products that have generated important environmental damages in China, which are consumed more often by Western impoverished social classes¹⁰⁵ (the *panes* of Roman times). In other words, the «green economy» and welfare of an important part of the population in the «old continent» is at the expenses of the pollution and the toxic living conditions of millions of Chinese citizens. The reduction of pollution is a goal that has to be attained globally, and not becoming a mere displacement.

But in the other hand, Chinese companies are investing in European real estate, logistics¹⁰⁶, textile¹⁰⁷ and automotive¹⁰⁸ factories and ICT¹⁰⁹ infrastructure. They are also buying public debt of States in economic difficulties in exchange of relevant deals¹¹⁰ and even purchasing football clubs¹¹¹ (the *circenses* of the Roman period). China will play a greater role in the years to come, this cannot be neglected. And the European «periphery» could be even more open to such negotiations and influence over the years. Guaranteeing the social cohesion while creating a common sense of shared values and high technological goals among its territories, and naturally assuring the European autonomy by reinforced cooperation, will be fundamental to determine the future destiny of the continent.

Overall, the United Nations shall play an important role to maintain a balanced international society in a world where challenges appear to be global, defending multilateralism while avoiding excluding frameworks like the G7 or the G20, and the same for the Chinese initiatives. The concentration of automated manufacturing in certain areas will amplify the gap between rich and poor countries all over the planet, and redistributing mechanisms at the international level are fundamental to mitigate also the damages caused by the climate crisis that is currently expanding.

¹⁰⁵ RAIM, Laura (2019). «Idées reçues sur la relance». *Le Monde Diplomatique*, No. 784, 66th year, p. 21.

¹⁰⁶ Since 2012, Barcelona has a logistics semi-automated terminal at the port, build and operated by Hutchison Port Holdings, a Chinese company. The port of Piraeus in Greece has also received the remarkable investment of another important Chinese corporation. Both infrastructures are considered to be strategic to enter at the European market.

¹⁰⁷ In Italy, the textile production of the Tuscan city of Prato has been severely affected by the arrival of Asian factories with their own workers. *Vid.* STANDING, Guy (2011): *The Precariat. The New Dangerous Class*. London and Oxford, Bloomsbury Academic. For the Castilian Edition: *El Precariado. Una nueva clase social*. Barcelona, Ediciones de Pasado y Presente, pp. 21-23.

¹⁰⁸ In 2010, the Zhejiang Geely Holding Group acquired the Volvo car manufacturing company.

¹⁰⁹ As an example, Huawei is building the 5G network in numerous European cities.

¹¹⁰ In the case of Italy, for example, after the difficult discussions between the European Commission and the «Consiglio» to allow the increment of the public deficit ceiling, the Italian government accepted to participate at the BRI (Belt and Road Initiative) and became the first State of the EU to be officially integrated in this macroproject, also qualified as the «new silk route».

¹¹¹ In Barcelona, the football club RCDE Espanyol is owned by a Chinese notable businessman, Che Yansheng.

6.2. DESCRIPTIVE ANALYSIS

Regarding the descriptive analysis, it is preferable to consult Chapter 4, as the numerous findings include sector and territorial specificities that here are difficult to summarise, and the reader will find better the information of his/her interest. Moreover, graphs are useful tools to understand the opinions of citizens more easily. Notwithstanding this, now will be structured several statements concerning such discoveries:

