WILLINGNESS TO GET VACCINATED AGAINST COVID-19

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WILLINGNESS TO GET VACCINATED AGAINST COVID-19

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Key Findings

- The paper develops a tractable two-period model on the vaccination decision and based on the model results formulates hypotheses on the effects of discount factors, risk aversion, information about the disease, the trust towards the health system and health insurance on the willingness to accept the vaccine.

- The analysis uses data from a nationally representative unique survey conducted in Armenia, which among others includes a question on the willingness to accept vaccine against COVID-19.

- The estimation results suggest that the individuals with lower trust towards the health system have a lower willingness to accept the vaccine. Having health insurance increases propensity to accept the vaccine, while neither risk aversion nor subjective information about the coronavirus disease affect that decision. The discount factor is found to have a positive relationship with the willingness to accept vaccine, but it turns insignificant in robustness checks. As compared with exponential discounters, the present- and future-biased individuals behave no differently.

- Number of covariates are included in the analysis, and significant association is found between willingness to get vaccination and employment, gender, education and marital status.

1. Introduction

The World Health Organization (WHO) declared COVID-19 disease a pandemic in March 2020. The disease and undertaken restrictive measures have been a major challenge to the health systems and economies of countries. Given these challenges countries were facing, significant resources were directed towards developing a COVID-19 vaccine, and in fact, vaccines have been developed in a very short period of time. Nevertheless, this does not mean that vaccine take-up will automatically follow. People could have doubts about the safety of the vaccine, and if too many individuals hesitate about being vaccinated, the general immunity may not be reached (Neumann-Böhme et al., 2020).

With the aim to investigate the attitude of people towards COVID-19 vaccination, this paper develops a tractable theoretical model for explaining the willingness to accept vaccine. It is based on the Nuscheler and Roeder (2015), where Yaari's (1987) dual theory is used combined with Laibson's (1997) quasi-hyperbolic discounting. The model not only explains the effect of discount factors, risk aversion and information about the disease on the decision to accept the vaccine, but as an extended result it also explains the effects of the trust towards the health system and health insurance on the willingness to accept a vaccine. The hypotheses formulated based on the theoretical model are tested using a data from a nationally representative survey conducted in Armenia. Note that Armenia is one of the developing countries which has been severely affected by the coronavirus disease[1].

The trust towards the health system is found to be positively associated with willingness to accept vaccine. Lower trust towards the health system reduces the likelihood of accepting the vaccine. The individuals with health insurance have higher propensity to accept the vaccine. The effects found for the trust towards health insurance system and availability of health insurance hold in all the estimated models and are highly significant. In the baseline estimations it is found that the future orientation increases the willingness to accept vaccine, but in robustness checks, the association turns insignificant though still positive. Further, in all estimated models, as compared with exponential discounters, the present- and future-biased individuals behave no differently; that is no significant effect is found. The same applies to risk aversion and subjective information.

[1] For example, in November 2020, it was one of the top ten countries in the world most severely hit by the pandemic as measured by the total cases per one million population.

To avoid omitted variables bias, number of covariates are included in the analysis. Significant association is found between willingness to get vaccination and employment, gender, education and marital status. The male respondents are more likely to accept the vaccination if available. The other listed covariates decrease that likelihood.

The paper contributes to the literature on the vaccination. The theoretical model developed is closely related to the one in Nuscheler and Roeder (2016), but it also includes the effects of trust towards the health system, as well as the availability of the health insurance. The paper also contributes to the ongoing literature by studying the factors associated with the willingness of getting vaccinated, in particular, against COVID-19. In that regard it is similar to Mullahy (1999) which examines the micro-determinants for the decision to get the influenza vaccine. Note that it is about the actual decision, while ours is about the intentions to get vaccinated and in the highly uncertain circumstances, where there are also concerns about the vaccine safety itself. Another contribution of this paper is a general description of the current state of willingness to get vaccinated, using survey data, specifically for people living in Armenia, a developing country significantly affected by COVID-19 pandemic. The paper in that regard relates to Neumann-Böhme et al. (2020) and Daly and Robinson (2021) which, considering data from representative surveys, report and discuss the general willingness to get vaccinated in European countries and U.S., respectively.

