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**BACHELOR THESIS IN ECONOMICS**

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*Cognitive determinants on individual decision-making:  
a Covid-19 vaccine experimental approach*

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**Abstract:**

When setting up a decision-making scenario, we have to take into account a huge number of factors that can influence the outcome of a decision. In our study, we will focus on the issue of Covid-19 vaccines. We will try to explain which are the most relevant cognitive determinants that lead individuals to the resolution of this choice. We conclude that of the three explanatory factors considered: risk-taking, altruism and intrinsic motivation, we only obtain significant effects to accept motivation as a significant driver. One of the possible causes of this outcome is the small sample size and the high vaccination rate in Spain and consequently its under-representation in the database.

**Keywords:** decision-making, vaccines, risk-taking, altruism, intrinsic motivation.

**JEL classification:** D64, D71, D81, D91, I12

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## INTRODUCTION

As we all know, in recent years we have been immersed in one of the worst health crises in living memory. With over 6.9 million deaths and 767.4 million infections, Covid-19 has jeopardized our perception of our lives.

The anti-vaccine movement has emerged due to this happening, and has been getting more importance in recent years. Theories such as the modification of DNA, the implantation of microchips that is believed to be able to control people, the reduction of the world's population or sterility are hypotheses that this group of people defends.

Focusing on this social group, we could classify them as people who, whether for health, scientific, religious or political reasons, consider that the fact of being vaccinated inflicts a greater risk on them than the benefit of receiving the vaccine.

The objective of this experiment is to find differences between people who have received the Covid-19 vaccine and those who have not, using different measures such as a risk aversion test, a modified dictator game or an intelligence test.

The disparities expected to be found between the two groups on the issue of risk aversion would be that people who did not get the vaccine would be less risk averse than people who did get the vaccine. This is mainly because receiving the vaccine has been shown to significantly reduce the likelihood of becoming infected by the virus, assuming that the disease itself is more dangerous than the possible side effects that could result from the vaccine.

It has also been decided to include a dictator game as people who have been vaccinated have not only done so to protect themselves but also the people around them. Therefore, getting vaccinated should be considered altruistic. The anti-vaccine collective is sometimes selfish because it has only its own ideals in mind and deprives society of collective immunity.

Finally, it would be interesting to include an intelligence test in order to try to see if there are any noticeable differences between the two groups. People who are not pro-vaccine may have both a lack of knowledge and an excess of reasoning due to higher intelligence in their decision-making process.

Having already set the scene for our study, we will now focus on disseminating the cognitive determinants that affect decision-making in general.

Within this world there are a myriad of factors that affect the behaviour of individuals. In this study, we will place special emphasis on those that in our opinion, and also on the basis of the literature, may be the most decisive when making the decision to be vaccinated or not against Covid-19.

These determinants are: risk propensity, level of altruism and intrinsic motivation. Each of them may affect the final decision in different ways. We will therefore try to explain how they influence the final decision.

First, the effect that risk has on the people who have to make this decision. There are still many theories and paradoxes about risk, but in our case we will stick to the maxim that risk is not given by any one factor. This human quality is inherent to each person and for that very reason cannot be explained by any socio-demographic factor. However, it should be noted that there are two different perspectives in identifying what risk is. Firstly, we will recognise risk as the fact of contracting the disease; this viewpoint is the most recurrent in people's thoughts. However, the more vaccine-averse may argue that, in their case, the side effects that result from the imposition of the vaccine is the risk to be avoided. In our case, we will use the most common argument.

Next, we will cover the level of altruism. We have computed this factor as the amount that each participant has donated to a cancer association. When making decisions, this can influence the way they consider the consequences of their actions on others. A highly altruistic individual may make decisions that benefit others, even if it involves personal sacrifice such as the side effects suffered from the imposition of the vaccine. They may make decisions that promote the common good and prioritise the welfare of others. Those who are less altruistic, on the other hand, may make decisions more focused on maximising their own benefit, even if that has a negative effect on others.

Finally, intrinsic motivation is defined as the internal drive that leads a person to engage in an activity for the pleasure or personal satisfaction it brings rather than for external rewards or motivations, such as social pressure or government impositions.

## LITERATURE AND EXPERIMENTAL EVIDENCE

### Existing studies

When making an individual decision, such as whether or not to be vaccinated, a number of determining factors come into play that generally follow a common pattern for individuals who find themselves in this situation.

We will now examine the existing literature on this subject, analyzing which are the most recurrent and how they affect the achievement of this practice.

If we focus on gender, theories such as that of *Zintel, S., et al. (2022)* show how men had a greater intention to be vaccinated, in this case, against Covid-19. Their calculations revealed that women confessed that they would vaccinate much less than men. This effect was observed in different countries where the study was conducted. Moreover, the discrepancies were even larger in the samples obtained from related work in the health care setting than in relation to the mean.

Regarding the effect of age and its link to the probability of receiving the vaccination schedule, the conclusions are several. We can see how the fact of being of legal age and being able to decide freely about oneself has a negative effect on the decision to be vaccinated as shown by *Ali et. al. (2020)*. However, people who have already reached an advanced age look favorably on the acceptance of vaccines and are more likely to receive them, *Bish et. al. (2011)*.

On the other hand, *Shim et. al. (2012)* concluded the important role that misperceptions about vaccine risk play and that this can truncate the efficiency of vaccination programs. Thus, a crucial tool to avoid this occurrence is public education, as it can increase the impact on vaccine safety and the consequent risk of infection in case of not receiving the vaccine. Education will thus help us to maintain adequate levels of vaccination to preserve herd immunity.

The contribution of *Bish et. al. (2012)* provides us with information on both the influence of the media on the reception of the vaccine and social pressure as a determining factor in receiving it. On the one hand, their research concludes that the differences between official health sources and social networks when it comes to receiving the guideline are substantial, as those who are informed through the former are more likely to receive them. Our interest in observing how fake news can affect, usually negatively, the decisions made by individuals and their perception of the vaccine in particular, has been closely related to these results. On the other hand, they make special emphasis

on the great power of social pressure in this type of decision making. Specifically, they found that the fact that outsiders, especially acquaintances, are vaccinated, encourages vaccination itself. This could be considered an extrinsic motivation which, as will be analysed later, can have a significant effect on decisions.

