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Perception of Artificial Intelligence in Spain

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Abstract

The present paper analyses perception of Artificial Intelligence of individuals in Spain and the factors associated with it. Data of 6,308 individuals from the Spanish survey (CIS, 2018) are used. The data include several measures of perception, innovation, place of residence (autonomous regions and province), gender, age, educational level, and other socioeconomic and technical variables. A binary logit regression model is formulated and estimated for the attitude towards robots and AI and its possible determinants. The results indicate that people have a negative attitude if they are not interested in scientific discoveries and technological developments and if AI and robots are not helpful at work.

Key words and phrases: perception, innovation, artificial intelligence, survey data, binary logit.

JEL Classifications: C21, C25, D12, D83, L63, L86, L96, P36.

1. Introduction.

The technology industry is becoming increasingly global. International collaboration in the development and governance of Artificial Intelligence (AI) may ensure that technology will positively contribute to the general welfare of all humanity. According to Feijóo et al. (2020), international cooperation based on intergovernmental organizations, private companies or academic researchers has improved common welfare.

In April 2018, the first European strategy for AI was presented addressing opportunities and challenges of the AI advances in the European Union (European Commission, 2018). The general idea is to promote the development and deployment of AI in the European Union countries but taking into account human and ethical implications of AI (von der Leyen, 2019).

The AI strategy in EU has been condensed in the "White Paper On Artificial Intelligence - A European approach to excellence and trust" by European Commission (2020) which the development and deployment of AI technologies inside an appropriate regulatory framework that addresses potential negative effects is promoted. So, two main points are considered related to research and trust on IA:

- Research on an AI: searching for collaboration between Member States, increasing investment in AI development and industrial applications deployment.
- Promote trust in AI: how to create a legal framework to ensure development safety and respect to fundamental rights.

Commission's White Paper express many opportunities that AI can bring to Europe's economy and society in order to build an ecosystem of excellence and trust in Europe for AI involving cross sectoral coordination across all areas of Europe through a number of legislative and non-legislative actions to be a global competitive player in AI. Europe needs top-class cyber-secure digital infrastructure to develop and run AI upon in order to foster full capacities in this area. Furthermore, this needs a broad deployment of 5G that creates opportunities for everyone in Europe (European Commission, 2020). In the same context, Vesnic-Alujevic, Nascimento and Pólvora (2020) makes a critical review on conditions and impacts of Artificial Intelligence and Machine Learning (ML) in society. Their study analyses the European AI policy framework from policy papers produced by European organisations.

Europe will be a pioneer in defining AI through regulation which could grant it competitive international influence. The definition provided by the Commission's High-Level Expert Group

on AI (AI HLEG, 2019) is clearer than definition included in White Paper (describing AI's main elements simply as "data" and "algorithms" would include all contemporary software). AI HLEG (2019) considers that AI depends on humans where a machine can only execute an action assigned from the outset by a human in any capacity (e.g. manufacturer, operator, developer or data supplier). So, according to AI HLEG (2019), "Artificial intelligence (AI) systems are software (and possibly also hardware) systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge, or processing the information, derived from this data and deciding the best action(s) to take to achieve the given goal. AI systems can either use symbolic rules or learn a numeric model. Furthermore, they can also adapt their behaviour by analysing how the environment is affected by their previous actions".

As a scientific discipline, AI includes several approaches and techniques, such as machine learning (of which deep learning and reinforcement learning are specific examples), machine reasoning (which includes planning, scheduling, knowledge representation and reasoning, search, and optimization), and robotics (which includes control, perception, sensors and actuators, as well as the integration of all other techniques into cyber-physical systems).

Supporting human capital to understand and advance AI is the clue. Businesses should play a closer role in influencing all levels of national education so that foreseen labour market needs, such as embracing AI, can be linked closer to national curriculums. Therefore, our citizens (including our workforce) gain the relevant STEM and transversal skills required to take part in the digital economy.

There are three core roles (with corresponding skill sets) that are required within these programmes to make them a success:

- Developers (people who can create AI systems);
- Trainers (people who can train AI systems e.g. preparing and testing data sets);
- Operators (e.g. people who can operate AI systems).

Nevertheless, it is more important to obtain trust in AI from the users. Europe should incentivise trust in its AI framework without interfering with the efficiency of AI decision making itself. Otherwise, we are simply holding back the power of AI to improve our societies and become

global leaders in this strategic technological area (AI HLEG, 2019). Enabling trust in AI through any new provisions should put transparency at the core:

- Consumer transparency: so, citizens understand when an AI is being used, which functions are AI enabled, if any human oversight validation exists and where the responsibility for decision making could be placed;
- Business transparency: to trigger a positive feedback loop so that industry has transparency of the AI decision making process with as much accuracy as possible. They should also understand their own responsibilities and the responsibilities of other actors that are involved in the delivery of that AI would support accountability.

Trust is a very important concept in common life and has different levels. McKnight and Chervany (1996) considered different levels of trust. Trusting Beliefs is the most important and is the determinant of Trusting Intention (based on perceptions) and Trusting Behaviour. People, according to Friedman, Khan and Howe (2000), only trust on people and do not trust in technology. Besides, they give some keys to try to obtain online trust.

However, talk about trust in AI in all the cases is not good. For instance, DeCamp and Tilburt (2019) explain why it is not a good idea (actually, it is an error) to talk about trust in AI in medicine. So, this paper will be focus on perception and attitude towards mainly for this reason.

European Commission (2020) is taking care about trust in a legal framework and fundamental rights, but not about to be comfortable with. This paper adopts the point of view of individuals about AI rather than business who provides the artificial intelligence.

Our main goal is to analyse the current perception of the influence of AI and how AI could change the future of society. An important aspect is to analyse how people think that AI is changing their life compared to how people think AI will change their future life. From this comparison, a way forward could be defined on how to learn about AI (skills, knowledge, capacities, etc..).

The rest of the paper is organized as follows: a brief of literature review in the next section; section 3 contains the description of the data used; then, methodology is explain in section 4; section 5 includes the binary logit model results of positive attitude towards robots and AI. Section 6 concludes.

2. Literature review.

Robotics and AI have a big impact on business and economics, the way that the relationship between humans and companies and between companies is changing (Dirican, 2015). AI gives new opportunities to lower costs and good revenues, that gives more efficiency and productivity (Porter, 1985).

Vesnic-Alujevic, Nascimiento and Polvora (2020) analyse European AI by critically reviewing the conditions and impacts of AI on society based on policy documents of European organizations. The point of view of this paper is the user of IA and its perception through a Spanish survey.

In addition to trust, the media translates some ideas about AI to people such as: this technology is important for the development of the society, but a danger in the development of this technology is implicit in representing a human by a machine.

This idea is not only about trust in a new technology, but it is about the danger for the society in the development of AI. Afsar, Badir and Khan (2015) explain that innovation trust is important to reduce the negative reactions to innovation from workers and it is important to the benefits of the company. Sun, Zhai, Shen and Chen (2020) review 1776 news articles from the New York Times, Washington Post, the Guardian, and USA Today to analyse the overall landscape of media coverage as well as the media framing of AI. The authors found fourteen major topics accumulated in the examined articles: regulation & policy and risk & weapon, among others. Siau and Wang (2018) insist on the importance of creating trust in AI, ML and robotics, and that trust is dynamic. The focus should be on, what they call, the initial trust and try not to lose it.

Krupiy (2020) considers another perspective from the law about how automatic decisions of AI affects to the society, particularly, experiences of individuals who have historically experienced disadvantage and discrimination.

One of the most interactive service developed using "intelligence" is the healthcare system. In this type of system, users must take actions on the decisions taken but the AI machine, and many times, this kind of environments are used to analyse how AI should be developed to take into account people's fear and how these applications should be developed to avoid this type of feeling (Kim & Kim, 2018).

Literature on perceptions in AI could be found. Brougham and Haar (2018) generate a survey for employees' perception of Smart Technology, AI, Robotics and Algorithms (STARA). Their study focuses on service sector and the point of view of employees in New Zealand, with 120 observations. Ryzhkova, Soboleva, Sazonova and Chikov (2020) conducted a survey of bank employees at a Russian bank to understand consumer´s perception of AI. Gao, He, Chen, Ki and Lai (2020) study the public perception of AI in healthcare by conducting a survey on social media. Thus, the perception of AI is very important in different contexts (banking, service and medical services, among others). The focus of this paper is the perception of AI of Spanish people, with a survey of more than 6000 observations.