To the best of my knowledge this is the first paper on the vaccination against the COVID-19, which, among other individual characteristics, considers also the individual heterogeneity in time and risk preferences, information about the disease, trust towards health system and availability of health insurance.

The reminder of the paper is organized as follows. The model is developed in Section 2. Section 3 presents data and the empirical model. The estimation results are reported and discussed in Section 4. Section 5 concludes.

2. Theoretical Model and Hypotheses Formulation

The model is a two-period model ($t = 1$, and $t = 2$). A continuum of individuals normalized to 1 is considered.

If the individual does not get vaccine in period 1, then that individual may contract the virus in both period 1 and period 2. The probability to contract the virus is $\pi_L \in (0,1)$. Catching the virus the individual faces losses denoted by $L > 0$, measured in monetary units. The losses include for instance the lost income, healthcare expenses and other inconveniences. It is assumed that probability to catch the virus is the same in both periods 1 and 2. If we assume that the probability is lower in the period 2, it will not change the main implications of the model.

If the individual gets the vaccine, the probability to catch the virus gets lower, $0 \leq \pi_{LV} < \pi_L$. We include possibility of imperfect protection, as for the COVID-19 case there is still some uncertainty over the effectiveness of the vaccine. The loss incurred if the individual catches the virus is considered the same as without the vaccination, L. If individual gets the vaccine, in period 1 the side effects might occur with probability $\pi_S \in (0,1)$ and in that case, the loss faced is denoted by $S > 0$, measured in monetary units.

Note that it is assumed that the individuals take all the probabilities as given.

Regardless of the decision to get the vaccination, the income levels both in period 1 and 2 are uncertain. Following the Nuscheler and Roeder (2015), the choice between risky alternatives is modelled following the Yaari's (1987) dual theory. Thus, the risk aversion is modelled through distortions of probabilities with income levels considered linear as opposed to expected utility theory where it is modeled with the strictly increasing and concave transformations of income levels while linear in probabilities. Let the distortion of probabilities be denoted by $\phi: [0,1] \rightarrow [0,1]$ with $\phi(0) = 0$ and $\phi(1) = 1$. The risk aversion takes place by overstatement of bad outcomes, that is $\phi(\pi_L) > \pi_L$; $\phi(\pi_s) > \pi_S$, $\phi(\pi_{VL}) > \pi_{VL}$.

Table 1 displays the expected income levels in the current period (period 1) and next period (period 2), where Y_{it} is the earning in period $t = 1, 2$. Given the time is involved, for the comparison between risky alternatives discounting should be made. Following Nuscheler and Roeder (2015), quasi-hyperbolic discounting model is considered (Laibson, 1997). Hence, the discount factor between current and next periods is $\beta\delta$, where $\delta \in (0,1)$ is the discount factor between two consecutive future periods and $\beta > 0$ is called present-bias factor if $\beta > 1$ and future-bias factor if $\beta < 1$. When $\beta = 1$ the discounting model is reduced to the standard (exponential) model.

Table 1. Expected income levels for individual i in period 1 and period 2 dependent on the decision to vaccinate

	$t = 1$	$t = 2$
Vaccinate ($v_i = 1$)	$Y_{i1} - \phi(\pi_S)S$	$Y_{i2} - \phi(\pi_{VL})L$
Do not vaccinate ($v_i = 0$)	$Y_{i1} - \phi(\pi_L)L$	$Y_{i2} - \phi(\pi_L)L$

The utility levels, $U_{it}(v_i)$, in period 1 when individual i gets the vaccination ($v_i = 1$) and does not get the vaccination are as follows:

$$U_{i2}(1) \ = Y_{i1} - \phi(\pi_S)S + \beta\delta(Y_{i2} - \phi(\pi_{VL})L)$$

$$U_{i1}(0) = Y_{i1} - \phi(\pi_L)L + \beta\delta(Y_{i2} - \phi(\pi_L)L)$$

Individual i would be willing to get the vaccination if $U_{i2}(1) > U_{i1}(0)$, which is the case if and only if:

$$\phi(\pi_L)L + \beta\delta L\big(\phi(\pi_L) - \phi(\pi_{VL})\big) - \phi(\pi_S)S > 0 \qquad (1)$$

The condition is less demanding if $\beta\delta$ is higher. Thus the following hypotheses can be formulated.