1. *Opinions about the future of work are characterised by neutrality and are slightly skewed to the negative side, considering all the participants of the study.*
2. *More educated citizens tend to have a more positive view about the future of employment. They have larger proportions electing hypothetical neutral and positive sceneries.*
3. *«Software» is the sector with the greatest expectations about the future of work, followed by «design and creation». At the end of the ranking, lower expectations are encountered at «personal services» and «retail» sectors.*
4. *A large proportion of citizens consider that robots and AI shall be regulated at the global level, that is, at the instances of the United Nations. The European Union appears as a «second best» choice. In both cases are represented by high proportions of more educated citizens.*
5. *Less educated citizens support the eventual normative framework covering robots and AI elaborated by the State, Autonomous Communities and the self-regulations of the industry. The same is applied to the rejection over all possible regulators. «Construction» is the sector where the rejection of laws was more important.*
5. *Half of the respondents consider that they cannot be substituted at their employment by robots or algorithms. The degree of answers accepting the substitution scenery varies across regions, becoming higher in counties where the industrial gross value added is superior, most of them located in the metropolitan area, outside Barcelonès.*
6. *«Transport» and «retail» are the sectors with the greatest perception of substitutability, considering also high difficulties at finding another job afterwards. In contrast, «health and pharmaceuticals», and secondly «teach and research», are the sectors with the lowest rates of expected substitution at work.*
7. *In case of substitution at work, the preferred measures hypothetically provided by the public bodies are free education and redistribution of the working hours. Public employment appears at third place, and the basic income only reaches 15% of the total, thus not reaching much support and confirming the results of the Swiss referendum of 2016.*
8. *The generation with the greatest use, on a weekly basis, of smartphone apps of different functionalities is represented by ages between 26 and 35 years old. As can be known by intuition, the degree of use decreases with the age and this has been well confirmed. «Software» and «administration and social services» are the sectors that present the higher intensity of use. And «personal services» and «transport» professionals are at the lowest level of practical use.*
9. *The functionalities of apps with more extended use during the week are the «messenger», «video and audio» and «social network of images». Those are followed by «purchases», «bank» and «travel», thus indicating a remarkable penetration of the so-called digital economy.*

6.3. EMPIRICAL ANALYSIS

When assessing the conclusions obtained in the empirical analysis, it is important to consider that had been confirmed seven different hypotheses of the fourteen initially depicted at the departing point of the study. The ordinary least squares (OLS) estimation has been the technique used to determine what factors were relevant over the dependent variable, that is, the evaluation over ten points of the future of work in a twenty years' time lapse, transformed from the opinion of citizens presented on a Likert-type scale. A linear relationship is verified in the case of seven variables, thus confirming their respective hypotheses:

1. *Using a greater number of mobile phone applications is positively related with a more favourable opinion of the incidence of robots and AI over employment (*)*.
2. *Using a robot at home or at the workplace is positively related with a more favourable opinion of the incidence of robots and AI over employment (***)*.
3. *Having an expectation that robots/AI will substitute the surveyed individual at work is negatively related with a more favourable opinion of the incidence of robots and AI over employment (***)*.
4. *Possessing a greater educational attainment is positively related with a more favourable opinion of the incidence of robots and AI over employment (**)*. This hypothesis was also confirmed in the descriptive analysis, commented before briefly.
5. *Having a specialised education in technology or natural sciences is positively related with a more favourable opinion of the incidence of robots and AI over employment (*)*.
6. *Choosing «soft» public policies for the case of labour substitution is positively related with a more favourable opinion of the incidence of robots and AI over employment (***)*.
7. *Evaluating positively the European Union's social policies is positively related with a more favourable opinion of the incidence of robots and AI over employment (***)*.

Between parentheses has been represented the significance levels of each variable, being *** 1%, ** 5% and * 10%. The rest of the hypotheses presented in the research, notably those referred to the territorial variables (where the municipal level played an important role), did not show a significant linear relationship with the dependent variable of the study. Thus, we cannot neglect at all their influence over the opinion of citizens, but at the present moment is not possible to isolate appropriately their real incidence. None of the hypotheses illustrated in the research has been rejected, which indicates a relatively acceptable design of the investigation.

In the cases of urban density and disposable income, a plot of a locally weighted regression of the municipalities with the greatest number of participants has unveiled a certain convex relationship. About unemployment, the behaviour of the regression oscillates attaining two maximum levels. Notwithstanding these facts, a greater sample of different municipalities, with varied characteristics of income, density and unemployment rates, is fundamental to conduct a deeper analysis and reach significant conclusions. The lack of resources available has not allowed the author to arrive at this point, but he welcomes further research oriented in this sense. The future deserves accurate analyses, and it is important that society as a whole becomes concerned about the challenges that we are facing and an internationally coordinated action is taken. Otherwise, the weight of automation will strike over us with unforeseeable consequences.