Grande, Muñoz de Bustillo, Fernández-Macías and Antón (2020) said that innovation is associated with employing destroy, and this is one of the reasons for the resistance to change of human labour force. They found no differences by sector, but there is a psychosocial risk associated with innovation. Their study was conducted in 32 European countries.

European Commission (2017) used a survey that contains some of the questions that are related in this paper. The survey was gathered on March 2017 and for the 28 country members. In figure 1 it could be seen that 61% on average have a positive attitude with robots and AI (in Spain is only 56%) and it could be seen the attitude by country. Figure 2 shows one perception related to jobs, and it is that will disappear more than will be new ones. The 74% of European think that it is true. Spain is the most agreeable country with that idea.

The 68% of Europeans think that AI is good to help people in their jobs and daily tasks at home (see figure 3) and 84% considers that robots are good to do hard and dangerous jobs (see figure 4). In Spain this percentage are 82% about robots that could do hard and dangerous jobs for people (figure 4), and 69% thinks that robots and AI is good to help people.

Most Spanish people (90%) think that robots and AI steal people's jobs. Spain is the second country with this opinion, while the European average is 72% (European Commission, 2017, p. 74).

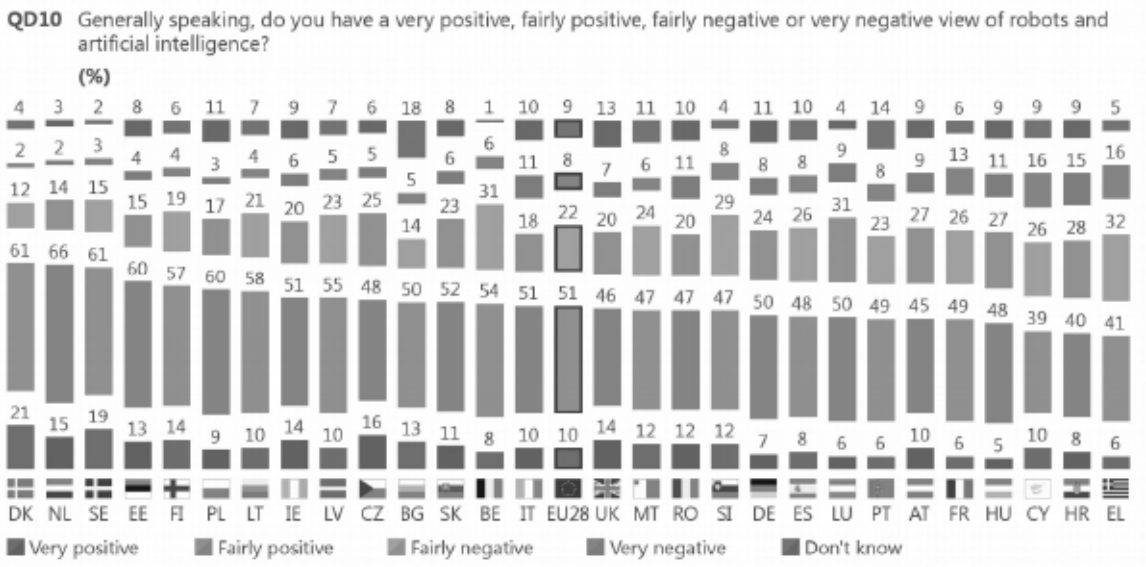

Figure 1. Attitude about robots and AI

Source: European Commission (2017)

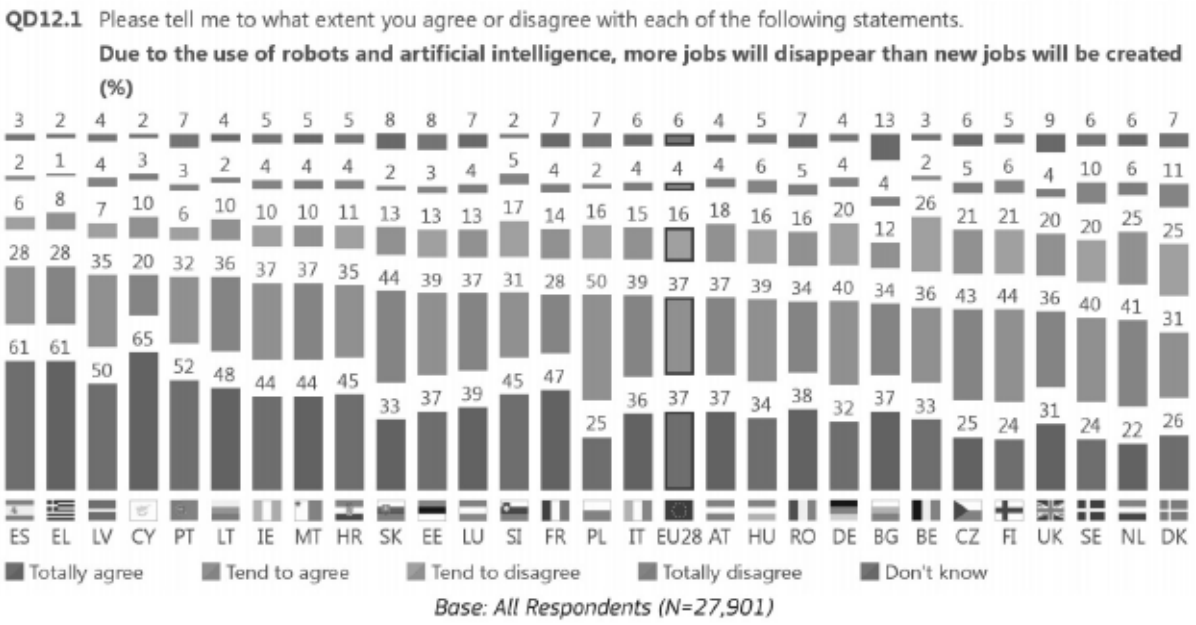

Figure 2. Using of robots and AI, more jobs will disappear than new ones will be created

Source: European Commission (2017)

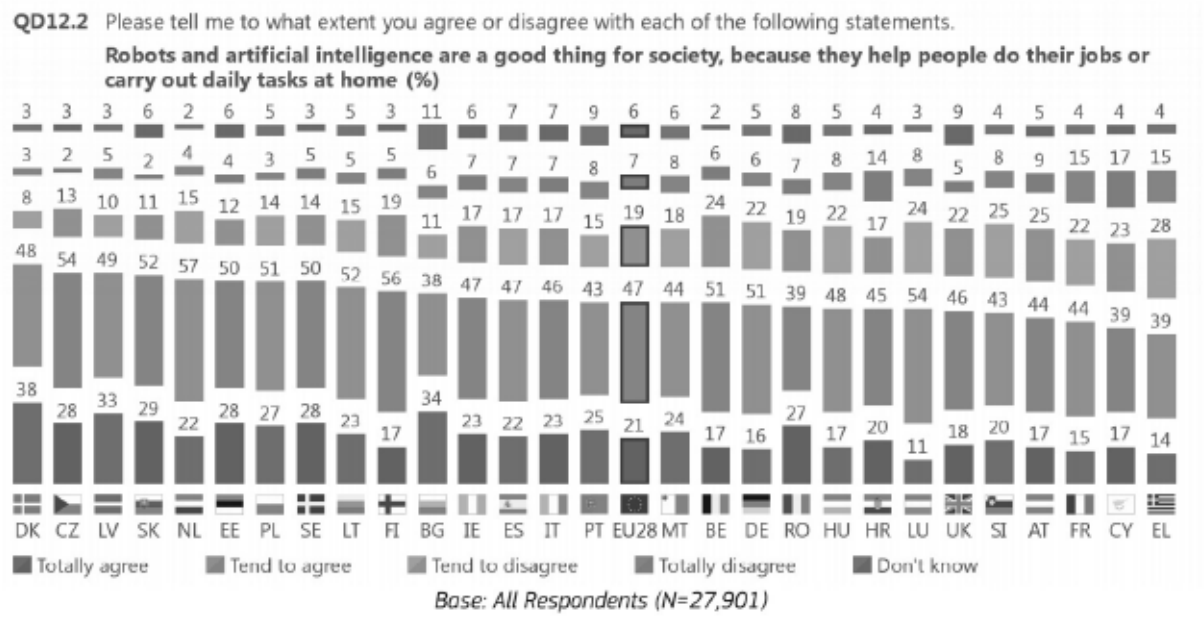

Figure 3. Robots and AI are good for society

Source: European Commission (2017)