Hypothesis 1. *The individuals with higher discount factor ($\beta\delta$) have higher willingness to get vaccinated.*

Hypothesis 2. *Compared to intertemporally unbiased individuals ($\beta = 1$), the future-biased individuals ($\beta > 1$) have higher willingness to vaccinate, while present biased individuals ($\beta < 1$) have lower willingness to vaccinate.*

The risk aversion modeled by the distortion of the probabilities of negative events leaves the effect on the condition (1) ambiguous.

Hypothesis 3. *The effect of risk aversion on the willingness to get vaccinated is ambiguous.*

The individual's subjective information about the disease also affects the decision to get vaccinated. If individual is poorly informed about the virus, then the probability of getting infected might be considered lower ($\tilde{\phi}(\pi_L) < \phi(\pi_L)$) and/or in case infected, the loss from infection might be underestimated ($\tilde{L} < L$). For a poorly informed individual the condition (1) is more demanding, hence the next hypothesis is formulated below.

Hypothesis 4. *The poorly informed individuals have lower willingness to get vaccinated.*

The individual's trust towards health care system also matters for the decision to vaccinate. Having lower trust, the individual when vaccinated may attach higher probability to adverse outcome of side effects ($\tilde{\phi}(\pi_S) > \phi(\pi_S)$) and/or to catching the virus in period 2 ($\tilde{\phi}(\pi_{VL}) > \phi(\pi_{VL})$)[2]. Note that this is not about the risk aversion and comes from the fact that individual considers the side effects and infection in period 2 more likely as trust towards the health system is low (for instance, because the quality of health care service is considered low, effectiveness of vaccine is low, etc.). Trust towards the system can also be reflected in the overstatement of the loss of the side effect[3] ($\tilde{S} > S$). Whichever is the approach to model trust, the lower trust implies that the condition (1) is more demanding. Thus the next hypothesis is formulated as follows:

Hypothesis 5. *The individuals with lower trust towards the health care system have lower willingness to get vaccinated.*

The fact that the individual has health insurance or not also can matter for the decision. Specifically, if insured, the individuals might perceive the potential losses from side effects to be lower[4], which implies that the condition (1) is less demanding. Thus, the last hypothesis is given below:

Hypothesis 6. *The individuals who have health insurance have a higher willingness to get vaccinated.*

[2] Note that it is assumed that $\tilde{\phi}(\pi_{VL}) < \phi(\pi_L)$.

[3] We do not consider it for the L, as if infected, the losses incurred are the same no matter if vaccinated or not.

[4] The side effect can be such that it can be covered by the health insurance.

Note that Hypotheses 1-4 are similar to those in Nuscheler and Roeder (2016), while the rest are the extended results of this paper. Next section presents the empirical model and data.

3. Empirical Model and Data

The theoretical framework as discussed suggests that the decision to vaccinate depends on time preferences, risk aversion, informedness about the virus, trust towards the system and health insurance. As the dependent variable VACCINATE is a binary variable, the following probability model is considered:

Prob (Vaccinate=1) = F(time preferences, risk aversion, information, trust, health insurance, controls)

The linear probability model is estimated, as there are also interaction terms in the models. For this model with inherent heteroscedasticity the HC3 robust standard errors are recommended to report to obtain the smallest bias (e.g. Angrist and Pischke, 2009; Nuscheler and Roeder, 2015).

The model is estimated using data from a nationally representative survey conducted in Armenia by Paul Avedisian Center for Business Research and Development at the American University of Armenia[5]. Table 2 details the variables under consideration and Table 3 provides the descriptive statistics of the data. In the next subsections data are discussed starting from the dependent variable.