Chapter VII / References

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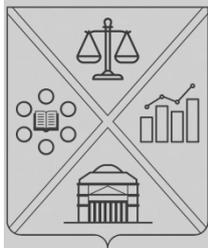
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Annexes

ANNEX I

**LIST OF PARTICIPANTS
MUNICIPALITY AND AREA OF RESIDENCE**

	Barcelona Province (Metropolitan)
	Barcelona Province (Non Metropolitan)
	Girona Province
	Lleida and Tarragona Provinces

CODE	MUNICIPALITY	No.
08001	Abdera	3
08014	Aiguafreda	1
17002	Aiguaviva	1
17006	Alp	1
17007	Amer	1
17008	Anglès	2
17009	Arbúcies	2
08006	Arenys de Mar	2
08010	Artés	2
25033	Artesa de Lleida	1
17012	Avinyonet de Puigventós	1
08013	Avinyonet del Penedès	4
08015	Badalona	35
08904	Badia del Vallès	4
08017	Balenya	1
17015	Banyoles	20
08252	Barberà del Vallès	18
08019	Barcelona	79
17016	Bàscara	1
08020	Begues	8
08022	Berga	1
17019	Besalú	2
17020	Bescanó	1
08023	Bigues i Riells	1
17022	Bisbal d'Empordà, la	14
17023	Blanes	23
17025	Bordils	1
25059	Bossòst	1
08033	Caldes de Montbui	14
08035	Calella	1
08037	Calldetenes	3

17034	Calonge	1
17035	Camós	2
17036	Campdevàdol	5
08039	Campins	1
08046	Cardedeu	5
08047	Cardona	13
17044	Cassà de la Selva	2
08051	Castellar del Vallès	2
08053	Castellbell i el Vilar	2
08054	Castellbisbal	1
08056	Castelldefels	44
08058	Castellet i la Gornal	1
08061	Castellgalí	1
17047	Castelló d'Empúries	6
08064	Castellterçol	1
08065	Castellví de la Marca	1
08066	Castellví de Rosanes	1
17049	Celrà	1
08067	Centelles	10
08266	Cerdanyola del Vallès	7
08068	Cervelló	1
25072	Cervera	1
08069	Collbató	1
08072	Corbera de Llobregat	1
08073	Cornellà de Llobregat	6
17056	Cornellà del Terri	1
17901	Cruïlles, Monells i Sant Sadurní de l'Heura	1
08074	Cubelles	2
43051	Cunit	1
43054	Espluga de Francolí, l'	1
08077	Esplugues de Llobregat	5
17065	Esponellà	1