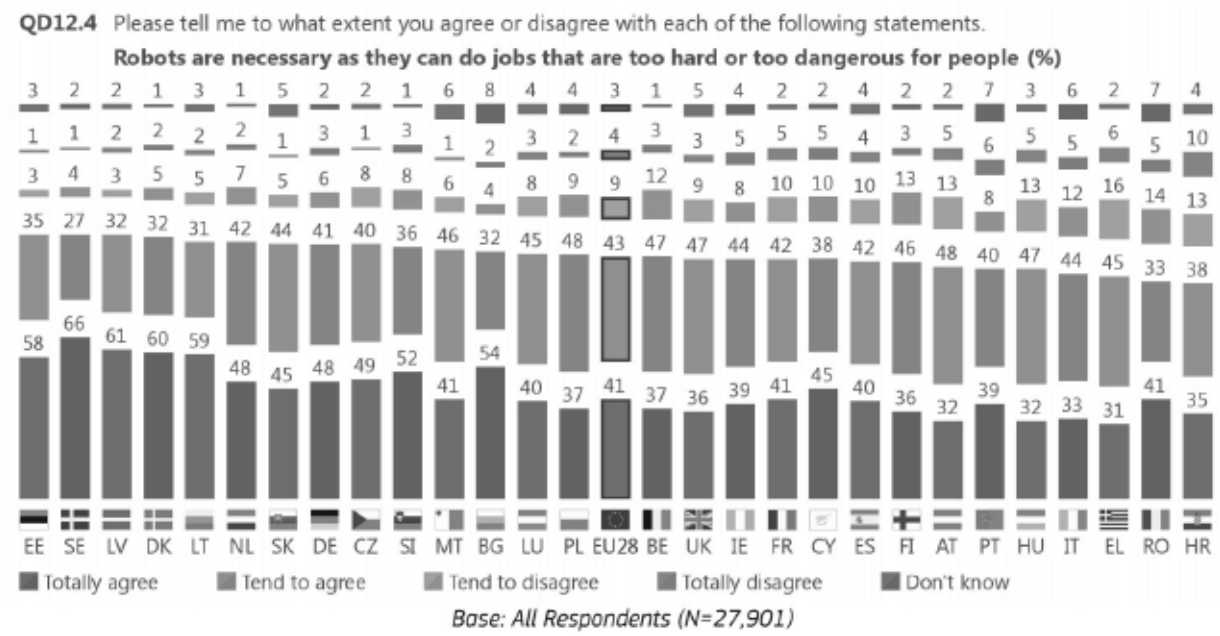

Figure 4. Robots are necessary for hard and dangerous jobs

Source: European Commission (2017)

In particular, the perception of innovation in Spain is decreasing, being in 2019 lower than in 2017 (COTEC, 2020). The groups of people who have changed their perception most, the most

sceptical now. They are women, young people between 18-29 years old, students and training profiles and low income (COTEC, 2020). More than 54% of respondents believe that innovation increases social inequality. Unemployed people and workers with basic education are the most concerned about the effect of technological change on social inequality (COTEC, 2020). However, these findings are not exclusive to Spain. Fast and Horvitz (2017) analysed the perception of AI in the New York Times for 30 years, and found that until 2009 it was increased, but then change. The main reason is that people are concerned about the negative impact of AI on work and ethics and loss of control over AI. In addition, they found that the perception of AI in healthcare and education never stops growing.

Therefore, Fundación Telefónica (2020) said that AI is global and emerging in all households and companies, but the focus is on companies and how the CEOs want to improve their companies by investing in AI.

3. Data.

The sample consists of a survey with data from 6,308 personal interviews on the perception of innovation and AI "Innovarómetro", conducted by Spain's Centro de Investigaciones Sociológicas (CIS, 2018). This centre is an official government body that produces high-quality statistics that are well-suited to the analysis. The CIS microdata have been made available to users free of charge via Internet (CIS, 2018). The basic tabulation of the survey is available on the CIS website (2018). The survey refers to the perception of individuals and includes questions on socio-demographics, perception of innovation, use and knowledge of ICT so on.

The data was collected through personal interviews and ten different measures of the perception of innovation. The innovation perception scale ranged from 1 to 4, where 1 corresponds to the lowest level of perception and 4 to the highest. Then, there are three questions about the perception of AI, and they have the same range of scale as the innovation perception. The variables used in the analysis can be seen in table 1. The independent variables about the interest in scientific discoveries and technological developments have been expressed in a five-point Liker scale (from 1 = no interest to 5 = much interest) which is considered effective for attitude measurement. The 1 category ("no interest") is the reference one. Note that "enough interest" is a category that only appear if the respondent is not able to answer, the respondent does not know that could select that option.

Table 1. List of variables used in analysis

DEPENDENT VARIABLES		VALUES
PA	POSITIVE ATTITUDE TOWARDS AI AND ROBOTS	Positive attitude = 1, otherwise = 0
INDEPENDENT VARIABLES		
ISDTD	INTEREST IN SCIENTIFIC DISCOVERIES AND TECHNOLOGICAL DEVELOPMENTS	1 = no interest, 2 = little interest 3 = enough interest, 4 = quite interest and 5 = much interest
IEEG	INNOVATION IS ESSENTIAL FOR ECONOMIC GROWTH	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
IACSM	INNOVATION ALLOWS COMPANIES TO SAVE MONEY	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
PDAI	MANY PEOPLE HAVE DIFFICULTIES IN ADAPTING TO INNOVATIONS	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
IIPQL	INNOVATION INCREASES PEOPLE'S QUALITY OF LIFE	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
ILJL	INNOVATION LEADS TO JOB LOSSES BECAUSE COMPANIES NEED FEWER WORKERS	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
IFFW	INNOVATION MAKES FACE-TO-FACE COMMUNICATION WORSE	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
MJD	DUE TO THE USE OF ROBOTS AND ARTIFICIAL INTELLIGENCE, MORE JOBS WILL DISAPPEAR THAN CAN BE CREATED	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
RGSHJ	ROBOTS AND ARTIFICIAL INTELLIGENCE ARE GOOD FOR SOCIETY BECAUSE THEY HELP PEOPLE DO THEIR JOBS	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
RNDW	ROBOTS ARE NEEDED BECAUSE THEY CAN DO BOTH VERY HARD AND DANGEROUS WORK FOR PEOPLE	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
MALE	GENDER: MALE	Male = 1, Female = 0

The collected data are representative of the entire country by gender, making them appropriate for analysis. Gender is a significative variable that needs to be included in this analysis because Goswami and Dutta (2016) concludes that in the ICT context men are more expert in technology than women. The gender gap is not the focus of this paper, but the variable is included because the database is representative by gender and will confirm whether or not there are differences between men and women in their perception of AI.

Table 2 shows the descriptive statistics of the different measures of innovation perception with different aspects of economy growth, consumption, quality of life and AI perception.

Table 2. Descriptive stats

	Min.	Max.	Std. Dev.	Mean	Median	Mode	n
ISDTD	1	5	1.129	3.74	4	4	6260
IEEG	1	4	0.623	3.31	3	3	6009
IACSM	1	4	0.69	3.12	3	3	5588
PDAI	1	4	0.776	2.92	3	3	6028
IIPQL	1	4	0.728	3.04	3	3	5920
ILJL	1	4	0.859	2.94	3	3	6013
IFFW	1	4	0.866	2.93	3	3	6021
MJD	1	4	0.852	3.16	3	4	6001
RGSHJ	1	4	0.807	2.86	3	3	5919
RNDW	1	4	0.776	3.16	3	3	5964
Male	0	1	0.500	0.49	0	0	6308
Positive attitude towards AI and robots (PA)	0	1	0.500	0.51	1	1	6048

		Frequency	Percent
Gender	Male	3066	48.6
	Female	3242	51.4

Figure 5 shows the percentage of respondents on the perception of innovation. It could be seen that there is a good perception about innovation related to economic growth, quality of life and even to companies' savings. However, the perception is not good if we think about the difficulty of adapting to new innovations. Seeing work related to innovation is not good because most respondents think that innovation leads to job losses and even worsens face-to-face communication.