3.1. Dependent Variable

The dependent variable VACCINATE is a binary variable that has the value 1 if respondent answered positively to the question: "*Will you be ready to get vaccinated against*

5 The potential respondents got an invitation to participate in an online survey through SMS massages on September 27th and December 4th. Respondents were chosen through proportionate stratified random sampling from Yerevan and all other marzes of Armenia.

coronavirus if vaccine available?" and 0, otherwise[6]. As can be noted from the table 26 percent of respondents expressed willingness to accept the vaccine.

Table 2. Variables and their descriptions

Variables	Description
Dependent Variable	
VACCINATE	1 if the person is willing to take COVID19 vaccine, 0 else
Time Preferences	
δ	500/amount requested in 11 years
β	amount requested in 11 years/amount requested in 1 year
$\beta\delta$	500/amount requested in 1 year
PRESENT BIAS	1 if $\beta < 1$, 0 else
EXPONENTIAL	1 if $\beta = 1$, 0 else
FUTURE BIAS	1 if $\beta > 1$, 0 else
Risk attitude	
RISK AVERSION	1 if certainty equivalent is less than expected earnings (125), 0 else
Information measures	
SUBJINFO	1 if feels very good or good informed about the coronavirus disease, 0 else
Trust towards health system	
TRUST HEALTH SYSTEM	Ordinal variable. Fully trust (1); Do not trust at all (5).
Health Insurance	
INSURED	1 if the respondent has a health insurance, 0 else
	Control variables
Risk Factors	
HEALTH	1 if self-rated health is very good, 0 else
AGE	1 If the age of the individual falls in the range specified (five categories: 16-24; 25-29; 30-34; 35-44; 45+), 0 else
HEALTH CARE	1 if health care and social service worker, 0 else
Labor Market	
EMPLOYED	1 if has a paid job, 0 else

6 The question also has an unsure answer option. The dependent variable is set to 0 if the unsure option was selected by the individual. For robustness purpose we treat this differently as well, the results are given in the estimation section.

Table 2 (cont.). Variables and their descriptions

Variables	Description
Other deomographics	
MALE	1 if the respondent is male, 0 if female.
UNIVERSITY DEGREE	1 if the individual holds bachelor's or a higher degree, 0 else.
MARRIED	1 if the respondent is married, 0 else
INCOME	nine categories for income ranging from 0 to 2000000+AMD
HH SIZE	Household size
CHILDREN	1 if has children, 0 else
URBAN	1 if the respondent lives in the urban area, 0 else
STUDENT	1 if the respondent is a student, 0 else
Contact with Covid-19 infected people	
COVID cases around	1 if had infected people in close contact, 0 else

Table 3. Descriptive statistics

VARIABLES	N	mean	Std.Dev.	min	max
VACCINATE	2,605	0.260	0.260	0	1
δ	1,676	0.768	0.768	0.250	1
β	1,672	0.998	0.998	0.262	3.810
$\beta\delta$	1,672	0.750	0.750	0.250	1
PRESENT BIAS	1,672	0.168	0.168	0	0.952
FUTURE BIAS	1,672	0.149	0.149	0	1
RISK AVERSION	1,659	0.234	0.234	0	1
SUBJINFO	2,747	0.632	0.632	0	1
TRUST HEALTH SYSTEM	2,013	2.496	2.496	1	5
INSURED	2,688	0.253	0.253	0	1
HEALTH	2,692	0.322	0.322	0	1
AGE (25-29)	1,768	0.209	0.209	0	1
AGE (30-34)	1,768	0.208	0.208	0	1
AGE (35-44)	1,768	0.240	0.240	0	1
AGE (45+)	1,768	0.133	0.133	0	1
HEALTH CARE	2,800	0.0350	0.0350	0	1
EMPLOYED	2,538	0.554	0.554	0	1
MALE	1,768	0.398	0.398	0	1
UNIVERSITY DEGREE	1,750	0.565	0.565	0	1
MARRIED	1,744	0.627	0.627	0	1
INCOME	1,261	3.234	3.234	1	9
HH SIZE	1,744	4.829	4.829	1	16