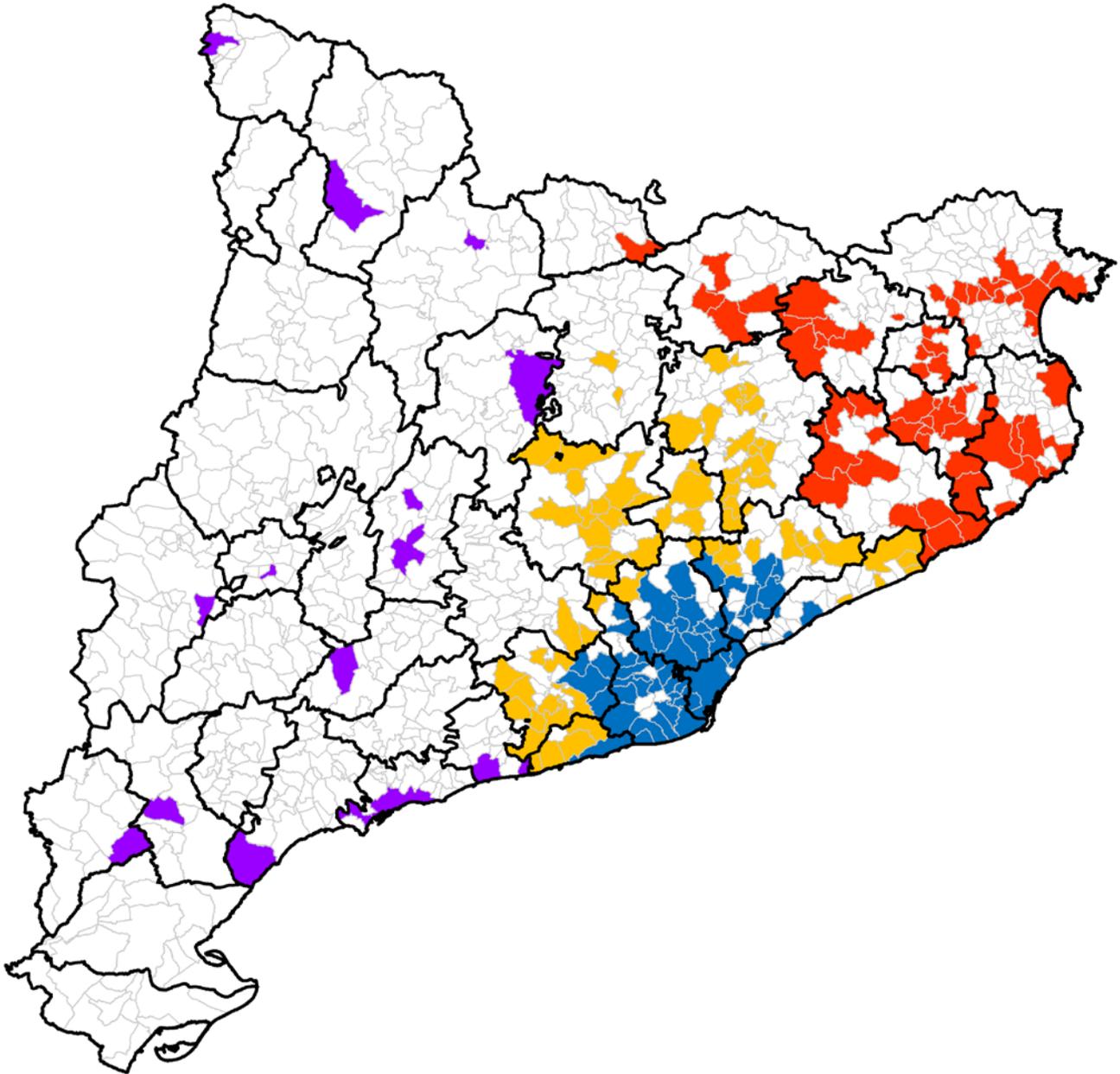
08079	Estany, l'	1
17005	Far d'Empordà, el	1
17066	Figueres	40
08084	Fonollosa	1
17071	Fontcoberta	1
17902	Forallac	2
17074	Fortià	1
08086	Franqueses del Vallès, les	2
08087	Gallifa	1
08088	Garriga, la	3
08089	Gavà	10
08091	Gelida	1
17079	Girona	64
08092	Gironella	1
08094	Granada, la	2
08096	Granollers	33
25110	Guissona	1
08101	Hospitalet de Llobregat, l'	26
17088	Lladó	1
08105	Llagosta, la	1
17089	Llagostera	1
08107	Lliçà d'Amunt	1
17095	Lloret de Mar	6
17103	Maçanet de la Selva	2
17097	Madremanya	1
08110	Malgrat de Mar	1
08112	Manlleu	10
08113	Manresa	46
08117	Masies de Voltregà, les	1
08118	Masnou, el	5
08119	Masquefa	1
08121	Mataró	14
08138	Moià	16
08123	Molins de Rei	6
25137	Mollerussa	2
08124	Mollet del Vallès	2
08128	Monistrol de Calders	1
08125	Montcada i Reixac	1
08135	Montmeló	2
08136	Montornès del Vallès	2
43093	Móra d'Ebre	1
08139	Mura	1
08140	Navarxes	2
08141	Navàs	1