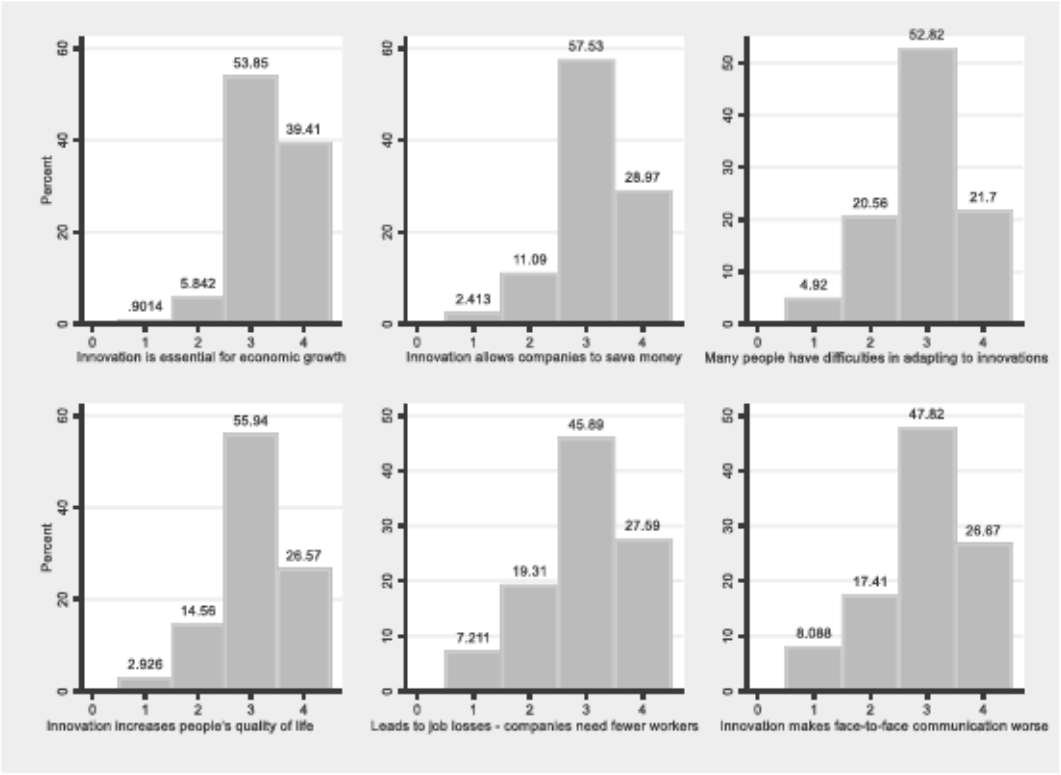

Figure 5. Percentage of innovation perception

In figure 6 the perception about robots and AI is bad if people associated them with job, because think that more jobs will disappear than they are creating new ones. But, if people is asking about how useful or helpful robots and AI than could be, people think that is a good idea. They know that robots help with the hard and dangerous work. This is in line with Randstad (2018) where it is stated that 63% of people in Spain believe that AI will be positive for their work.

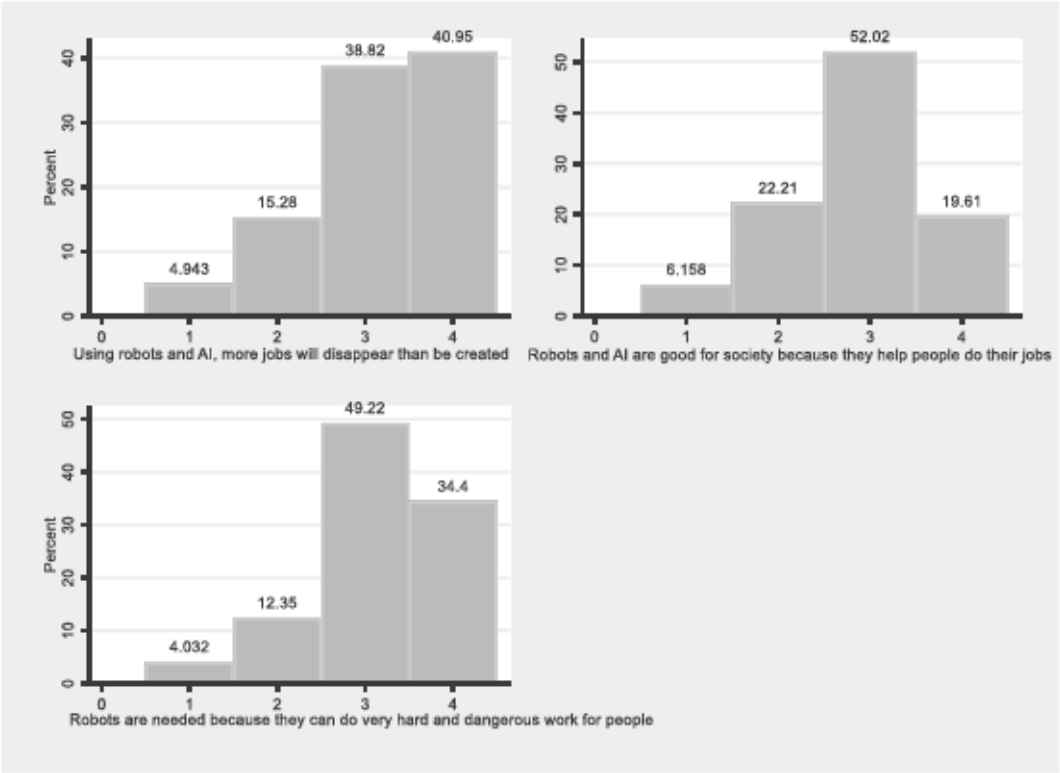

Figure 6. Percentage of artificial intelligence perception

Table 3 shows the correlation matrix of the main variables. Simple correlations are below 0.55 and multiple correlations -coefficients of determination- are also below 0.70 in all cases. Thus, little linear correlation is shown with no evidence of multicollinearity in any case.

Table 3. Correlation matrix 2018

Positive attitude towards AI and robots											
ISDTD	-0.179										
IEEG	0.186	-0.224									
IACSM	0.105	-0.135	0.333								
PDAI	-0.161	0.090	-0.019	0.050							
IIPQL	0.217	-0.188	0.403	0.280	-0.068						
ILJL	-0.229	0.111	-0.090	0.007	0.367	-0.149					
IFFW	-0.191	0.076	-0.087	0.015	0.387	-0.130	0.483				
MJD	-0.279	0.128	-0.118	-0.065	0.259	-0.155	0.474	0.320			
RGSHJ	0.341	-0.107	0.190	0.152	-0.070	0.230	-0.128	-0.103	-0.113		
RNDW	0.258	-0.150	0.185	0.140	-0.031	+0.166	-0.081	-0.061	-0.056	0.542	
Male	0.134	-0.055	0.050	0.060	-0.015	0.051	-0.055	-0.062	-0.053	0.083	0.079

4. Methodology

Categorical models where dependent or explained variables are coded as "0" and "1" are called as dummy dependent variable models among limited dependent variable models. When qualitative variable models can take two such values, the first models that usually come to mind are linear probability model (LPM), logit and probit models. The most obvious problem in LPM is that the estimated probability values fall outside the range of "0" and "1". That problems associated to linear probability models are explained, among others by Gujarati (2009) and Aldric and Nelson (1984).

Logit and probit models are the most widely used models for estimating the functional relationship between dependent and independent variables in practice. Besides, logit and probit models can be considered among the generalized linear models (GLM) family. When the dependent variable is binary this model cannot be estimated using the normal least squares method (OLS). Instead, the maximum probability estimate is used which requires assumptions about the distribution of errors. Often, the choice is between the normal errors in the probit model and the logistic errors in the logit model (Long, 1977).

In this paper binary logit and probit models are studied to estimate as dependent variable "Positive attitude towards AI and robots". This binary dependent variable tries to answer if the interest on innovation of individual private people of Spain depends or not of their perception of AI (results could be seen in next section, in table 4). R 4.0.3 (R Core Team, 2020) was used to perform the data analysis.

The independent variables about innovation are measure between one and four, where one means that respondent has little interest in that kind of innovation and four means that respondent is much interested. The independent variable about the global interest in scientific discoveries and technological developments is measure between one and five, that means between no interest and much interest.