Table 3 (cont.). Descriptive statistics

VARIABLES	N	mean	Std.Dev.	min	max
CHILDREN	1,743	0.641	0.641	0	1
URBAN	1,759	0.688	0.688	0	1
STUDENT	1,768	0.119	0.119	0	1
COVID cases around	2,546	0.402	0.402	0	1

3.2. Time Preference and Risk Aversion

The survey elicits the time preference and risk aversion of respondents by asking exactly the same questions as in Nuscheler and Roeder (2015) and using them in the similar manner in the analysis as they do (details are described below). The two questions for the time preferences are as follows:

(i) "Suppose you are given the opportunity to receive \$500 in 10 years or another amount in 11 years. What should be the minimum amount to be paid in 11 years so that you would prefer to wait 11 years than receive \$500 in 10 years?"

(ii) "Suppose you are given the opportunity to receive \$500 today or another amount in 1 year. What should be the minimum amount to be paid in 1 year so that you would prefer to wait 1 year than receive \$500 today?"

The categories from which the choice is made are as follows: 500-550; 551-600; 601-650; 651-700; 701-750 or other amount specified by the respondent. For the analysis the amount was set equal to the middle of the interval, if the respondent chose one of the provided categories. In case a value was entered by the respondent, it was considered as it was with no rearrangement.

The discount factor is calculated as $\beta\delta$= 500/amount requested in 1 year, and the average discount factor is 0.75 in the data.

To elicit the risk attitude of respondents, the following question was asked.

"Suppose you choose between the following two alternatives:

(i) A lottery with a 50% chance of winning \$50 and a 50% chance of winning \$200.

(ii) You are given a certain amount of money without a lottery.

What should be the minimum amount in option (ii) for it to be more preferable to you than the lottery in option (i) described?”

The answer categories were 90-100; 101-110; 111-120; 121-130; 131-140; 141-150 or other amount specified by the respondent. Again the same approach is adopted: if the categories are selected, the middle of the interval is considered, otherwise the amount entered.

The variable RISK AVERSION is equal to 1 if the certainty equivalent of the lottery indicated by the respondent is less than expected earnings (125) and 0, otherwise. Around 23 percent of respondents are risk averse.

3.3. The Subjective Information

The respondents rated how well they are informed about the coronavirus disease. Five categories were provided to make the choice from (from very good to very bad), as well as an option was available if the respondent found it difficult to answer. The variable used in the analysis is constructed to be equal to 1 if respondent feels informedness about the coronavirus disease is very good or good, 0 else. This is only subjective assessment and can differ from the objective reality. The 63 percent of respondents rate themselves as being good or very good informed about the coronavirus disease.

3.4. Trust Towards Health System

The respondents were asked to indicate their level of trust towards the health system. The choice was to be made from five categories from the “fully trust” (1) to “do not trust at all” (5). Regarding the trust towards the health system the average is closer to the neutrality, but with a closer look 80 percent have indicated a level of trust varying from full trust to neutrality.

3.5. Health Insurance

The individuals were also asked if they have health insurance or not. 25 percent indicated having health insurance.

3.6. Control Variables

We consider a number of control variables, categorizing them into groups. In particular, under risk factors we consider age and health, the latter of which is a self-reported indicator. The average age in the data set is 33. Table 3 provides descriptive statistics for considered age categories. Around 32 percent of respondents rated their health level as very good. Also, we consider in the risk factor group those working in the health care and social service sectors. However, note that it constitutes only around 4 percent of respondents[7]. As for labor market status, around 56 percent of respondents indicate having a paid job.

Considering other demographic factors, 41 percent of respondents are men, 58 percent of respondents indicate holding a bachelor's or higher degree and 63 percent are married. The income of 82 percent of respondents (out of 1502) is in the range of 120001 – 192000AMD. 70 percent of respondents reside in urban areas. Around 41 percent of respondents indicate having coronavirus-infected people in their close contacts.