17111	Navata	1
25146	Navès	1
08145	Olèrdola	1
08146	Olesa de Bonesvalls	1
08147	Olesa de Montserrat	1
08148	Olivella	1
17114	Olot	36
08151	Oristà	1
08153	Òrrius	2
08155	Palafolls	2
17117	Palafrugell	1
17118	Palamós	1
17120	Palau-saverdera	1
08905	Palma de Cervelló, la	1
08158	Papiol, el	3
17130	Pera, la	1
17132	Peralada	1
08161	Piera	1
43106	Pinell de Brai, el	1
08169	Prat de Llobregat, el	1
08172	Premià de Mar	1
17139	Preses, les	1
17142	Quart	1
17145	Ribes de Freser	1
17147	Ripoll	35
08180	Ripollet	3
17149	Riudaura	1
08181	Roca del Vallès, la	15
08183	Roda de Ter	5
17152	Roses	2
08184	Rubí	19
08187	Sabadell	38
08191	Sallent	18
17155	Salt	21
08196	Sant Andreu de la Barca	1
08197	Sant Andreu de Llavaneres	1
08199	Sant Bartomeu del Grau	1
08200	Sant Boi de Llobregat	1
08202	Sant Celoni	2
08205	Sant Cugat del Vallès	25
08207	Sant Esteve de Palautordera	1
08210	Sant Feliu de Codines	6
17160	Sant Feliu de Guíxols	4
08211	Sant Feliu de Llobregat	44

08209	Sant Fost de Campsentelles	1
08213	Sant Fruitós de Bages	1
17163	Sant Gregori	4
17164	Sant Hilari Sacalm	1
08215	Sant Hipòlit de Voltregà	3
17167	Sant Joan de les Abadesses	1
08218	Sant Joan de Vilatorrada	1
08217	Sant Joan Despí	12
08220	Sant Julià de Vilatorrada	7
08221	Sant Just Desvern	5
08224	Sant Martí de Centelles	1
08227	Sant Martí Sarroca	2
08231	Sant Pere de Ribes	4
08234	Sant Pere de Vilamajor	1
17178	Sant Pere Pescador	1
08236	Sant Quintí de Mediona	1
08237	Sant Quirze de Besora	2
08238	Sant Quirze del Vallès	37
08240	Sant Sadurn d'Anoia	2
08262	Sant Vicenç de Castellet	17
08263	Sant Vicenç dels Horts	3
17180	Santa Coloma de Farners	12
08245	Santa Coloma de Gramenet	45
08246	Santa Eugènia de Berga	2
08248	Santa Eulàlia de Ronçana	2
08251	Santa Margarida i els Monjos	1
08259	Santa Maria de Palautordera	1
17184	Santa Pau	2
08260	Santa Perpètua de Mogoda	1
08192	Santpedor	2
17186	Sarrià de Ter	1
25203	Seu d'Urgell, la	1
08269	Seva	2
08270	Sitges	16
08272	Sora	1
25209	Sort	1
08273	Subirats	1
08274	Súria	13
17194	Susqueda	1
08278	Taradell	4
43148	Tarragona	1
08279	Terrassa	27
08283	Tona	3
08284	Tordera	1

08285	Torelló	6
08287	Torrelavit	1
08288	Torrelles de Foix	1
17199	Torroella de Montgrí	1
17202	Tossa de Mar	4
08291	Vacarisses	2
17208	Vall de Bianya, la	1
17207	Vall d'en Bas, la	1
08295	Vallirana	4
43162	Vandellòs i l'Hospitalet de l'Infant	1
43163	Vendrell, el	1
08298	Vic	39
17213	Vidreres	4
17214	Vilabertran	1
17215	Vilablareix	2
08301	Viladecans	23
17221	Vilafant	7
08305	Vilafranca del Penedès	37
17228	Vilanant	1
08902	Vilanova del Vallès	2
08307	Vilanova i la Geltrú	13
43171	Vila-Seca	1
08219	Vilassar de Mar	1

MAP OF PARTICIPANTS ¹¹²
CONSIDERING THEIR MUNICIPALITY OF RESIDENCE
1.405 participants in total



¹¹² Map adapted by the author from Municat, an agency of the Government of Catalonia dedicated to promote the knowledge of local entities with didactic purposes. On line [Last consultation in 30/08/2019]: <http://municat.gencat.cat/ca/municat/municat-a-lescola/descarrega-de-mapes-muts/>