4.1. Logit Model

In the logit regression model, none of the assumptions involved in the linear regression analysis are not sought.

$$\Pr(y_i = 1|x_i;\beta) = \Lambda(x_i'\beta) = \frac{e^{(x_i'\beta)}}{1+e^{(x_i'\beta)}} \quad (1)$$

$$\Pr(PA_i = 1) = \beta_0 + \beta_1 ISDTD_i + \beta_2 IEEG_i + \beta_3 IACSM_i + \beta_4 PDAI_i + \beta_5 IIPQL_i + \beta_6 ILJL_i + \beta_7 IFFW_i + \beta_8 MJD_i + \beta_9 RGSHJ_i + \beta_{10} RNDW_i + \beta_{11} Male_i + u_i \quad (2)$$

where β_0 is the constant term and β_i are regression coefficients.

The coefficients cannot be directly interpreted as the effect of a change in independent variables on the expected value of the dependent variable. For this reason, marginal effects can be calculated in applications. Furthermore, the sign of the coefficients indicates the direction of the relationship between the argument and the probability of occurrence of the event.

The logit model is tested with the "chi-square test" and the existence of each independent variable in the model is tested by "Wald test statistics". However, in cases where there is a classification and assignment process and where normal distribution assumption and continuity assumption are not prerequisite, data should be analysed with logit model.

4.2. Probit Model

As mentioned above, a problem with LPM is that the predicted probability values fall outside the range of "0" and "1". One of the models used to solve this problem is the probit model together with the logit model. Probit is a nonlinear model in terms of coefficients that allows the probabilities to remain between the range "0" and "1". When the dependent variable yi is binary, Pi is expressed in equation 3:

$$\Pr(y_i = 1|x_i;\beta) = \phi(x_i'\beta) \quad (3)$$

where ϕ is the cumulative distribution function and β maximum likelihood coefficients of the standard normal distribution.

This model assumes that the basic dependent variable is normally distributed, whereas in logit model is assumed that the variable is based on the logistic curve. Although these two models (logit and probit) give similar results, it is not possible to directly compare the predicted main mass coefficients of the two models. However, they can be compared with a coefficient proposed by Amemiya (1981).

If $\phi(Z)$ cumulative normal distribution function is defined as $\phi(Z)=P(Z \leq z)$ for the normal standard variable Z, then equation 4 and equation 5 are expressed as follows:

$$\Pr(y_i = 1) = 1 - \phi(x_i'\beta) \quad (4)$$

$$\Pr(y_i = 0) = \phi(x_i'\beta) \quad (5)$$

where the variable Z here is a standardized normal variable with a mean of "0" and a variance of "1". Thus, the model can be represented by equation 6 where F^{-1} is the inverse of the normal cumulative distribution function:

$$F^{-1}(PA_i) = F^{-1}(I_i) = \beta_0 + \beta_1 ISDTD_i + \beta_2 IEEG_i + \beta_3 IACSM_i + \beta_4 PDAI_i + \beta_5 IIPQL_i + \beta_6 ILJL_i + \beta_7 IFFW_i + \beta_8 MJD_i + \beta_9 RGSHJ_i + \beta_{10} RNDW_i + \beta_{11} Male_i + u_i \quad (6)$$

In this paper logit and probit models are compared using a questionnaire. When dummy variables that take two or more values are included in regression models as dependent variables, dependent variables indicate preference or decision. The most commonly used models among these preference models are logit and probit models.

5. Empirical results.

This section presents the results of the binary logit and probit models of innovation and AI perception that have been developed. The estimated models explain the attitude (positive or negative) towards AI and robots of respondent. Both binary regression models use as reference category that people have a positive attitude. So, the dependent variable was generated as a dummy variable taken the value 1 if the attitude is positive or high positive, and 0 otherwise.

The independent variables about interest in discoveries and technological development is measured between 1 and 5. Besides, the rest of independent variables have four categories (and it is used the same reference category).

The estimation results of binary logit and binary probit models are shown in tables 4 and 5, respectively.

Table 4. Binary Logit Regression

	Positive attitude towards AI and robots (PA)				
		Little interest	Enough interest	Quite interest	Much interest
Interest in scientific discoveries and technological developments (ISDTD)	----	2.182** (0.26)	1.654* (0.26)	2.924*** (0.24)	2.887*** (0.25)
Innovation is essential for economic growth (IEEG)	----	0.667 (0.44)	----	0.772 (0.42)	1.031 (0.42)
Innovation allows companies to save money (IACSM)	----	0.494** (0.27)	----	0.495** (0.25)	0.552* (0.26)
Many people have difficulties in adapting to innovations (PDAI)	----	1.031 (0.19)	----	0.809 (0.18)	0.643* (0.19)
Innovation increases people's quality of life (IIPQL)	----	0.737 (0.25)	----	0.968 (0.24)	1.390 (0.25)
Innovation leads to job losses because companies need fewer workers (ILJL)	----	1.569** (0.17)	----	1.123 (0.16)	0.924 (0.17)
Innovation makes face-to-face communication worse (IFFW)	----	0.983 (0.16)	----	0.887 (0.15)	0.706** (0.16)
Due to the use of robots and artificial intelligence, more jobs will disappear than can be created (MJD)	----	0.913 (0.20)	----	0.531** (0.19)	0.301*** (0.19)
Robots and artificial intelligence are good for society because they help people do their jobs (RGSHJ)	----	1.368 (0.21)	----	4.210*** (0.20)	6.057*** (0.21)
Robots are needed because they can do both very hard and dangerous work for people (RNDW)	----	1.029 (0.25)	----	1.714* (0.23)	2.251*** (0.24)
Male	1.481*** (0.07)				
Constant	0.305 (0.60)				
Hosmer-Lemeshow R^2	0.20036				
McFadden R^2	0.20036				
Cox-Snell R^2	0.24096				
Nagelkerke/Cargg&Uhler R^2	0.32243				
n	6308				

Notes: Exp (B) and Standard deviation in parenthesis. The reference category is "No interest"

Table 5. Binary Probit Regression

	Positive attitude towards AI and robots (PA)				
		Little interest	Enough interest	Quite interest	Much interest
Interest in scientific discoveries and technological developments (ISDTD)	----	1.565** (0.15)	1.323 (0.15)	1.868*** (0.14)	1.860*** (0.15)
Innovation is essential for economic growth (IEEG)	----	0.785 (0.26)	----	0.861 (0.25)	1.022 (0.25)

Innovation allows companies to save money (IACSM)	----	0.658** (0.16)	----	0.653** (0.15)	0.692* (0.15)
Many people have difficulties in adapting to innovations (PDAI)	----	1.029 (0.11)	----	0.891 (0.10)	0.778* (.11)
Innovation increases people's quality of life (IIPQL)	----	0.843 (0.15)	----	0.990 (0.14)	1.228 (0.15)
Innovation leads to job losses because companies need fewer workers (ILJL)	----	1.302** (0.09)	----	1.070 (0.09)	0.951 (0.10)
Innovation makes face-to-face communication worse (IFFW)	----	0.997 (0.09)	----	0.926 (0.09)	0.813** (0.09)
Due to the use of robots and artificial intelligence, more jobs will disappear than can be created (MJD)	----	0.961 (0.12)	----	0.697*** (0.11)	0.497*** (0.11)
Robots and artificial intelligence are good for society because they help people do their jobs (RGSHJ)	----	1.212 (0.12)	----	2.383*** (0.11)	2.952*** (0.12)
Robots are needed because they can do both very hard and dangerous work for people (RNDW)	----	1.014 (0.14)	----	1.381* (0.13)	1.616*** (0.14)
Male	1.267*** (0.04)				
Constant	0.552 (0.34)				
Hosmer-Lemeshow R^2	0.20045				
McFadden R^2	0.20045				
Cox-Snell R^2	0.24085				
Nagelkerke/Cargg&Uhler R^2	0.32235				
n	6308				

Notes: Exp (B) and Standard deviation in parenthesis. The reference category is "No interest"

Akaike Information Criterion (AIC) and Bayes Information Criterion (BIC) are information criteria that allow comparison of both logit and probit models are showed in table 6.

Table 6. Model selection criteria: AIC and BIC

	Logit model	Probit model
AIC	5.112.952	5.113.387
BIC	5.162.337	5.162.771

Both logit and probit model analyses are very similar and the probability estimates obtained are close to each other. When all the results obtained are evaluated together, it is more important that the coefficients give expected signs and the explanatory variables are statistically

significant in binary models such as logit and probit than the goodness of fit measure. This value may be too low when R^2 is calculated for these models, but this will not indicate that the model is weak. For this reason, some Pseudo R^2 has been calculated. In all cases Pseudo R^2 values are very low for logit and probit models. Nevertheless, when the models were compared, the lowest AIC and BIC values 5.112.952 and 5.162.337 were found for the logit model. Therefore, it can be said that logit model is better than probit model in this case. The coefficients of the logit model and the probit model are not the same but the information obtained from the marginal effects is quite similar and the variables found to be insignificant in logit model were also found to be significant in probit model.