4. Estimation Results

The estimation results are displayed in Table 4. In all regressions, the heteroskedasticity of residuals is accounted for by reporting the robust HC3 standard errors.

In terms of time preferences, the results in the models 2-4 suggest that there is a significant positive association between the discount factor and the likelihood of the willingness to accept the vaccine. This is in line with the Hypothesis 1: future orientation leads to higher willingness to accept vaccine. Models 3-4 also test the Hypothesis 2 on whether the present and future-biased individuals behave any differently than the exponential discounters. It is found that there is no such difference. Note that, the bias is interacted with the discount factor, while for the robustness check the estimation is performed also without interaction and results remain the same (see Table A.1., Appendix).

It is found that neither risk aversion nor subjective information about the disease are significantly related with the propensity to vaccinate, which means that no evidence is found in support of Hypothesis 3 and 4.

The trust towards the health system turns out to be significantly associated with the likelihood of willingness to accept the vaccine. Thus, a firm support is found for

[7] It is around 7.4 percent of those who have job and responded to the question on their job sector.

Hypothesis 5. The final conjecture, Hypothesis 6, states that the insured individuals are more likely to accept vaccination. In line with this hypothesis a significant positive association is found. These results persist across all models.

Note that to avoid the omitted variable bias, all the estimated models include control variables. In terms of the effects of control variables, estimation results show that there is a significant association between willingness to get vaccination and employment, gender, education, marital status. The male respondents are more likely to accept the vaccination if available. The other covariates in the list decrease that likelihood. In particular, education, i.e. holding bachelor's or higher degree, decreases the likelihood of acceptance of the vaccine, and it might probably be due to concerns about vaccine safety.

Table 4. Estimation results

Variables	Model 1	Model 2	Model 3	Model 4
$\beta\delta$		0.19**	0.20**	0.19**
		(0.08)	(0.08)	(0.08)
$\beta\delta$ ×PRESENT BIAS			0.04	0.03
			(0.05)	(0.05)
$\beta\delta$ ×FUTURE BIAS			0.02	0.02
			(0.05)	(0.05)
RISK AVERSION				0.02
				(0.03)
SUBJINFO	0.04	0.04	0.04	0.04
	(0.03)	(0.03)	(0.03)	(0.03)
TRUST HEALTH SYSTEM	-0.05***	-0.05***	-0.05***	-0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
INSURED	0.06**	0.08**	0.07**	0.08**
	(0.03)	(0.03)	(0.03)	(0.03)
HEALTH	-0.01	-0.01	-0.01	-0.01
	(0.03)	(0.03)	(0.03)	(0.03)
AGE (25-29)	0.01	-0.00	0.00	0.01
	(0.05)	(0.05)	(0.05)	(0.05)
AGE (30-34)	-0.04	-0.06	-0.05	-0.05
	(0.05)	(0.05)	(0.05)	(0.05)
AGE (35-44)	-0.06	-0.07	-0.07	-0.06
	(0.05)	(0.05)	(0.05)	(0.05)
AGE (45+)	-0.03	-0.05	-0.04	-0.04
	(0.05)	(0.05)	(0.05)	(0.05)