ANNEX II

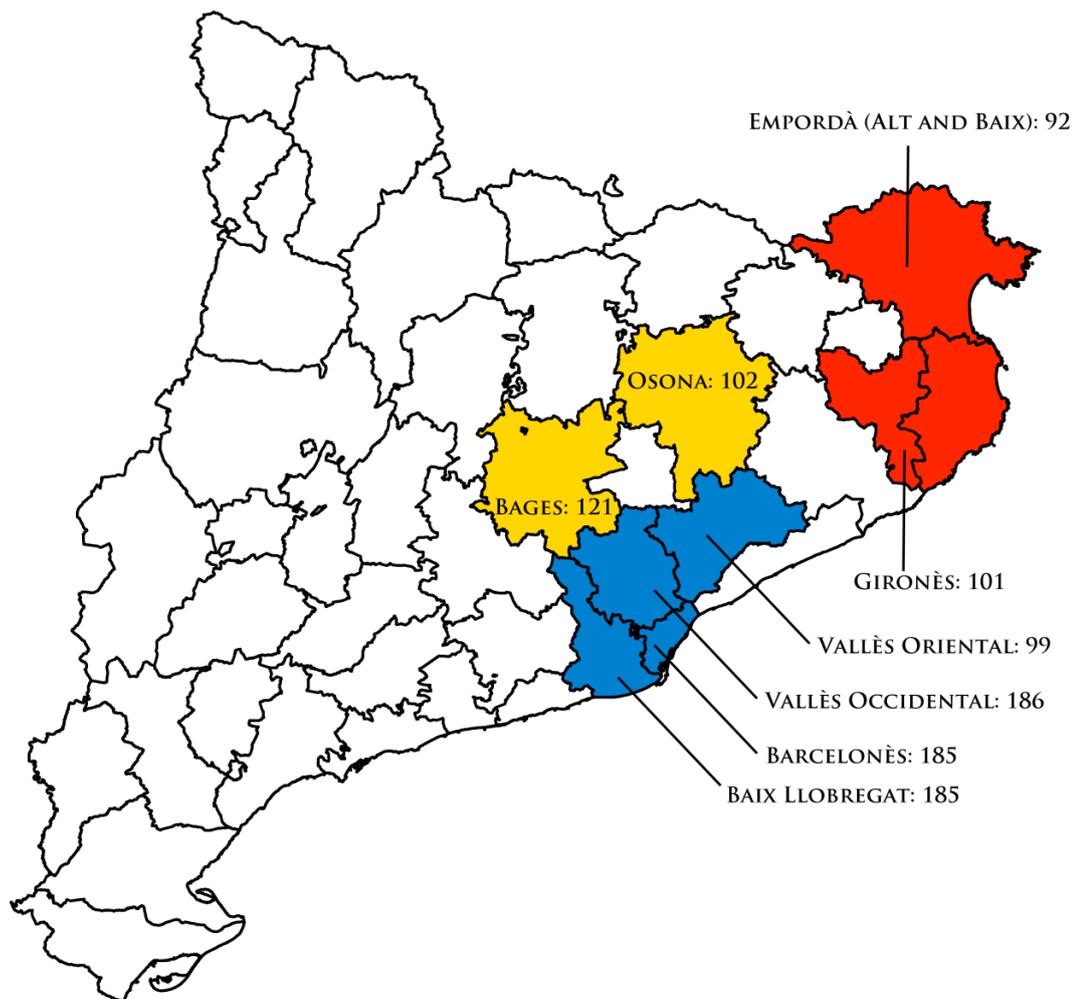
**MAIN MAGNITUDES
MUNICIPALITIES WITH MORE PARTICIPANTS (1.079 in total)**