So, in the logit model estimated for the current study, it could be seen that males are more interesting than females in technological developments. This result is consistent with He and Freeman (2010).

About AI, it is clear that if people think that robots and AI is useful, then they are more interested in developments, but if they are afraid that AI and robots will lead to the elimination of jobs, people is less interest in scientific discoveries and technological developments.

If people are afraid about innovation, they are less interest in that. It could be seen with the variables about the difficulties in adapting to innovations, their thinking about innovation leads to job losses and that innovation makes face-to-face communication worse. In case they think that innovation could be good for them, they are much interest in developments. As it could see with the importance that people have about innovation is essential for economic growth and that it increases people's quality of life.

In brief, for having the best attitude towards AI and robots, the individual should think that they are good for society (helping doing jobs). This variable has the biggest coefficient and it is also significative. The second bigger coefficient has much interest in scientific discoveries and technological developments. And finally, thinking that robots are really needed for hard and dangerous works.

On the contrary, a negative attitude will come from respondents who thinks that many people have difficulties in adapting to innovations, innovations lead to job losses, innovation makes face-to-face communication worse and that the use of robots and AI will disappear jobs.

6. Conclusions

The current paper analyses perception of AI of individuals in Spain and the factors associated with it. It is not the first time that this topic is analysed. Fast and Horvitz (2017) found that the perception of AI of New York people till 2009 was increased, but then changed. The main reason is that people get worried about the negative impact of AI on work, and ethical and loss of control of AI. In addition, they found that the perception of AI in health care and education over 30 years never stops growing.

In a European context, European Commission (2017) conducted a survey and found that there is different perception in AI and robots, but only a basic tabulation of the question was done. Turning to Spanish studies, CIS (2018) and COTEC (2020) analyses the same data used in this paper although they only achieve a basic tabulation of each question and reaches no specific conclusion.

One of the main findings in this paper is that there is a gender gap with the attitude towards AI and robots, that is consistent with Goswami and Dutta (2016) and He and Freeman (2010). The attitude no positive to AI and robots is due to responders think that people may have difficulties in adapting to, relationships face-to-face will be worse and that will steal jobs. On the contrary, the positive attitude is coming from the thinking that robots and AI are helpful and for a good perception of innovation. When people perceive innovations like something good, they have a better attitude with AI and robots.

Unfortunately, one of the limitations of this study is the cross-section data used. So, with this type of data there is not enough information to make a proper approximation to the evolution of AI perception and try to find why people trust or not on it. It should be better having a time series database or panel data.

Taking into account our goal, that is to say, "how people think that AI is changing their life comparing with how people think that AI will change their future life", this analysis shows three different levels: companies, governments and customers. Analysing the data what policy recommendations could be derived: workers do not accept easily AI, consumers want to know benefits, but they need to trust in AI, so the "unknown" uses of information extracted with AI should be controlled by government.

Considering that it is crucial to obtain users' confidence in AI, three types of policy recommendations could be derived in the light of the conclusions reached:

1) From the point of view of AI companies, create a special program to workers to be able to adapt to AI and robots. Let people see the importance of robots and AI to help, not to destroy jobs.
2) From the policy maker point of view, it is important to write the regulation about privacy taking care of consumers (future users of AI). Some education policy should be done, to help future users to be prepared. It is as important companies as future users' perception.
3) Improving customer perception is desirable and it will be reflected in they could use if they know the benefits.

Finally, this paper suggests the need for further research on this topic and related to, perhaps with a panel data analysis if available and/or European comparison.

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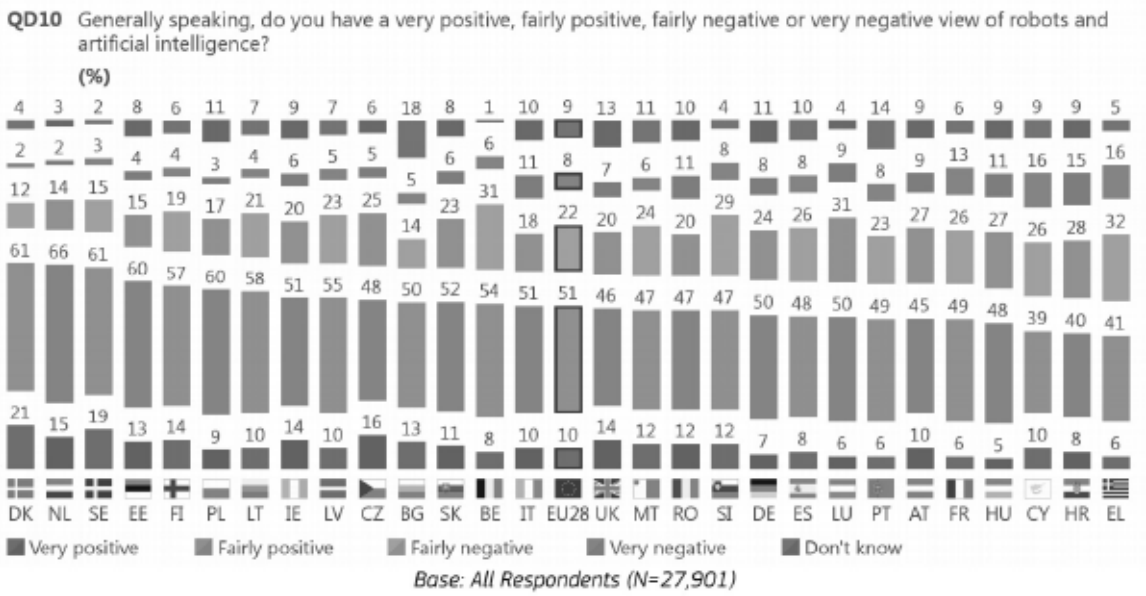

Figure 1. Attitude about robots and AI

Source: European Commission (2017)

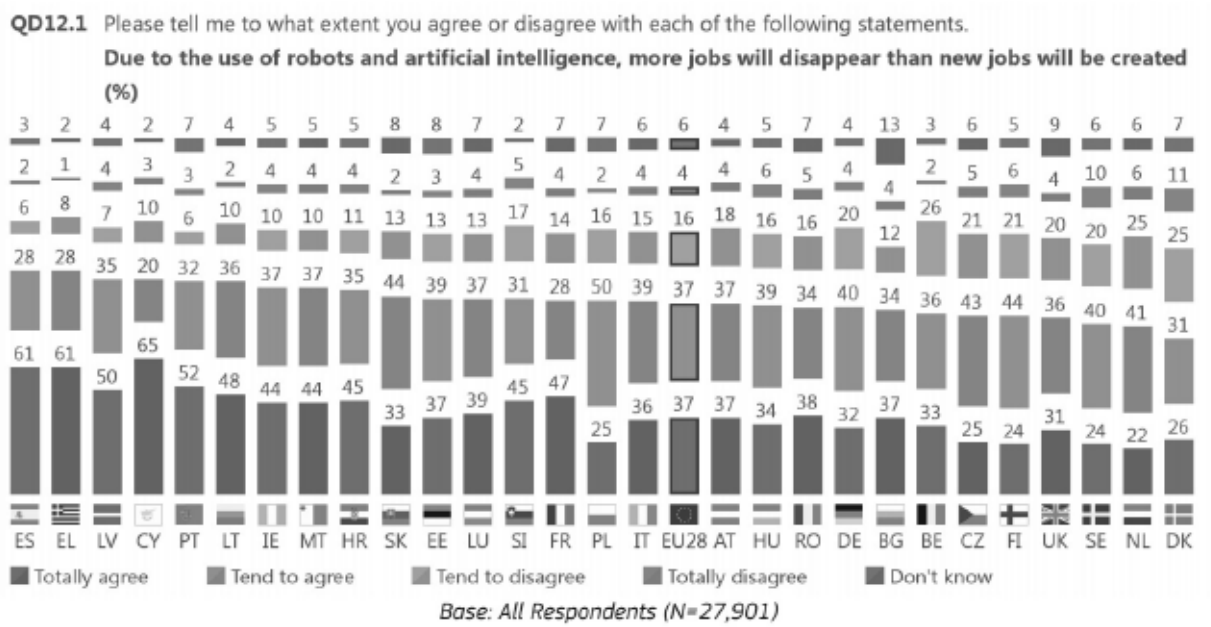

Figure 2. Using of robots and AI, more jobs will disappear than new ones will be created