Given the incipient search for answers to the question of why a considerable part of the population has not wanted to be vaccinated against Covid-19, several studies in the United States use experimental economics to find a solution to influence those who have not yet wanted to do so. *Moore et. al. (2021)* have suggested that there are three sources of motivation: extrinsic motivators such as the social pressure just mentioned; intrinsic, such as fear; and structural, i.e., government impositions.

Depending on the level of rootedness of people who consider themselves practitioners, *Shelton (2013)* differs in the frequency of attendance to religious celebrations with the probability of abstaining from vaccination. Believers with more attachment are claimed to be less likely to vaccinate. Whereas people who rarely or never attended religious services were more supportive of vaccination.

In the field of game theory, subjects will act in their self-interest by choosing decisions that maximize their benefits. However, the results obtained when including the condition of altruism in optimal vaccination policies in an epidemiological model of influenza vaccination are contrary to this maxim. Altruism means that decisions regarding vaccination, instead of acting in the self-interest of the individual, are shifted towards the interest of society, i.e., towards the social optimum. Health policies should be based on this aspect since it has been shown that its contribution would be of great help in improving the results of this public good. Thanks to the contribution of *Shim (2012)* already discussed, we could imagine a positive correlation between the degree of altruism of people and their attachment to vaccination. *Tsutsui (2012)* also concludes that the philanthropic capacity of the subjects plays a vital role in the decision to receive the vaccine or not.

There are numerous opinions when it comes to risk. Economically, risk aversion is known as a higher assumption of monetary costs to avoid incurring risks. *Tsutsui et al. (2012)* in their study on vaccines in Japan obtain results indicating that there is no relationship between risk aversion and the decision to vaccinate when it comes to monetary terms, i.e. when we talk about the monetary cost of getting vaccinated. However, risk aversion goes beyond that. Recent studies, such as *Hudson and Montelpare (2022)*, emphasize that vaccine-related risk aversion can be viewed from two different points of view. We could consider that an individual is risk averse for not

wanting to be vaccinated to avoid side effects, adopting a posture that they themselves categorize as passive risk. On the other hand, wanting to be vaccinated to avoid the disease is an active risk, so we can obtain ambiguous results.

Risk aversion is an experimental measure that has given rise to infinite theorems, paradoxes and research on how it can affect decision making under uncertainty. Since getting vaccinated is considered a decision that involves a certain level of uncertainty, it is interesting to consider not only how risk preferences affect it, but what determines whether a subject has some preferences or others with respect to risk.

While Expected Utility Theory suggests that individuals base their preferences rationally, Prospective Theory stands that, relative to a reference point, people evaluate outcomes and are more sensitive to losses than gains. It also indicates that there are cognitive biases, systematic errors or deviations from rational decision making that can affect individuals' judgments and choices.

However, there are many theories that criticise the ideas that the Expected Utility defends. Among them we highlight the Allais Paradox and the Framing effect. First, the Allais Paradox is a decision-making problem that demonstrates that Expected Utility Theory can sometimes be inconsistent. Participants in this challenge are presented with two gambling situations with various possibilities and outcomes. According to Expected Utility Theory, most people tend to make decisions that fail to be consistent.

The Allais paradox, in particular, shows an irrational loss aversion and a tendency to prefer options with a higher probability of making a profit, even if that involves a higher risk of loss. The phenomenon in which the way information is presented or "framed" influences people's decisions is known as the Framing Effect. Thus, people may make different decisions depending on how an option is presented to them.

People might be more likely to take a risk for an option in terms of profit, for example. However, if the same option involves loss, people may feel less willing to take the risk and prefer safer options. Expected utility and probability, as well as the way information is presented, affect people's decisions. Hence, Expected Utility Theory argues that people always make rational and consistent decisions, but these phenomena contradict this. They reveal that cognitive biases, emotional biases and the way information is presented can significantly affect the way decisions are made. As a result, more theories and models have been created that seek to explain and understand these phenomena.



Altruism is an individual characteristic that has been shown, through extensive literature, to be a determining factor in decision making, and not only when it comes to vaccination. This factor, in turn, is given by various determinants, both demographic and social. Many papers report that the higher the age, the higher the probability of contributing to a donation, as well as the level of education received (*Bekkers (2007)*). Intelligence, however, provides more ambiguous results. *Guo et al. (2019)*, found a positive relationship between intelligence and pro-social values when donating. This relationship is mostly due to high ability to understand others' feelings and higher empathic concern.

On the other hand, it has been shown that being a believer generates contributions to public goods *Owen et. al. (2007)*. Thus, if we conceive of vaccination as a public good, practitioners should be more likely to be vaccinated because they care more about the public good.

## HYPOTHESES

The development of this research will be based on 3 main hypotheses on which we will carry out an econometric analysis. This will test whether or not the hypotheses are fulfilled.

-  $H_1$ : *Individuals who obtained a higher coefficient on the risk propensity test would be expected to be less sympathetic to vaccines.*

Assuming that individuals identify risk as the fact of contracting the disease against which there is a vaccine, we could assume that risk aversion could also be due to the side effects caused by the implantation of the vaccine.

-  $H_2$ : *People are expected to be less likely to be vaccinated the less altruistic they are.*

In this hypothesis we start from the point that if we understand the vaccine as a social good, its introduction will considerably prevent the spread of this disease and will therefore be beneficial for the society in question.

-  $H_3$ : *The less intelligent individuals are, the less likely they are to be vaccinated.*

Higher IQs will help them understand why the provision of vaccines is crucial. They will be better able to understand the scientific studies that demonstrate effectiveness, high benefits and relatively few side effects.

In addition, 3 equations will be posed that contrast the determinants of different qualities of individuals: Risktaking, Donation and Intrinsic Motivation. Regarding Risktaking, we expect that no single factor will be a determinant of risk preferences, as shown in the literature. For Donation and Intrinsic Motivation, however, we want to analyse which are the relevant variables that may influence people's individual characteristics.

## EXPERIMENTAL DESIGN

### Questionnaire

- a) The number of times this questionnaire can be answered by the same person is restricted to one. Thus, you are asked to register with your e-mail address to avoid possible second accesses.
- b) Once you have accessed this, there are a series of instructions that you are recommended to read for optimal performance during the test.
- c) The design of the survey is dissected into different sections. In this section we are going to focus on the questionnaire part as such. Below is a list of all the questions that appear in the questionnaire:
  - a. Gender
  - b. Age
  - c. Level of education attained
  - d. Do you practice any religion?
  - e. If yes, please specify which one
  - f. Have you received any doses of Covid-19 vaccine?
  - g. If yes, how many?
  - h. What factors have encouraged you to get vaccinated?
  - i. If you have not received any doses, what factors have encouraged you NOT to be vaccinated?
  - j. Please indicate, in your opinion, how supportive you consider yourself to be on a scale of 1-10.