CODE	MUNICIPALITY	DISPOSABLE INCOME (in thousand €)	UNEMPLOYMENT RATE (in %)	FUTURE OF WORK (over 10 points)	SUBSTITUTION INDEX (over 10 points)	EU SOCIAL POLICIES (over 10 points)
08015	Badalona	21.495	12.81	4.8857	3.9143	3.5286
17015	Banyoles	22.426	7.71	4.9000	4.8000	2.9750
08252	Barberà del Vallès	21.738	10.32	4.5556	3.4444	3.7778
08019	Barcelona	28.514	8.83	5.0253	1.7722	3.9810
08020	Begues	29.695	6.29	4.3750	2.5000	3.0625
17022	Bisbal d'Empordà, la	19.170	13.13	4.2857	1.8571	3.2857
17023	Blanes	20.071	15.89	4.9565	3.6957	4.7826
08033	Caldes de Montbui	24.232	9.73	4.9286	1.1429	3.9643
08047	Cardona	20.799	9.46	4.2308	1.6923	4.8077
08056	Castelldefels	31.208	9.04	6.1364	2.8182	4.6705
08067	Centelles	20.634	9.15	5.6000	2.2000	4.0500
17066	Figueres	20.661	15.50	5.1250	3.3250	3.8500
08089	Gavà	25.251	10.30	6.2000	2.4000	3.3000
17079	Girona	24.887	10.15	5.3438	2.9688	4.1875
08096	Granollers	23.236	11.35	4.5455	4.3030	3.9394
08101	Hospitalet de Llobregat, l'	20.164	10.93	4.0000	2.1538	3.6154
08112	Manlleu	21.080	14.08	3.5000	2.9000	4.4500
08113	Manresa	22.334	14.00	5.1304	2.8913	3.8913
08121	Mataró	20.975	14.04	6.0000	2.6429	4.1786
08138	Moià	21.694	9.42	4.1250	4.8750	3.8750
17114	Olot	21.309	8.37	5.4167	3.6667	4.0278
17147	Ripoll	20.779	9.10	5.3714	2.2571	4.2429
08181	Roca del Vallès, la	24.306	8.98	4.5333	3.6000	3.4667
08184	Rubí	21.754	12.47	3.8947	4.3158	4.3158
08187	Sabadell	22.654	12.20	4.7105	1.8684	4.0658
08191	Sallent	21.080	9.58	4.2222	2.0556	2.6944
17155	Salt	17.733	15.45	4.0476	3.7619	5.3333
08205	Sant Cugat del Vallès	38.354	6.22	3.9200	2.6000	3.4000
08211	Sant Feliu de Llobregat	24.204	8.01	4.9545	2.5682	4.1477
08217	Sant Joan Despí	25.791	7.85	3.0833	3.1667	3.7917
08238	Sant Quirze del Vallès	32.096	6.58	4.5946	2.2703	4.0811
08262	Sant Vicenç de Castellet	19.803	13.43	4.2353	2.3529	3.0000
17180	Santa Coloma de Farners	21.135	9.26	5.5833	1.0000	3.5417

08245	Santa Coloma de Gramenet	18.664	13.09	4.3111	2.8222	3.7111
08270	Sitges	31.572	9.55	5.0625	1.5625	3.7813
08274	Súria	22.657	10.65	3.9231	2.3846	3.6154
08279	Terrassa	21.751	12.63	5.0000	2.5185	4.1667
08298	Vic	22.235	9.75	5.0000	3.0513	4.3077
08301	Viladecans	21.746	10.65	4.4348	5.0435	4.0435
08305	Vilafranca del Penedès	22.139	10.94	5.1892	4.1081	4.1081
08307	Vilanova i la Geltrú	22.904	12.97	3.6154	3.3846	3.0000

**MAP OF THE COUNTIES / «COMARQUES»¹¹³
WITH MORE PARTICIPANTS**

According to the 2018 census, contain 68.39% of the total population of Catalonia.



¹¹³ Map adapted by the author from Municat, an agency of the Government of Catalonia dedicated to promote the knowledge of local entities with didactic purposes. On line [Last consultation in 30/08/2019]: <http://municat.gencat.cat/ca/municat/municat-a-lescola/descarrega-de-mapes-muts/>

ANNEX III

OUTPUT OF THE REGRESSION

Results using the software STATA 14.1

Variable	Coefficient	Standard Error	<i>t</i>	<i>P</i> > <i>t</i>	Sign.	[95% Conf. Interval]	
<i>Territorial variables:</i>							
01-Ter:METROPOL-AREA	-0.0381558	0.158427	-0.24	0.810	-	-0.3489384	0.2726267
02-Ter:CAPITAL-COUNTY	0.2043297	0.1390813	1.47	0.142	-	-0.0685028	0.4771622
03-Ter:HIGH-URBAN-DENSITY	-0.1045017	0.1598949	-0.65	0.514	-	-0.4181638	0.2091604
04-Ter:DISPOSABLE-INCOME	0.0032241	0.0217644	0.15	0.882	-	-0.0394706	0.0459188
05-Ter:UNEMPLOYMENT-RATE	-0.0271541	0.0310024	-0.88	0.381	-	-0.0879708	0.0336626
<i>Technological variables:</i>							
06-Tech:APPS-USE	0.0493097	0.0265332	1.86	0.063	*	-0.0027398	0.1013592
07-Tech:ROBOTS-USE	0.4943210	0.1388380	3.56	0.000	***	0.2219656	0.7666763
08-Tech:ROBOTS-APPROACH	-0.1386061	0.1414081	-0.98	0.327	-	-0.4160032	0.1387910
09-Tech:SUBSTITUTION	-0.4463353	0.1370902	-3.26	0.001	***	-0.7152620	-0.1774087
<i>Educational variables:</i>							
10-Educ:EDUC-ATTAINMENT	0.3761132	0.1552162	2.42	0.016	**	0.0716292	0.6805973
11-Educ:TECH-SCIENCE	0.2951279	0.1624238	1.82	0.069	*	-0.0234951	0.6137509
<i>Public policies variables:</i>							
12-PubPol:MEASURE-SOFT	0.5744630	0.1364556	4.21	0.000	***	0.3067811	0.8421448
13-PubPol:UN-OECD	0.1617546	0.1326715	1.22	0.223	-	-0.0985039	0.4220132
14-PubPol:EU-SOCIAL-POL	0.2716078	0.0357058	7.61	0.000	***	0.2015645	0.3416511
<i>Control variables:</i>							
Ctrl:GENDER	-0.4586755	0.1331103	-3.45	0.001	***	-0.7197949	-0.1975561
Ctrl:AGE	0.0039154	0.0042357	0.92	0.355	-	-0.0043936	0.0122244
Ctrl:ORIGIN	0.0859180	0.1794406	0.48	0.632	-	-0.2660866	0.4379226
Ctrl:OCCUPATION	-0.2501068	0.1417861	-1.76	0.078	*	-0.5282453	0.0280317
<i>Constant:</i>							
CONSTANT	3.434091	0.801065	4.29	0.000	***	1.86266	5.005522

Notes: Ordinary Least Squares (OLS) estimation. *N* = 1,405. / $R^2 = 0.1024$. / Levels of significance: *** 1%, ** 5%, * 10%.

The impact of robots and automation in Catalonia

An analysis of citizens' opinions about employment and public policies

ARNAU GUIX I SANTANDREU

ABSTRACT

Robots and automation processes have arrived to stay. Despite positive outcomes derived from new technologies, such as a remarkable rise in productivity over time and easier communications, humans are observing how new *species* are irrupting at their current labour posts. It is estimated that approximately 50% of jobs have potentially automatable tasks, and that the remaining ones will experience radical transformations. Also, humans, in most of the cases without knowing it, are the source of information for the learning of algorithms, which are beginning to execute intellectual tasks with extreme precision and quality.

The present analysis is articulated in three fronts: at first, are exposed the main international indicators that justify concerns about the *silicon newcomers*; secondly, is elaborated a descriptive study of citizens' opinions in Catalonia about the impact of robots and automation processes, also covering the desirable public policies that could be applied; and finally, is developed an econometric model that unveils what profile characteristics of citizens are relevant to evaluate robots and digitalisation like a threat to society, or otherwise like an opportunity, thus verifying the initial hypotheses of the study.

Keywords: robots, automation, substitution, employment, public policies, basic income, redistribution.



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