Source: European Commission (2017)

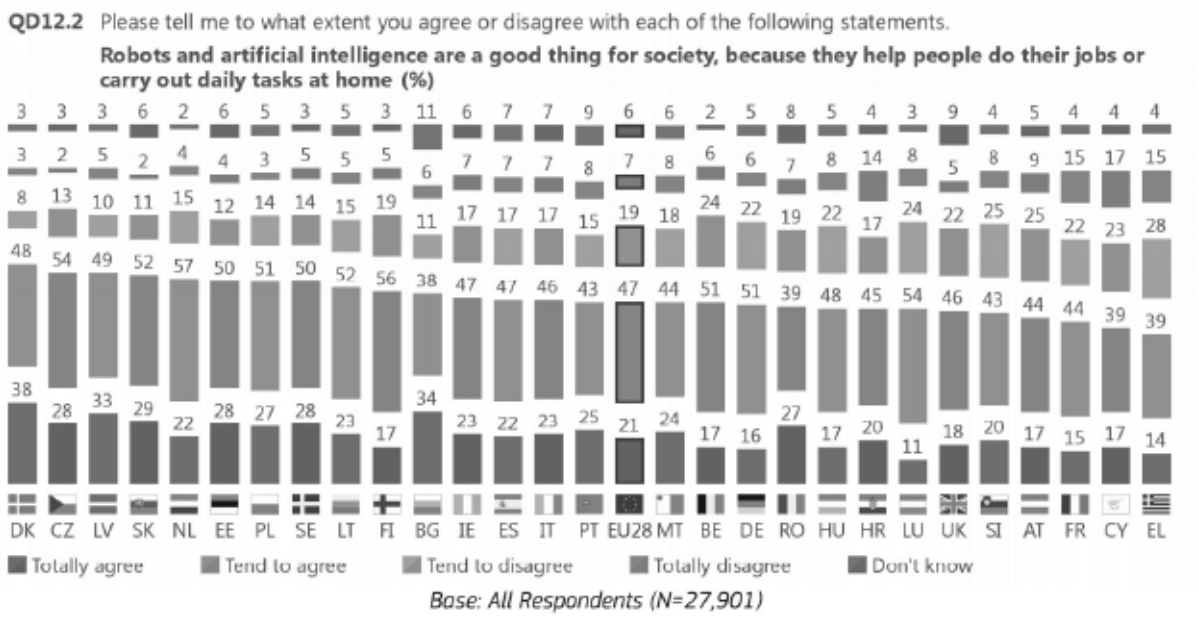

Figure 3. Robots and AI are good for society

Source: European Commission (2017)

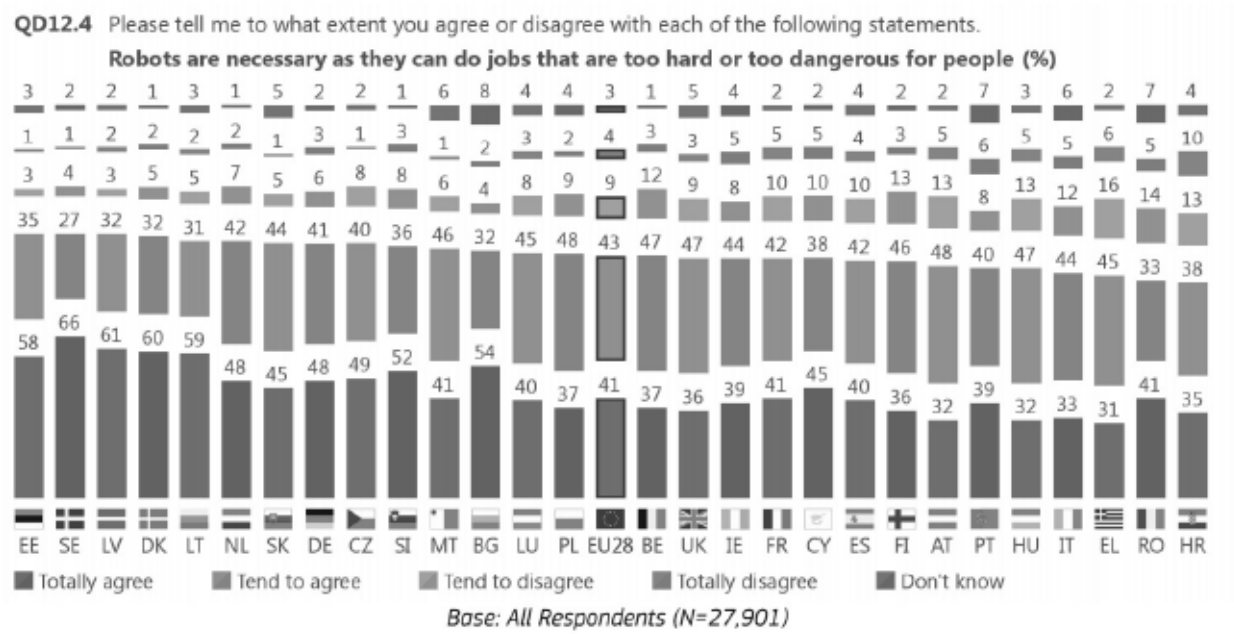

Figure 4. Robots are necessary for hard and dangerous jobs

Source: European Commission (2017)