Table 4 (cont.). Estimation results

Variables	Model 1	Model 2	Model 3	Model 4
HEALTH CARE	-0.01	-0.01	-0.01	-0.01
	(0.06)	(0.06)	(0.06)	(0.06)
EMPLOYED	-0.07**	-0.07**	-0.07**	-0.07**
	(0.03)	(0.03)	(0.03)	(0.03)
MALE	0.15***	0.14***	0.14***	0.14***
	(0.03)	(0.03)	(0.03)	(0.03)
UNIVERSITY DEGREE	-0.09***	-0.08**	-0.08**	-0.08**
	(0.03)	(0.03)	(0.03)	(0.03)
MARRIED	-0.12***	-0.11***	-0.11***	-0.11***
	(0.04)	(0.04)	(0.04)	(0.04)
INCOME	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
HH SIZE	-0.00	-0.00	-0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)
CHILDREN	0.07	0.06	0.06	0.06
	(0.04)	(0.04)	(0.04)	(0.04)
URBAN	-0.05	-0.05	-0.05	-0.05
	(0.04)	(0.04)	(0.04)	(0.04)
STUDENT	0.05	0.04	0.04	0.05
	(0.05)	(0.05)	(0.05)	(0.05)
COVID cases around	0.01	0.01	0.01	0.01
	(0.03)	(0.03)	(0.03)	(0.03)
Constant	0.43***	0.30***	0.29***	0.29**
	(0.09)	(0.11)	(0.11)	(0.11)
Marz F.E.	Yes	Yes	Yes	Yes
Observations	1,224	1,203	1,203	1,194
R-squared	0.10	0.11	0.11	0.10
F-Stat	4.636	4.629	4.381	4.133
Prob > F	0	0	0	0
Degree of Freedom	1192	1170	1168	1158

Robust HC3 standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1

In Table 4 the dependent variable has been constructed in a way that it takes on value 1 if the respondent has answered the question positively and 0 otherwise. Note, however, that the question has not only an answer option “No”, but also “Unsure”, which means that these two answers are treated identically in Table 4. For the robustness check next the following values for the dependent variable are considered: 1 - “No”, 2 - “Unsure”, 3 - “Yes”. Given this definition of dependent variable, an ordered logit model is estimated and results are reported in Table 5. The estimated odds ratios are reported to facilitate the interpretation of results. A value above one indicates that a given covariate increases the likelihood of willingness to get vaccinated, while a value below one decreases it. The further the value is from one, the stronger the association. In all regressions, potential heteroskedasticity of residuals is accounted for by reporting the robust standard errors. Note that the discount factor does not have a significant association with the willingness to the accept the vaccine, while the results obtained for the other hypotheses survive. This exercise serves also as the robustness check for the obtained estimates.

Table 5. Estimation results of the ordered logit model

Variables	Odds ratio
$\beta\delta$	1.601
	(0.572)
$\beta\delta$ ×PRESENT BIAS	1.208
	(0.238)
$\beta\delta$ ×FUTURE BIAS	1.251
	(0.239)
RISK AVERSION	1.082
	(0.144)
SUBJINFO	1.223
	(0.153)
TRUST HEALTH SYSTEM	0.715***
	(0.036)
INSURED	1.392**
	(0.181)
HEALTH	0.706**
	(0.099)
AGE (25-29)	1.059
	(0.217)
AGE (30-34)	0.778
	(0.164)
AGE (35-44)	0.736
	(0.159)
AGE (45+)	0.802
	(0.189)
HEALTH CARE	0.997
	(0.239)
EMPLOYED	0.822
	(0.115)
MALE	1.858***
	(0.237)
UNIVERSITY DEGREE	0.826
	(0.114)
MARRIED	0.623***
	(0.110)

Table 5 (cont.). Estimation results of the ordered logit model

Variables	Odds ratio
INCOME	0.999
	(0.045)
HH SIZE	0.995
	(0.037)
CHILDREN	1.405*
	(0.277)
URBAN	0.768*
	(0.118)
STUDENT	1.094
	(0.243)
COVID cases around	1.029
	(0.129)
Marz F.E.	Yes
Observations	1,194
Wald chi2 (35)	116.2
Prob > chi2	1.20e-10
Pseudo R2	0.0510

Robust HC3 standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

The paper developed a theoretical model to examine the willingness to accept vaccine and is based on the Nuscheler and Roeder (2015), where Yaari's (1987) dual theory is used combined with Laibson's (1997) quasi-hyperbolic discounting. The presented model, as in Nuscheler and Roeder (2015), explains the effect of discount factors, risk aversion and information measures. As an extended result, it also explains the effects of the trust towards the health system and health insurance on the willingness to accept a vaccine.

Using a data from a nationally representative survey conducted in Armenia, the association of the willingness to get vaccinated against COVID-19 with individuals' characteristics and perceptions is examined. In the baseline estimations it is found that the discount factor is positively associated with the willingness to accept vaccine, which is in line with the prediction from the theoretical model. Nuscheler and Roeder (2015) find in theory positive association of discount factor, but their data reveals a negative one. In this regard our results confirm the existence of a positive association, but in alternative estimations we perform for robustness checks the association turns insignificant though still positive. Further, in all estimated models, as compared with exponential discounters, the present- and future-biased individuals behave no differently, that is no significant effect is found. The same applies to risk aversion and subjective information.

Meanwhile, the trust towards health system is found to be positively associated with willingness to accept a vaccine. Lower trust towards the health system reduces the likelihood to accept a vaccine. The individuals with health insurance have a higher propensity to accept the vaccine. The effects found for the trust towards the health system and availability of health insurance hold in all the estimated models and are highly significant. To avoid omitted variables bias, number of covariates are included in the analysis. Significant association is found between willingness to get vaccination and employment, gender, education, marital status. Specifically, the male respondents are more likely to accept the vaccination if available. The other listed covariates decrease that likelihood.

APPENDIX

Table A.1. Estimation results without interaction with the discount factor

VARIABLES	Model 1	Model 2	Model 3
$\beta\delta$	0.19**	0.20**	0.19**
	(0.08)	(0.09)	(0.09)
PRESENTBIAS		0.02	0.01
		(0.03)	(0.03)
FUTUREBIAS		0.02	0.02
		(0.04)	(0.04)
RISK AVERSION			0.02
			(0.03)
SUBJINFO	0.04	0.04	0.04
	(0.03)	(0.03)	(0.03)
TRUST HEALTH SYSTEM	-0.05***	-0.05***	-0.05***
	(0.01)	(0.01)	(0.01)
INSURED	0.08**	0.07**	0.08**
	(0.03)	(0.03)	(0.03)
HEALTH	-0.01	-0.01	-0.01
	(0.03)	(0.03)	(0.03)
AGE (25-29)	-0.00	-0.00	0.01
	(0.05)	(0.05)	(0.05)
AGE (30-34)	-0.06	-0.05	-0.05
	(0.05)	(0.05)	(0.05)

Table A.1 (cont.). Estimation results without interaction with the discount factor

VARIABLES	Model 1	Model 2	Model 3
AGE (35-44)	-0.07	-0.07	-0.06
	(0.05)	(0.05)	(0.05)
AGE (45+)	-0.05	-0.04	-0.04
	(0.05)	(0.05)	(0.05)
HEALTH CARE	-0.01	-0.01	-0.01
	(0.06)	(0.06)	(0.06)
EMPLOYED	-0.07**	-0.07**	-0.07**
	(0.03)	(0.03)	(0.03)
MALE	0.14***	0.14***	0.14***
	(0.03)	(0.03)	(0.03)
UNIVERSITY DEGREE	-0.08**	-0.08**	-0.08**
	(0.03)	(0.03)	(0.03)
MARRIED	-0.11***	-0.11***	-0.11***
	(0.04)	(0.04)	(0.04)
INCOME	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)
HH SIZE	-0.00	-0.00	-0.00
	(0.01)	(0.01)	(0.01)
CHILDREN	0.06	0.06	0.06
	(0.04)	(0.04)	(0.04)
URBAN	-0.05	-0.05	-0.06
	(0.04)	(0.04)	(0.04)
STUDENT	0.04	0.04	0.05
	(0.05)	(0.05)	(0.05)
COVID cases around	0.01	0.01	0.01
	(0.03)	(0.03)	(0.03)
Constant	0.30***	0.29**	0.29**
	(0.11)	(0.11)	(0.12)
Marz F.E.	Yes	Yes	Yes
Observations	1,203	1,203	1,194
R-squared	0.11	0.11	0.10
F-Stat	4.629	4.363	4.121
Prob > F	0	0	0
Degree of Freedom	1170	1168	1158

Robust HC3 standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1

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