The assignment of the set of questions corresponds to determine the characteristics of the individuals, from age to the factors that have encouraged them to be vaccinated.

The questions must be answered obligatorily, except for those that are not compatible with the subject's answers.

The information collected will only be used for research purposes. The anonymity of the persons who have collaborated is guaranteed.

The transcription of the complete questionnaire as provided to the subjects is attached in the appendix.

## Tests

### S-GG lottery test

In order to determine how individuals behave when faced with risky decisions, we have used the S-GG lottery test. In the measurement of this social characteristic, the use of the famous Holt and Laury test usually predominates; however, we will now explain why in our case it is more beneficial to use the S-GG.

The main difference lies in the fact that the test we have opted for is two-dimensional in nature, so that we can both calculate the mean of individuals when making such decisions and see how susceptible they are to variations in risk. In addition, this test has no inconsistency problems.

The fact that we use four panels of lotteries means that the information we can gather from each observation of a given individual is much richer and more complete than in the case of HL.

We can investigate how the payoffs alternate according to how the risk increases. If we start from the safest lottery, which is on the far left of each of the four panels, this choice gives us a payment called  $c$ , which is equivalent to 1€. As we advance in the panel we observe how the prize will be higher at the cost of a lower probability of success, this variation is completely linear. In addition, there is another coefficient,  $t$ , which also increases as the experiment progresses.

All of the above can be found in the following mathematical expression that tells us how to calculate the expected value of each of the possible choices:

$$p \cdot X = c + t \cdot (1 - p)$$

By making the pertinent changes we obtain the following table:

*Table 1: S-GG Lottery test*

<b>Panel 1</b>										
$p$	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
$x$	1,00 €	1,12 €	1,27 €	1,47 €	1,73 €	2,10 €	2,65 €	3,57 €	5,40 €	10,90 €
$r$	0.091	0.082	0.073	0.064	0.055	0.045	0.036	0.027	0.018	0.009
<b>Panel 2</b>										
$p$	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
$x$	1,00 €	1,20 €	1,50 €	1,90 €	2,30 €	3,00 €	4,00 €	5,70 €	9,00 €	19,00 €
$r$	0.5	0.45	0.4	0.35	0.3	0.25	0.2	0.15	0.1	0.05
<b>Panel 3</b>										
$p$	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
$x$	1,00 €	1,67 €	2,50 €	3,57 €	5,00 €	7,00 €	10,00 €	15,00 €	25,00 €	55,00 €
$r$	0.833	0.75	0.667	0.583	0.5	0.417	0.33	0.25	0.167	0.083
<b>Panel 4</b>										
$p$	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
$x$	1,00 €	2,20 €	3,80 €	5,70 €	8,30 €	12,00 €	17,50 €	26,70 €	45,00 €	100,00 €
$r$	0.909	0.818	0.727	0.636	0.545	0.455	0.364	0.273	0.182	0.091

Thus, from the choices we can obtain two variables, their mean and the sensitivity of the probability choice to increases in the value of the prize:

- $\bar{p} = \frac{\sum_{i=1,2,3,4}^4 p_i}{4}$
- $\overline{\Delta p} = 0.6(p_1 - p_4) + 0.3(p_2 - p_3)$

Regarding the second equation, it should be noted that the implementation of these coefficients (0.6 and 0.3) are weights obtained from the project The lottery-panel task for bi-dimensional parameter-free elicitation of risk attitudes by Aurora García-Gallego, Nikolaos Georgantzís, Ainhoa Jaramillo-Gutiérrez and Melanie Parravano.

## Dictator Game

In order to quantify the level of altruism of the individuals participating in the experiment and to be able to relate it later to the decision to be vaccinated or not, we have implemented a task based on the dictator game. This game is a descendant of the previous ultimatum game, with the difference that, in the latter, the receiver of the money can decide, while in the dictator game he cannot.

As the game instructions indicate, there are two participants, the dictator and the receiver. The dictator is endowed with an initial amount of money on which he will have to decide how much of it he wants to donate to the receiver (if he wants to donate it at all). Therefore, the receiver has a purely passive role, accepting the amount that the dictator offers him.

For our experiment, a modified dictator game has been used. As mentioned before, the non-interactive game is that in which there is just one player and the recipient has a passive role, so just one dictator exists. The game is that the only payment the dictator receives is what they decide not to offer to the recipient. The name of the recipient is also modified, since the individual is not told to give money to another individual but to a cancer association. This was designed with the aim of appeal to one's feelings.

Our modified dictator game is altered by two parts, the starting amount assigned to the player, and the receiver.

Typically, in the experiments that occupy this test, the player's endowment is €10. According to the literature, we have found that as this amount is increased, the subject tends to be increasingly greedy and therefore his donation in average term is lower, *Larney, Rotella and Barclay* (2019).

On the other hand, the purpose of modifying the recipient by choosing to allocate the contribution to a cancer association, as mentioned above, is to appeal to the sensitivity of the participants.

Thus, we have two modifications whose strengths contradict each other. A comparison between the average donation of an ordinary dictator game and this modified dictator game shows very striking differences.

Engel (2011) shows that the average donation could be around 28.35% and in our test we obtain an average of 80.90%. As we can see, the effect of greed caused by the modification of the initial endowment is not even able to counteract the effect of the modification of the recipient. We obtain an average almost three times higher with these changes.

Countless research and experiments have been conducted on the dictator game and its various implications. Since many factors have been shown to influence dictator donation, the results we can obtain by not controlling subjects in an experimental laboratory may be different. In fact, List (2007) shows that donation increases when the physical presence of the experimenter is given while it is being performed. The fact that the payments are not real also influences the amount that the dictator decides to donate, being higher (Engel (2011)).

## CRT-Long

Frederick's Cognitive Reflection Test (CRT) developed in 2005 is a tool that measures an individual's ability to discard a presumably convincing answer and reflect further on the question asked as this may lead the subject to find the correct solution.

A crucial limitation of the CRT is that it can discriminate strongly between subjects, which means that it may not be able to provide much information about the cognitive ability of the test takers.

In order to mitigate this effect, The Development and Testing of a New Version of the Cognitive Reflection Test Applying Item Response Theory (IRT) developed by Primi et. al. (2016) poses a series of additional questions and provides evidence of the suitability of this new project to better analyze the cognitive abilities of subjects with respect to the original CRT.

For the development of this test it is of vital importance to take into consideration the time spent by each of the subjects who have performed it. In this way, although we have had to do without a large percentage of the sample, with a series of estimates we can deduce how long it took them to perform the test.

## Procedures

The questionnaire was developed using the Google Forms platform. The only prerequisite was that the participant had to have an e-mail address, since the time spent answering the form was to be monitored.

The target audience was completely open, anyone, whoever they were, could do it. In addition, the requirement to provide an e-mail address was motivated simply so that when the questionnaire was completed, the website would know who was answering the questions in order to join both parts in a spreadsheet to have all the data unified. Thus, once this task was completed, a code was assigned to each participant in order to guarantee anonymity.

In order to comply with this premise, the questionnaire was divided into two parts: the first would be composed of sociodemographic questions and the second part would contain all the tests used to carry out the experiment.

In the initial explanation, it was commented that this task was part of a Final Degree Project, so that the payments promised in each section of this would be hypothetical.

## RESULTS

### Descriptive summary statistics

Table 2: Main summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Female	92	.5978261	.4930235	0	1
Churchgoer	92	.3913043	.4907165	0	1
Christianism	92	.3804348	.488154	0	1
Covid-19 vaccine	92	2.380435	.8495945	0	4
Non-mandatory dose	92	.4891304	.5026209	0	1
Solidarity	92	7.271739	1.267543	4	10
Risktaking	92	4.967391	2.783196	1	10
Donation	92	16.17935	5.396673	0	20
CRT	92	2.315217	1.809191	0	6
Time (min)	81	18.667	19.620	4	120
Intrinsic motivation	88	.7045455	.4588614	0	1

Our sample consisted of a total of 92 individuals; however, when we wanted to monitor the time spent answering the questionnaire and therefore divide it into two parts, there was a notable difference between the people who answered the first part (140 people) and those who finally completed the whole process. More than a third of the main sample had to be discarded.

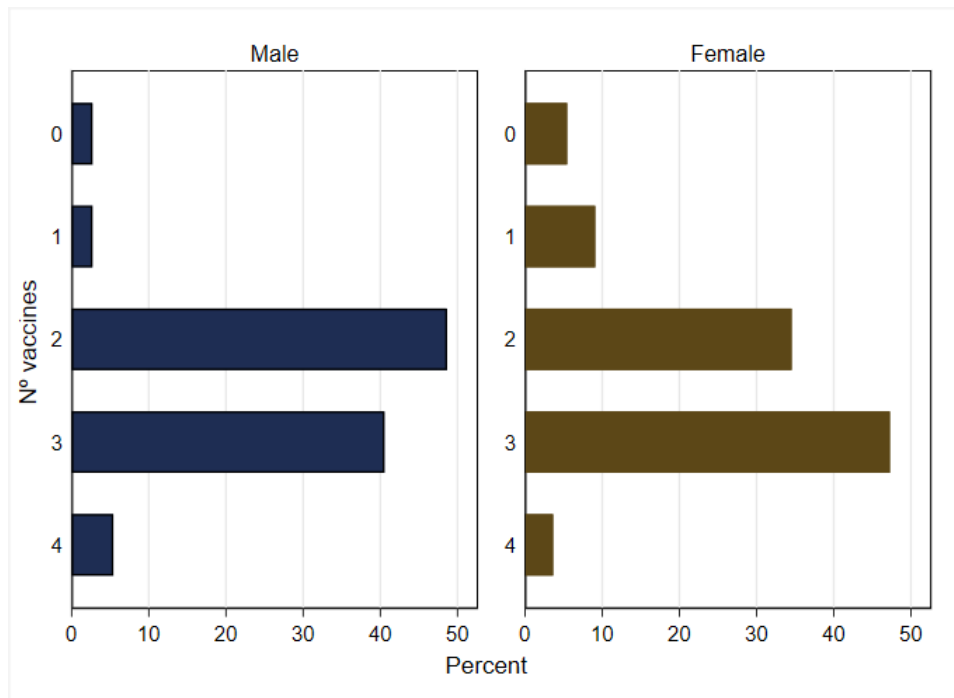
As we can see, the observations in the table above are very even. In the case of the two variables that do not agree with the rest, the reason will be explained later. A total of 92 individuals have answered the form provided and thanks to this we have been able to collect their data. As regards the variable Time, a number of observations had to be eliminated because they were atypical data which greatly distorted the results. As for the variable Intrinsic motivation, this variable includes the incentives that have been determinant in the subjects' decision to get vaccinated. Thus, as in the total sample we had 4 people who had not received any of the 4 Covid-19 vaccine guidelines, they were not taken into consideration in this particular case.

On the other hand, the next aspect to comment on is the averages obtained from the analysis of the observations. 59.78% of the people who answered the questionnaire were women. Of the total sample, 39.13% acknowledged that they practiced any religion, but 38.04% were Christian.



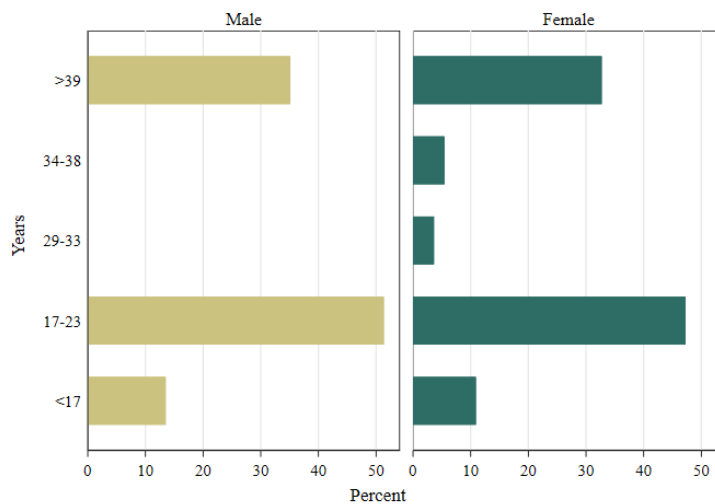
With the analysis of the following 2 variables, we will use a graph to make the interpretation more visual.

Figure 1: Number of vaccines by gender



In Spain, a total of 4 doses of the Covid-19 vaccine have been administered to citizens who have wanted to receive this injection. Looking at the graph, we can see that most people have received between two and three vaccines. With regard to the gender difference, the number of doses received is predominantly two for men. However, this number is not the same for women, as they have generally chosen to receive one more dose.

Figure 2: Age and gender



With the extremes (0 and 4 vaccinations received) being the least frequent values, we observe that it is more common for women not to have wanted to be vaccinated and, in contrast, there is a higher percentage of men who have decided to complete the entire vaccination schedule. This could have occurred because the age of the men was higher than that of the women, since according to the literature it is more common for individuals to receive more doses the older they are. In our case, as we can see in the graph above, this premise does not hold true. Therefore, these differences cannot be explained by age.

On the other hand, 48.91% of the total have received the guidelines, called “booster” by the health authorities themselves. These, unlike the first two, did not count towards obtaining the Covid-19 passport, without which the individual’s social life would be reduced, as it was required for most leisure activities and even transport.

When asked how supportive they considered themselves to be on a scale of one to ten, the average was around seven.

The next variable to be discussed is Risktaking, whose values are obtained through a series of lotteries in order to determine how likely the subject is to be classified as a risk-taker. The result obtained is consistent with the literature discussed above given that the lottery chosen on average is the one closest to the fifth, adopting a risk-neutral position.

Donation is the answer to the question of how much of the twenty euros I would donate to a cancer charity. Obtaining an average of around sixteen euros.

The variable CRT computes the number of correct questions in the cognitive intelligence test, with a maximum of six, the average of the subjects is 2.13.

Time is the variable that shows how long it took the subjects to answer the second part of the questionnaire, consisting of the risk aversion test, the altruism game and the cognitive intelligence test. Having removed the outliers, we obtain an average of approximately 19 minutes.

Finally, if we analyse Intrinsic motivation, we observe that more than 70% of people who have received at least one vaccine did so because of an endogenous incentive. In other words, the decision to be vaccinated was not due to social pressure or a possible obligation.

Two variables could not be included in the table because they had been ordered according to their own considerations. Thus, the results obtained lacked logic. In the following tables, these two variables will be presented:

Table 3: Age proportion table

Age	Proportion	Standard Error	Logit [95% Conf. Interval]	
1	.1195652	.0338265	.0669294	.2045223
2	.4891304	.0521163	.3875147	.5916525
3	-	-	-	-
4	.0217391	.0152039	.0053422	.0842032
5	.0326087	.0185171	.0103945	.0976141
6	.3369565	.0492792	.2469355	.4405945

1= <17 years, 2= 17-23 years, 3= 24-28 years, 4= 29-33 years,  
5= 34-38 years, 6= >39 years

The age of the subjects in the sample is mainly between two ranges: 17-23 years old and over 39 years old, with a proportion of 48.91% and 33.7% respectively.

On the other hand, these individuals either have or are currently studying: Secondary School 15.22%, Baccalaureate 13.04%, TYD 26.09%, University degree 36.96% and Postgraduate studies 8.7%.

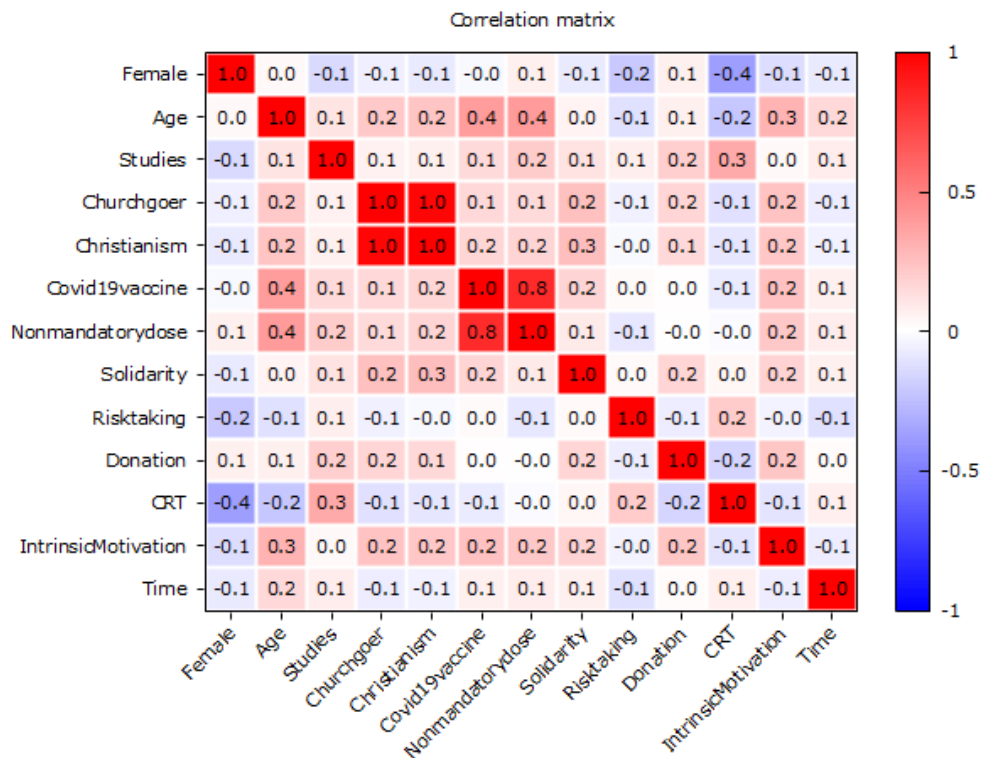
Table 4: Studies proportion table

Studies	Proportion	Standard Error	Logit [95% Conf. Interval]	
1	.1521739	.0374481	.0916035	.24212
2	.1304348	.0351119	.0750183	.2171763
3	.2608696	.0457803	.1804832	.361276
4	.3695652	.0503236	.2762526	.4737646
5	.0869565	.0293767	.0436739	.1657015

1= Secondary School, 2= Baccalaureate, 3= TYD, 4= University degree,  
5= Postgraduate studies

## CORRELATIONS

Figure 3: Correlation matrix



As we can see from the correlation matrix, the correlation matrix does not show very high values in absolute terms. This may be mainly due to the fact that the sample size can be considered small and may not be sufficient to determine how the variables behave with respect to each other.

Ignoring this limitation, one would expect predictable results before the matrix is constructed. The number of vaccinations against Covid-19 and the fact of having received booster doses are among the variables with the greatest statistical strength when it comes to the age variable. These results were to be expected given that it is common knowledge that awareness of vaccinations increases with increasing age, due to possible complications in the event of contracting the disease and the assumption of greater risk in the event of not being administered these guidelines.

As for the Churchgoer and Christianity variables, we can see that they are also moderately correlated with Solidarity, this variable having been created with the data obtained from the question asked of the subjects in the questionnaire: "How supportive do you consider yourself to be". It is true that believers are normally thought to have

more inculcated values in relation to concern for people with fewer resources, and it would be expected that this correlation would have a positive coefficient.

On the other hand, we highlight the correlation between the level of education attained and the number of correct answers obtained in the CRT. Again, this result is not insignificant, since the probability of obtaining a better score will be greater when the intellectual background is more extensive.

If we now focus on the negative coefficients, we will analyse the three effects that predominate over the rest.

The first effect to comment on is the negative correlation between CRT and Female. Brañas-Garza, Kujal, and Lenkei (2019) have concluded that this statement. This is consistent with findings from the experimental literature indicating that males are more skilled in mathematics than females.

Next, and in accordance with the literature, the relationship between Female and Risktaking. These two factors have been studied on countless occasions, leading to the conclusion that females are less likely to be risk takers.

Finally, if in the analysis of the positive correlations we have commented on the favourable effect of the level of studies achieved with the results obtained in the CRT test, we now see how the result of this as a function of age is negative. Moreover, we can also see that the resulting coefficient of Age and Studies is slightly positive. Thus, there is no logical reason to argue for this result.

## Risk taking

The regression is composed of a continuous dependent variable, Risktaking, and twelve explanatory variables of which Female, Churchgoer, Christianity, Non Mandatory Dose, Intrinsic Motivation are dichotomous.

The objective of the construction of this economic model is to try to demonstrate whether risk aversion is explained by some sociodemographic characteristic of the subjects who have collaborated in this study.

The estimation is shown below:

$$Risktaking_i = \beta_0 + \beta_1 Female_i + \beta_2 Age_i + \beta_3 Studies_i + \beta_4 Churchgoer_i + \beta_5 Christianity_i + \beta_6 Covid19Vaccine_i + \beta_7 NonMandatoryDose_i + \beta_8 Solidarity_i + \beta_9 Donation_i + \beta_{10} CRT_i + \beta_{11} Time_i + \beta_{12} IntrinsicMotivation_i + u$$

Table 5: OLS Regression by Risktaking

VARIABLES	(1) Model_1 Risktaking
Female	-0.590 (0.105)
Age	-0.0612 (0.0443)
Studies	0.118 (0.0513)
Churchgoer	-4.062 (0.716)
Christianism	3.860 (0.677)
Covid-19 Vaccine	0.642 (0.196)
Non-Mandatory Dose	-1.471 (0.266)
Solidarity	-0.0905 (0.0412)
Donation	-0.0270 (0.0523)
CRT	0.147 (0.0957)
Time	1.67e-05 (0.0209)
Intrinsic Motivation	0.1358 (0.7411)
Constant	3.895
Observations	88
R-squared	0.098

Normalized beta coefficients in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

In this regression we have included all the possible variables that we had created.

If we interpret the sign obtained by each of the variables, we can see that being a woman, being older, being a practitioner of any religion, not having received the Covid-19 booster doses, solidarity and contributing less to charity all have a negative sign.

On the other hand, that the individual has attained a more advanced level of education, is considered a practicing Christian, has received the Covid-19 vaccination guidelines and has obtained a better score on the intelligence test all translate into a positive relationship with risk taking.

In relation to the literature on this factor, risk aversion, being an innate human quality, cannot be defined by any parameter. This is in agreement with the results obtained from the regression, since none of the twelve explanatory variables is significant at least at the 10% significance level.

## Donation

For this analysis we have constructed an econometric model which includes the variables that, as shown in the graph of the correlation matrix, may a priori have the most significant effects on contributions to donation. This variable was obtained through the experiment when the subjects were asked how much they were willing to donate to a charity.

Although many of the variables to be included in the regression have been shown to be determinant in influencing donation, we analyze the effect that receiving the Covid-19 vaccine may have on it.

In this way, we obtain an equation in which the explanatory variables are the following:

$$Donation_i = \beta_0 + \beta_1 Age_i + \beta_2 Studies_i + \beta_3 Covid19Vaccine_i + \beta_4 CRT_i + \beta_5 Intrinsic Motivation_i + u$$

Table 6: OLS regression by Donation

VARIABLES	(2) Model_2 Donation
Age	-0.142 (-0.0531)
Studies	1.241** (0.281)
Covid-19 Vaccine	-0.926 (-0.118)
CRT	-0.736** (-0.247)
Intrinsic Motivation	2.759** (0.233)
Constant	14.92***
Observations	88
R-squared	0.143

Normalized beta coefficients in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

If we focus on analyzing the resulting signs, we observe that people who have attained a higher level of education and who are motivated to act for internal reasons will be more generous when it comes to donating.

On the other hand, age, the fact of being more sympathetic to the Covid19 vaccination guidelines and having a higher cognitive intelligence cause the amounts donated by these profiles to be lower.

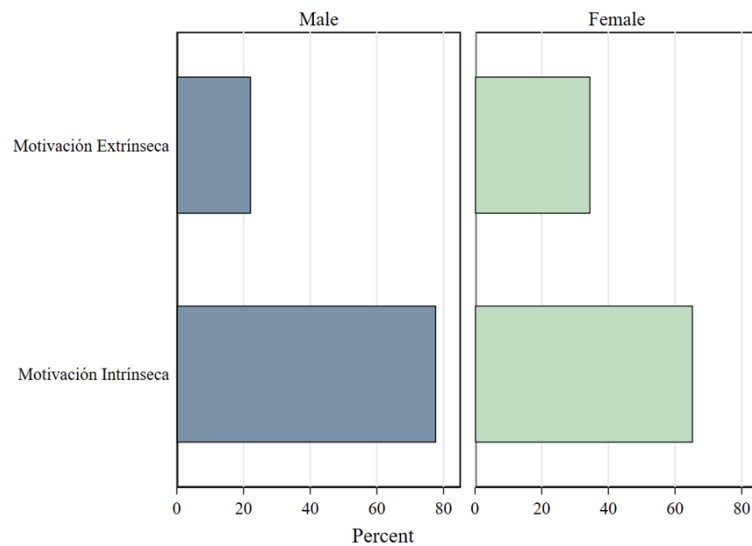
When analyzing the level of significance acquired by the variables belonging to this model, we find that 3 out of the 5 independent variables have turned to have significant effects on donation. First, we obtain that the higher the education received by the individual, the higher they contribute to a donation, being true that the statements of more educated people who are guided by their own arguments are more likely to donate an amount greater than 95% certainty. In contrast, people with greater cognitive development will be less likely to make more generous contributions, also at the same level of evidence, what does not seem to be consistent with the existing literature. Lastly, intrinsic motivation has also shown to be significant on the amount of donation, thus meaning that, at 5% level of significance, the fact that one individual is guided by their inner motivation does affect the level of donation.



## Intrinsic Motivation

Before delving into the econometric analysis of this variable, a graph has been provided below which shows both types of motivation by which individuals are guided in certain decision making, separated by gender. Broadly speaking, we can see that a higher percentage of both women and men say they are motivated by internal rather than external factors. On the other hand, the percentage of men guided by intrinsic motivation is higher than that of women, and the opposite, to a greater extent, occurs when the motivation is extrinsic.

Figure 4: Intrinsic and Extrinsic Motivation by gender



Finally, in order to determine the reasons that motivate individuals to adopt positions where their own thinking predominates, we have designed an economic model that takes Intrinsic Motivation as the explained variable. Among this equation we included 3 dummy variables (Female, Non Mandatory Dose and Solidarity), and other variables such as Age, Studies, Risktaking, Donation, CRT and Time. Since the Intrinsic Motivation is also a binary variable, our approach will consist of a Logit Model to estimate the effects.

$$\begin{aligned}
 P(\text{Intrinsic Motivation} = 1|X) &= \Lambda(\beta_0 + \beta_1 \text{Female}_i + \beta_2 \text{Age}_i + \beta_3 \text{Studies}_i + \beta_4 \text{Non Mandatory Dose}_i \\
 &+ \beta_5 \text{Solidarity}_i + \beta_6 \text{Risktaking}_i + \beta_7 \text{Donation}_i + \beta_8 \text{CRT}_i \\
 &+ \beta_9 \text{Time}_i + u)
 \end{aligned}$$

Regarding the signs of the coefficients of the variables, at first glance we observe that the fact of being a woman may have a negative effect on intrinsic motivation, which could mean that an individual is less likely to be guided by intrinsic motivation because she is a woman. The same is true for educational level, which seems to have a negative influence on having intrinsic motivation. Also with a negative sign we find the variables Risktaking and CRT, because both the higher preference for risk and intelligence will have a decreasing effect on the probability that the individual will be guided by this type of motivation.

Table 7: Logit regression by Intrinsic Motivation

VARIABLES	(1) Model_3 Intrinsic Motivation
Female	-1.289* (-1.389)
Age	0.362** (1.597)
Studies	-0.163 (-0.437)
Solidarity	0.285 (0.765)
Risktaking	-0.00388 (-0.0234)
Donation	0.108** (1.282)
CRT	-0.125 (-0.496)
Time	5.10e-05 (0.226)
Constant	-2.793
Observations	88

Normalized beta coefficients in  
parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

From the results provided by this Logit model we obtain that Female, Age and Donation all have significant effects when it comes to influencing intrinsic motivation. The likelihood that the person will be guided by own arguments will increase when she is female, given a significance level of 10%. At a significance level of 5%, age has also been shown to be relevant so that older age increases the likelihood of being driven by intrinsic motivation. On the other hand, how tall the individual is will also increase the likelihood that the subject will be driven by personal motivations.

However, we have not found evidence that demonstrates the significance of the level of education attained, how supportive the subject considers him/herself to be, and the level of risk aversion in trying to conclude which factors influence intrinsic motivation.

### Global equation

Having analysed each cognitive determinant separately in order to test which factors have significant effects on them, we decided to build an econometric model to see whether unifying statistical forces are able to explain what are the compelling reasons for individuals to be vaccinated against Covid-19.

In this way, we obtain the following equation:

$$Covid - 19 Vaccine_i = \beta_0 + \beta_1 Risktaking_i + \beta_2 Donation_i + \beta_3 Intrinsic Motivation_i + u$$

Table 8: Global regression

VARIABLES	(1) Model 4 Covid-19 Vaccine
Risktaking	-0.0148 (-0.0591)
Donation	-0.0124 (-0.0968)
Intrinsic Motivation	0.394** (0.260)
Constant	2.486***
Observations	88
R-squared	0.070

Normalized beta coefficients in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

In terms of the results achieved, let us first comment on the signs obtained. Both Risktaking and Donation have a negative sign. Although this result could be expected, we do not have enough significance to conclude that it is a relevant factor. On the other hand, the variable Donation, which measures the level of altruism of each subject, obtained a negative sign. This result is far from what we might initially expect, given that more altruistic people should think more about others and be more inclined to get vaccinated. Moreover, this result is not considered significant.

Finally, the determinant of intrinsic motivation can be accepted at a significance level of 95% and its sign is consistent with the rational. People who have been governed by purely self-determined thoughts will be more inclined to get vaccinated because the reason for doing so is personal and not imposed, for example, by government health policies.

## CONCLUSION

As we have seen, it is often difficult to understand people's behavior and decision-making when there is a high level of uncertainty. Although vaccines have been around for a long time, it is true that the Covid-19 pandemic caught most of us unawares. The effects that the vaccine against this virus could have both on the individuals themselves and on society in general were rather uncertain, something that has greatly influenced the decision to be vaccinated or not. This is where the antivaccine current grew and where we have based our analysis.

In analyzing the three main determining factors in deciding whether or not to vaccinate, we have obtained different results.

First of all, let us comment on the results obtained with respect to risk. According to the literature, the conclusions obtained on the factors that determine the level of risk propensity indicate that no single component can explain the level of risk preference, as it is a quality specific to each individual. This attribute can be influenced by so many factors that it is very difficult to determine its drivers. In addition, the way in which information about possible choices is presented also plays an important role and thus conditions the individual's decision, a concept introduced by Kahneman and Tversky 1981 (framing effect).

The second result we obtained refers to altruism. The positive significance of the level of donation studies in the dictator game indicates that, as expected from the literature, as age increases, individuals become more altruistic. This result is in line with Engel's (2011) research. The next element to comment on in this econometric model is cognitive ability and how it affects individuals' level of altruism. Although the results are often ambiguous, in our case they are consistent with those of Tetsuya and Kazuhito (2019) in which intelligent individuals are more likely to donate larger amounts. Finally, the results show how intrinsic motivation positively affects altruism. This is corroborated by Warneken and Tomasello in 2009 when in their study they found that both infants and primitive humans, i.e. primates, engage in altruistic behaviour even if they are not consciously aware of it. This verifies that altruism is understood as an intrinsic quality of living beings.

Moreover, intrinsic motivation this time as a dependent variable and not as an explanatory variable is given by: Female, Age and Donation. The fact of being female reduces the likelihood that the motives for action are their own, and they behave on extrinsic grounds to a greater extent than men. On the other hand, if we talk about how age affects this parameter, we see that the relationship is direct. This may be due to the fact that when we are younger, when it comes to carrying out any activity, we are more motivated by external factors such as the approval of others. On the other hand, as we get older, we are driven by our own motivations.

To conclude, we have included all these variables: Risktaking, Donation and Intrinsic motivation in a model in order to determine how they affect the number of vaccine doses individuals receive. The results show that only intrinsic motivation can be considered as a cognitive determinant of the decision to be vaccinated or not. The reason why only this variable was able to explain the decision may be due to the fact that these conclusions were drawn from a small sample with little representation from the anti-vaccine group. We are in a developed country where the availability of vaccine supply has been high compared to other regions. Also, the role played by the government has been crucial in achieving remarkably high vaccination rates: more than 85% of the Spanish population has the full regimen (2 first doses) and 56% the booster doses.

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# APPENDIX

## TRANSCRIPTION FORM

Welcome to this experimental session. Thank you very much for your collaboration in our research. The purpose of this experiment is to study how people make decisions in different economic contexts.

The instructions are simple; please follow them carefully.

For the completion of this questionnaire you will have 2 forms, you must complete this questionnaire and then access through the link that will be provided at the end of the survey in order to continue with the experiment.

### **PART 1**

Gender:

- Male
- Female

Age:

- <17 years
- 17 - 23 years old
- 24 - 28 years old
- 29 - 33 years old
- 34 - 38 years old
- > 39 years old

Level of education attained:

- E.S.O.
- Baccalaureate
- Training cycle
- University studies
- Postgraduate studies

Do you practice any religion?

- Yes, I do
- No, I do not

If yes, please specify which one:

- Christianity
- Islam
- Hinduism
- Other

Have you received any doses of Covid-19 vaccine?

- Yes
- No

If yes, how many?

- 1
- 2
- 3
- 4

What factors have encouraged you to get vaccinated?

- Open answer

If you have not received any doses, what factors have encouraged you NOT to be vaccinated?

- Open answer

Please indicate, in your opinion, how supportive you consider yourself to be on a scale of 1-10.

## PART 2

You should answer the following questions:

1. A bat and a ball cost €1.10 in total. The bat costs \$1.00 more than the ball. How much does the ball cost? \_\_\_\_\_ cents.
2. If it takes 5 machines 5 minutes to make 5 machines, how long would it take 100 machines to make 100 machines? \_\_\_\_\_ min.
3. In a lake there is an area covered with water lilies and every day that area doubles in size. If it takes 48 days to cover the lake, how long does it take to cover half the lake? \_\_\_\_\_ days.
4. If three elves can wrap three toys in one hour, how many elves does it take to wrap six toys in 2 hours? \_\_\_\_\_ elves.
5. David got both the 15th highest and 15th lowest grades in the class. How many students are in the class? \_\_\_\_\_ students.
6. If you flip a coin three times, what is the probability that it will come up "heads" at least once?  
"heads" at least once? \_\_\_\_\_ %

## PART 3

Indicate the lottery you would choose knowing that it is subject to your given probability of success:

	PANEL 1									
LOTERÍA	1	2	3	4	5	6	7	8	9	10
PROB.	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
€	1.00	1.10	1.30	1.50	1.70	2.10	2.70	3.60	5.40	10.90

- Lottery 1
- Lottery 2
- Lottery 3
- Lottery 4
- Lottery 5

- Lottery 6
- Lottery 7
- Lottery 8
- Lottery 9
- Lottery 10

Indicate the lottery you would choose knowing that it is subject to your given probability of success:

PANEL 2										
LOTERÍA	1	2	3	4	5	6	7	8	9	10
PROB.	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
€	1.00	1.20	1.50	1.90	2.30	3.00	4.00	5.70	9.00	19.00

- Lottery 1
- Lottery 2
- Lottery 3
- Lottery 4
- Lottery 5
- Lottery 6
- Lottery 7
- Lottery 8
- Lottery 9
- Lottery 10

Indicate the lottery you would choose knowing that it is subject to your given probability of success:

PANEL 3										
LOTERÍA	1	2	3	4	5	6	7	8	9	10
PROB.	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
€	1.00	1.70	2.50	3.60	5.00	7.00	10.00	15.00	25.00	55.00

- Lottery 1
- Lottery 2

- Lottery 3
- Lottery 4
- Lottery 5
- Lottery 6
- Lottery 7
- Lottery 8
- Lottery 9
- Lottery 10

Indicate the lottery you would choose knowing that it is subject to your given probability of success:

PANEL 4										
LOTERÍA	1	2	3	4	5	6	7	8	9	10
PROB.	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
€	1.00	2.20	3.80	5.70	8.30	12.00	17.50	26.70	45.00	100.00

- Lottery 1
- Lottery 2
- Lottery 3
- Lottery 4
- Lottery 5
- Lottery 6
- Lottery 7
- Lottery 8
- Lottery 9
- Lottery 10

#### **PART 4**

In this decision we give you 20 euros to share between you and a cancer charity. You can donate as much of these 20 euros as you want, i.e. you can donate nothing, all or part of it. The part that you do not donate to the association will belong to you, this payment being hypothetical.

- How much do you donate to the association? \_\_\_\_ euros.