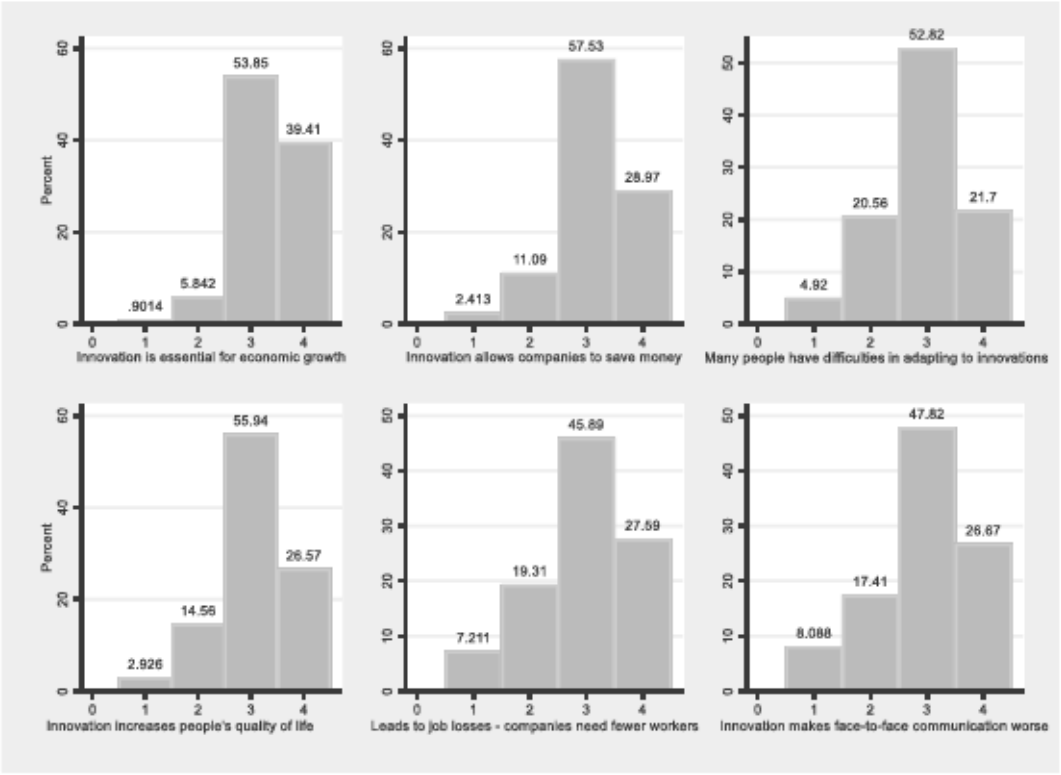

Figure 5. Percentage of innovation perception

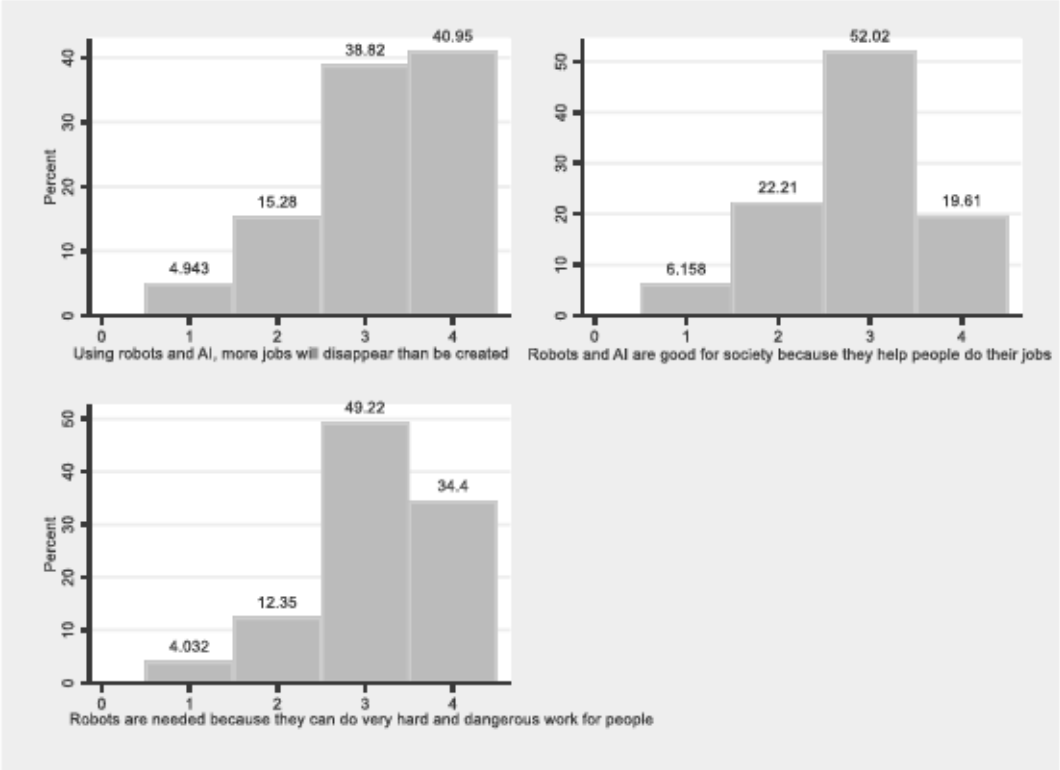

Figure 6. Percentage of artificial intelligence perception

Table 1. List of variables used in analysis

DEPENDENT VARIABLES		VALUES
PA	Positive attitude towards AI and robots	Positive attitude = 1, otherwise = 0
INDEPENDENT VARIABLES		
ISDTD	Interest in scientific discoveries and technological developments	1 = no interest, 2 = little interest 3 = enough interest, 4 = quite interest and 5 = much interest
IEEG	Innovation is essential for economic growth	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
IACSM	Innovation allows companies to save money	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
PDAI	Many people have difficulties in adapting to innovations	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
IIPQL	Innovation increases people's quality of life	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
ILJL	Innovation leads to job losses because companies need fewer workers	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
IFFW	Innovation makes face-to-face communication worse	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
MJD	Due to the use of robots and artificial intelligence, more jobs will disappear than can be created	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
RGSHJ	Robots and artificial intelligence are good for society because they help people do their jobs	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
RNDW	Robots are needed because they can do both very hard and dangerous work for people	1 = no interest, 2 = little interest 3 = quite interest and 4 = much interest
Male	Gender: Male	Male = 1, Female = 0

Table 2. Descriptive stats

	Min.	Max.	Std. Dev.	Mean	Median	Mode	n
ISDTD	1	5	1.129	3.74	4	4	6260
IEEG	1	4	0.623	3.31	3	3	6009
IACSM	1	4	0.69	3.12	3	3	5588
PDAI	1	4	0.776	2.92	3	3	6028
IIPQL	1	4	0.728	3.04	3	3	5920
ILJL	1	4	0.859	2.94	3	3	6013
IFFW	1	4	0.866	2.93	3	3	6021
MJD	1	4	0.852	3.16	3	4	6001
RGSHJ	1	4	0.807	2.86	3	3	5919
RNDW	1	4	0.776	3.16	3	3	5964
Male	0	1	0.500	0.49	0	0	6308
Positive attitude towards AI and robots (PA)	0	1	0.500	0.51	1	1	6048

		Frequency	Percent
Gender	Male	3066	48.6
	Female	3242	51.4

Table 3. Correlation matrix 2018

Positive attitude towards AI and robots											
ISDTD	-0.179										
IEEG	0.186	-0.224									
IACSM	0.105	-0.135	0.333								
PDAI	-0.161	0.090	-0.019	0.050							
IIPQL	0.217	-0.188	0.403	0.280	-0.068						
ILJL	-0.229	0.111	-0.090	0.007	0.367	-0.149					
IFFW	-0.191	0.076	-0.087	0.015	0.387	-0.130	0.483				
MJD	-0.279	0.128	-0.118	-0.065	0.259	-0.155	0.474	0.320			
RGSHJ	0.341	-0.107	0.190	0.152	-0.070	0.230	-0.128	-0.103	-0.113		
RNDW	0.258	-0.150	0.185	0.140	-0.031	+0.166	-0.081	-0.061	-0.056	0.542	
Male	0.134	-0.055	0.050	0.060	-0.015	0.051	-0.055	-0.062	-0.053	0.083	0.079

Table 4. Binary Logit Regression

	Positive attitude towards AI and robots (PA)				
		Little interest	Enough interest	Quite interest	Much interest
Interest in scientific discoveries and technological developments (ISDTD)	----	2.182** (0.26)	1.654* (0.26)	2.924*** (0.24)	2.887*** (0.25)
Innovation is essential for economic growth (IEEG)	----	0.667 (0.44)	----	0.772 (0.42)	1.031 (0.42)
Innovation allows companies to save money (IACSM)	----	0.494** (0.27)	----	0.495** (0.25)	0.552* (0.26)
Many people have difficulties in adapting to innovations (PDAI)	----	1.031 (0.19)	----	0.809 (0.18)	0.643* (0.19)
Innovation increases people's quality of life (IIPQL)	----	0.737 (0.25)	----	0.968 (0.24)	1.390 (0.25)
Innovation leads to job losses because companies need fewer workers (ILJL)	----	1.569** (0.17)	----	1.123 (0.16)	0.924 (0.17)
Innovation makes face-to-face communication worse (IFFW)	----	0.983 (0.16)	----	0.887 (0.15)	0.706** (0.16)
Due to the use of robots and artificial intelligence, more jobs will disappear than can be created (MJD)	----	0.913 (0.20)	----	0.531** (0.19)	0.301*** (0.19)
Robots and artificial intelligence are good for society because they help people do their jobs (RGSHJ)	----	1.368 (0.21)	----	4.210*** (0.20)	6.057*** (0.21)
Robots are needed because they can do both very hard and dangerous work for people (RNDW)	----	1.029 (0.25)	----	1.714* (0.23)	2.251*** (0.24)
Male	1.481*** (0.07)				
Constant	0.305 (0.60)				
Hosmer-Lemeshow R^2	0.20036				
McFadden R^2	0.20036				
Cox-Snell R^2	0.24096				
Nagelkerke/Cargg&Uhler R^2	0.32243				
n	6308				

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Innovation increases people's quality of life (IIPQL)	----	0.843 (0.15)	----	0.990 (0.14)	1.228 (0.15)
Innovation leads to job losses because companies need fewer workers (ILJL)	----	1.302** (0.09)	----	1.070 (0.09)	0.951 (0.10)
Innovation makes face-to-face communication worse (IFFW)	----	0.997 (0.09)	----	0.926 (0.09)	0.813** (0.09)
Due to the use of robots and artificial intelligence, more jobs will disappear than can be created (MJD)	----	0.961 (0.12)	----	0.697*** (0.11)	0.497*** (0.11)
Robots and artificial intelligence are good for society because they help people do their jobs (RGSHJ)	----	1.212 (0.12)	----	2.383*** (0.11)	2.952*** (0.12)
Robots are needed because they can do both very hard and dangerous work for people (RNDW)	----	1.014 (0.14)	----	1.381* (0.13)	1.616*** (0.14)
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Notes: Exp (B) and Standard deviation in parenthesis. The reference category is "No interest"

Table 6. Model selection criteria: AIC and BIC

	Logit model	Probit model
AIC	5.112.952	5.113.387
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Conflict of Interest

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: