Preferences After Pan(dem)ics: Time and risk in the shadow of Covid-19

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Appendix

A.1.-Impact of different events on preferences: Summary

Table 7 Impact of different types of events on preferences

	Ambiguity aversion			Risk aversion			Impatience			Total
Impact	Raise	Null	Lower	Raise	Null	Lower	Raise	Null	Lower	
Natural disasters	1			9	6	4	2	5	2	29
War / Violence	2			4		2	1		1	10
Economic recession				4	1		1			6
Covid-19				3	3	3	1	1	1	12
Total	3			20	10	9	5	6	4	57

Notes: The complete list of studies is reported in Appendix A.1– Table 8.

Table 8 Impact of different events on preferences

Articles	Event	Risk aversion	Impatience	Ambiguity aversion	Hypothetic money	Time to measurement
Abatayo & Lynham (2020)	Natural disaster (Typhoon)	Decreases	Not significant	-	No	18 months after the event
Angrisani et al. (2020)	Covid-19	Not significant	-	-	No	From 1 year before the event to 2 months after the event
Bäckman et al. (2020)	Covid-19	Increases	-	-	Yes	From 2 months before the event to 2 months after the event
Beine et al. (2020)	Natural disaster (Earthquake)	Increases	Increases	-	No	From 1 month before to 3 months after the event
Bu et al. (2021)	Covid-19	Increases	-	-	Yes	From 2 months before the event to 4 months after the event
Callen (2015)	Natural disaster	-	Decreases	-	Yes	30 months after the event

	(Earthquake / Tsunami)					
Callen et al. (2014)	War/violence	Increases	-	-	Yes	0 to 96 months after the event
Cameron & Shah (2015)	Natural disaster (Flood/Earthquake)	Increases	-	-	No	0 to 36 months after the event
Cameron & Shah (2015)	Natural disaster (Flood/Earthquake)	Not significant	-	-	No	0 to 332 months after the event
Cameron & Shah (2015)	Natural disaster (Earthquake)	Increases	-	-	No	0 to 416 months after the event
Cameron & Shah (2015)	Natural disaster (Flood)	Not significant	-	-	No	0 to 416 months after the event
Cassar et al. (2017)	Natural disaster (Tsunami)	Increases	Increases	-	No	52 months after the event
Cavatorta & Groom (2020)	War/violence	Decreases	Increases	Increases	No	Natural experiment (Ongoing exposure)
Chantarat et al. (2015)	Natural disaster (Flood)	Not significant	Not significant	-	Yes	28 to 31 months after the event
Chantarat et al. (2015)	Natural disaster (Flood)	Increases	Not significant	-	Yes	28 to 31 months after the event
Cohn et al. (2015)	Economic recession	Increases	-	-	No	Lab experiment
Drichoutis and Nayga (2021)	Covid-19	Not significant	Not significant		No	From 4 years before the event to 2 months after the event
Guenther al. (2020)	Covid-19	Not significant	-	-	No	Dates not specified
Guiso et al. (2018)	Economic recession	Increases	-	-	Yes	12 months before and 19 months after the event
Hardardottir (2017)	Economic recession	-	Increases	-	Yes	From 10 years before to 4 years after the event
Hanaoka et al. (2018)	Natural disaster (Earthquake)	Not significant	-	-	Yes	1 month before, 11 months after, and 59 months after the event

Harrison et al. (2022)	Covid-19	Decreases	Decreases		No	From 3 months after the event to 8 months after the event
Ingwersen (2015)	Natural disaster (Tsunami)	Decreases	Not significant	-	Yes	From 7 to 12 months before, and from 5 to 17 months after the event
Ingwersen (2015)	Natural disaster (Tsunami)	Not significant		-	Yes	From 7 to 12 months before, and from 53 to 65 months after the event
Jetter et al. (2020)	Economic recession	Not significant	-	-	Yes	From 72 months before to 84 months after the event
Kim & Lee (2014)	War/violence	Increases	-	-	Yes	684 months after the event
Kim & Lee (2014)	War/violence	Increases	-	-	Yes	0 to 900 months after the event
Li et al. (2021)	Covid-19	Increases	Increases	-	No	From 3 months before the event to 2 months after the event
Moya (2018)	War/Violence	Increases	-	Increases	No	From 0 to 120 months after the event
Necker & Ziegelmeyer (2016)	Economic recession	Increases	-	-	Yes	From 12 months before to 24 months after the event
Page et al. (2014)	Natural disaster (Flood)	Decreases	-	-	No	2 months after the event
Sahm (2012)	Economic recession	Increases	-	-	Yes	Ongoing exposure
Samphantharak & Chantarat (2015)	Natural disaster (Flood)	Increases	Not significant	-	Yes	30 to 33 months after the event
Sawada & Kuroishi (2015)	Natural disaster (Flood)	Not significant	Increases	-	No	19 months after the event
Shachat et al. (2021)	Covid-19	Decreases	-	-	No	From 8 months before to 45 days after the event
Shupp et al. (2017)	Natural disaster (Tornado)	Increases	-	Increases	No	3.5 months after the event
Tsutsui & Tsutsui-Kimura (2022)	Covid-19	Decreases	-	-		From 1 month before to 1 month after

Van Den Berg et al. (2009)	Natural disaster (Hurricane)	Increases	-	-	No	98 months after the event
Voors et al. (2012)	War/violence	Decreases	Decreases	-	No	From 72 to 192 months after the event
Willinger et al. (2013)	Natural disaster (Volcanic eruption)	Increases or decreases depending on locations	-	-	No	2 months and 7 months after the event

Notes: Chantarat et al. (2015) (first line) focused on results obtained at the village-level, whereas Chantarat et al. (2015) (second line) focused on results obtained at the household-level. Cohn et al. (2015) experimentally investigates changes in subjects' risk aversion preferences in an experimental market involving exogeneous booms and busts. In Hanaoka et al. (2018), the relationship is not significant for the whole sample. Jetter et al. (2020) found significant results for the male subsample using a local measure of the consequence of the crisis (unemployment rate). In Kim & Lee (2014) (second line), the result only holds for people who have been exposed to war during their childhood. People having been exposed to war at an older age are not significantly more risk averse than people who have not been exposed to war. In Page et al. (2014), the effect has been found for individuals whose properties were directly affected by the flood. In Shupp et al. (2017), risk aversion is found to decrease for people who have lost a friend or neighbor. In Tsutsui & Tsutsui-Kimura (2022), the authors found different results between mega and moderate risks. In Willinger et al. (2013), the authors consider five different locations for their experiment. Subjects' risk aversion increased after the event in three of the five locations, and decreased in the other two.

A.2.-Structural model of utility

In this section we present the model used to represent participants utilities functions. Our methodology calculates maximum-likelihood estimates for individual parameters using each row of the MPLs as a separate choice. Deviations from the behavior predicted by these estimates are assumed to be errors by participants in "calculating" the utilities of the different options; that is, we also estimate a Fechner error structure.

A.2.1- Time and Present bias task

Time preferences and present bias were measured using two different MPLs with identical monetary amounts, the options differing by six months in time of payment. The first of these options required choosing between a variable payment in 6 months or a fixed, higher amount in 12 months' time, the second between payment immediately or in 6 months. In both cases, the more distant payment was fixed at €100, while the closer varied between €98 and €55. A single switching point on each MPL puts bounds on an estimate of the time preference (β) and present bias (γ) parameters of the standard Laibson (1997) model, for the expected utility of a stream of wealth between now t0 and T:

$$EU_T^{x_{t0},\dots,x_T} = \beta^{t0} \times u(x_{t0}) + \gamma \times \sum_{i=t1}^{T} \beta^i \times u(x_i) \quad (1)$$

Time preferences are bounded by the switching point in the 6-vs-12-month MPL. Present bias is then recovered by the difference between the switching points in the two MPLs. In this model, a value of β<1 (resp. =1, >1) indicates the agent has a preference for gains closer in time (resp. is indifferent over time of payment, prefers gains farther into the future). In a parallel manner, γ<1 (resp. =1, >1) indicates that the agent is present biased (resp. neutral, future biased). Following previous work (Andersen et al., 2008), it should be noted that the utility function used for our delayed payment is corrected by the curvature of risk as our preferences will be estimated jointly.

A.2.2- Risk aversion and Ambiguity task

The risk aversion task had 14 choices, each framed as betting on the flip of a coin. The constant option across choices paid €50 on a Heads and €40 on a Tails. The variable option always paid €10 for Tails, while for Heads the value ranged from €54 (in which case it was practically dominated) to €112 (in which case the expected value was greater than the highest prize of the constant option). Thus, in all cases the constant option had a lower variance than the variable, and the expected value of the variable rose monotonically across choices. A rational, risk-neutral decision-maker should choose the high-variance option if and only if it has the higher expected value. More generally, risk aversion can be measured as the utility curvature that best explains the number of safe options chosen.

To measure ambiguity aversion, we asked participants to choose between betting on a random process with 50% chance of winning, or a predetermined process with two outcomes. The former has a transparent objective probabilistic distribution, while the latter has only subjective uncertainty, and gives no guidance as to what distribution may have been used to create the result. Similarly to Chakravarty and Roy (2009), the ambiguous process was framed as a bag containing 10 balls, which could be either blue or red – all the balls in the ambiguous bag were the same color. Therefore, a draw from it involved no risk, but only uncertainty. This was the constant option in the MPL table; winning a bet using the ambiguous bag always won €100, while losing a bet on the Ambiguous bag paid €0. The risky bag, which represented the variable option in the MPL, was described as containing five balls of each color. Winning a bet on this bag paid between €140 and €60, while losing paid €0. Participants first decided which color ball they wanted to bet on, and then in each option, had to choose whether to bet using the risky or the ambiguous bag. Clearly, ambiguity-neutral participants should take the risky bag if and only if it gives a higher prize upon winning. The ambiguity averse may be willing to accept a lower prize in order to bet on the clearer option.

We combined behavior in the risk and ambiguity tasks to estimate the parameters of the discrete form of the second-order model due to Klibanoff et al. (2005), as presented by Nau (2006) (Model 1):

$$EU(X)=\sum_{p=1}^{P}\left(\sum_{q=1}^{Q} {x_{p,q}}^{\alpha}\right)^{\rho} \quad (2)$$

with $\mathbb{P}(1,\ldots,P)$ the set of ambiguous events, $\mathbb{Q}(1,\ldots,Q)$ the set of risky events and $\mathbf{X}(x_{1,1},\ldots,x_{P,Q})$ the wealth associated to these events. A value $\alpha<1$ (resp.= 1, >1) indicates that the subject is risk averse (resp. neutral, seeking); similarly $\rho<1$ (resp.= 1, >1) indicates ambiguity aversion (resp. neutrality, seeking).

A.2.3- Prudence task

Intuitively, prudence corresponds to the sensitivity of risk aversion to base wealth; it can be interpreted as the third derivative of the utility function. Our task to elicit prudence was based on the lottery design in Eeckhoudt and Schlesinger (2006). The basic format was a pair of coin flips. Heads wins more than tails on the first flip, varying the starting position for the second flip, which had zero mean. The A and B options in each choice varied whether the zero-mean flip occurred after a win on the first, or a loss. Prudence dictates that participants favor adding zero-mean variance after a win; the less prudent prefer to flip again after a loss. Both options had the same expected values and standard deviations; parametrization of the lotteries are thus symmetric (c.f. Ebert and Wiesen, 2011, 2014 or Heinrich and Mayrhofer, 2018 who used non-symmetric lotteries). Different choices in the MPL varied the stakes of the second flip.

Previous studies using similar elicitation tasks focused on the number of times the prudent choice was selected (Eekhoudt and Schlesinger, 2006; Krieger and Mayrhofer, 2017; Masuda and Lee, 2019; Noussair et al., 2014). However, this measurement is not suitable for our joint estimation as we also want to consider the impact of risk aversion on prudence. Instead, we estimate the likelihood to select a prudent choice, a measure we called *prudence propensity* (*PP*). It is defined in our overall likelihood function for the three choices of the prudence task by:

$$PP\times u(\text{Option A})-(1-PP)\times u(\text{Option B}) \quad (3)$$

The interpretation of prudence as the third derivative of utility shows that in general, prudence and risk aversion are not independent. In our estimation, for instance, our utility function under risk only is simply $u(x)=x^{\alpha}$, which implies that its third derivative is $u'''(x)=\alpha(\alpha-1)(\alpha-2)x^{\alpha-3}$. Therefore, if a participant is risk averse with $0<\alpha<1$, that implies for gains ($x>0$) we obtain a third derivative $u'''(x)>0$ meaning the participant is also prudent. The interpretation of an estimated $PP>0.5$ (resp. =0.5, <0.5) is therefore a level of prudence even higher than (resp. the same as, lower than) that structurally assumed by our utility function.

A.2.4- Fechner error terms

Our estimation assumes a deterministic choice process. However, much previous work confirms that behavioral data exhibits extensive violations of deterministic predictions; that is, choice has a stochastic component as well as the deterministic component modeled through, for instance, risk and ambiguity aversion, time discount rates, present bias or prudence. These violations can be interesting in themselves to estimate, to the extent that they correspond to behavioral traits reflecting important psychological processes. One of the more common models of stochastic choice is known as the Fechner error, as elaborated for instance in Hey and Orme (1994). This model assumes that participants bring a fixed decision rule to a choice and execute it correctly, but that the process of calculating utilities may occur with some randomness. We selected it because it represents the possibility that stress or cognitive load from the generalized risk of the pandemic could interfere with the decision process. The hypothesis is therefore that the pandemic will increase the Fechner error term.

A.3.-Results from a joint ML estimation

In this section we present the results of a joint maximum likelihood estimation, clustering at the participant level. Table 9 shows the estimated parameters for time discounting, present bias, risk aversion, prudence propensity, ambiguity aversion and Fechner error term. The reference point for our results is *Later*, our last measurement during the Covid-19 crisis. The choice not to use *Pre-Covid-19* as the reference point is conservative, as the initial wave, while demographically similar, was procedurally distinct from the later ones. Model (1) represents our baseline, including only the waves made during the Covid-19 crisis, model (2) extends the analysis to also include the *Pre-Covid-19* wave of observations from BRISKEE. For models (3) and (4), we consider subsample of our baseline model; the lowest 25% (internal control) and the highest 25% (external control) scores using a z-score transformation on the score obtained by participants on the Locus of Control scales.

We look first at time discounting in model (1). Our results show that, on average, our participants are significantly discounting time (H0: β=1, p<0.001). The discount rate was significantly (at 1%) higher (that is, β closer to 0) during *Lockdown* than *Later*. *Post-Lockdown*, however, the estimate is not significantly different from *Later*, and post estimation t-tests also show no significant difference between *Lockdown* and *Post-Lockdown* (p=0.279). Subjects, in other words, were least patient during the *Lockdown* phase, with levels of patience slowly rising over the later waves. In principle, this could be explained either by participants i) slowly growing more patient during the crisis or ii) recovering from an initial shock. To investigate which, we consider observations from before Covid using the BRISKEE dataset. In model (2), no significant difference appears between *Pre-Covid-19* and *Later*, and post estimation test confirms a significant difference both between *Pre-Covid-19* and *Lockdown* (p<0.001) and between *Pre-Covid-19* and *Post-Lockdown* (p<0.001). In other words, explanation ii) is confirmed;

time discounting appeared to move back towards its initial (i.e *Pre-Covid-19*) value, reaching it 4 months later.

This "shock and slow recovery" pattern is a phenomenon we will see in several of our estimations. Anticipating another recurring pattern, models (3) and (4) show that the effect of the Covid-19 crisis on participants' patience is not independent of their measured locus of control scores. The preferences of internal-locus participants, who tend to believe that they drive events in their lives, are mostly unaffected by the crisis. However, participants who believe that external forces shape their lives are more impacted. Especially when we compare their behavior during *Lockdown* and *Later*, our results show that they are discounting time significantly more in the former than the latter. With respect to the previous literature, Table 8 reports that out of the 12 studies featured, 5 report an increase in subjects' impatience, 4 find no significant change in subjects' time preferences, and 3 show a decrease in subjects' impatience. The Covid-19 literature also shows mixed results despite a limited number of studies: out of the 3 studies included in Table 8, one reports a decrease in subjects' impatience, one reports an increase in subjects' impatience, and one finds no significant change in subjects' time preferences. Our results are in line with Li et al. (2021).

Table 9 Joint ML estimation of time discounting, present bias, risk aversion, prudence propensity, ambiguity aversion depending on the Covid-19 sanitary conditions

		Baseline	Extended	Low	High
	Model	(1)	(2)	(3)	(4)
Time discounting: β	*Pre-Covid 19*		0.044		
			(0.024)		
	Lockdown	-0.056**	-0.056**	-0.005	-0.101**
		(0.020)	(0.020)	(0.031)	(0.038)
	Post-Lockdown	-0.035	-0.035	-0.058	-0.053
		(0.021)	(0.021)	(0.036)	(0.041)
	Constant	0.821***	0.821***	0.810***	0.819***
		(0.015)	(0.015)	(0.024)	(0.031)
Present bias: γ	*Pre-Covid 19*		-0.005		
			(0.008)		
	Lockdown	-0.005	-0.005	-0.019	0.020
		(0.008)	(0.008)	(0.012)	(0.014)
	Post-Lockdown	0.006	0.006	0.014	0.009
		(0.008)	(0.008)	(0.015)	(0.013)
	Constant	0.988***	0.988***	0.985***	0.985***
		(0.006)	(0.006)	(0.009)	(0.011)
Risk aversion: α	*Pre-Covid 19*		-0.087		
			(0.052)		
	Lockdown	0.122**	0.122**	-0.006	0.226**
		(0.044)	(0.044)	(0.070)	(0.078)
	Post-Lockdown	0.081	0.081	0.072	0.183*
		(0.045)	(0.045)	(0.076)	(0.084)
	Constant	0.443***	0.443***	0.474***	0.424***
		(0.032)	(0.032)	(0.052)	(0.057)
Ambiguity aversion: ρ	*Pre-Covid 19*		-0.130*		
			(0.059)		
	Lockdown	0.127**	0.127**	-0.010	0.235**
		(0.045)	(0.045)	(0.070)	(0.082)
	Post-Lockdown	0.087	0.087	0.071	0.191*
		(0.047)	(0.047)	(0.077)	(0.088)
	Constant	0.416***	0.416***	0.456***	0.393***
		(0.033)	(0.033)	(0.053)	(0.061)
Prudence propensity: PP	*Pre-Covid 19*		-0.026		
			(0.022)		

	Lockdown	0.008	0.008	0.022	0.005
		(0.010)	(0.010)	(0.016)	(0.018)
	Post-Lockdown	0.012	0.012	0.016	0.003
		(0.010)	(0.010)	(0.016)	(0.017)
	Constant	0.560***	0.560***	0.558***	0.556***
		(0.008)	(0.008)	(0.011)	(0.014)
Fechner error: s	*Pre-Covid 19*		-0.218		
			(0.265)		
	Lockdown	0.525*	0.525*	-0.357	1.585*
		(0.268)	(0.268)	(0.378)	(0.633)
	Post-Lockdown	0.331	0.331	0.192	1.013
		(0.265)	(0.265)	(0.484)	(0.558)
	Constant	1.438***	1.438***	1.639***	1.334***
		(0.168)	(0.168)	(0.311)	(0.279)
	Observations	26,775	31,174	9,585	8,550
	Log. Likelihood	-12,940.685	-15,236.629	-4,536.828	-4,136.696

Notes: Robust standard errors in parentheses are clustered at the subject level. Significant results are reported: * p<0.05; ** p<0.01; *** p<0.001. The number of observations is equal to each line of decision made by every participant.

Regarding present bias across all models, our results show that on average our sample is slightly present biased (models (1) and (2) with H0: γ=1, p=0.034); however, there is no significant difference between *Lockdown* and *Later*, *Post-Lockdown* and *Later*, and also *Pre-Covid-19* and *Later.* Post estimation t-tests show no significant differences between *Pre-Covid-19* and *Lockdown* (p=0.922), between *Lockdown* and *Post-Lockdown* (p=0.112) or between *Pre-Covid-19* and *Post-Lockdown* (p=0.141). Thus, present bias preferences appear to have been relatively stable during this period. Moreover, participants' locus of control seems to be independent from their present bias. We note briefly an intuitive conjecture that these null results might reflect conflicting forces: uncertainty about the future might increase present bias, while the effect of the lockdown itself, putting life on hold as it were, might decrease it. Present bias, at any rate, has not been a major focus of previous work on natural disasters, and so the results are hard to compare directly to the literature in Table 8.

Turning to risk aversion, models (1) and (2) repeat the shock-and-recovery pattern found for patience. First, on average our sample is risk averse (H0: α=1, p<0.001). We do not find significant (at 5%) difference between our *Pre-Covid-19* measurement compared to *Later*. However, participants are significantly less risk averse during *Lockdown* than *Later*. Post estimation t-tests shows that participants' risk aversion parameters are significantly different between *Pre-Covid-19* and *Lockdown* (p<0.001) and *Pre-Covid-19* and *Post-Lockdown* (p=0.001), but are not significantly different between *Lockdown* and

Post-Lockdown (p=0.346). Risk aversion reaches its lowest value during the lockdown and post-lockdown phases. Like the time discounting parameter, after those phases, risk aversion tends towards its initial *Pre-Covid-19* value. Also like time discount rates, using models (3) and (4) we can see that this effect is driven by the participants with external locus of control. Table 8 shows that the majority of the previous results on disasters (17/30) report an increased risk aversion while only 6/30 report a decrease in subjects' risk aversion – see Appendix A.1 for more information. Focusing on the smaller and more mixed Covid-19 literature, 3/9 studies report an increase in risk aversion, 3/9 find that risk aversion is not significantly affected, and 3/9 report a decrease in risk aversion as the exposure to virus increases. Our results regarding risk aversion are in line with Shachat et al. (2021), Harrison et al. (2022) and Tsutsui & Tsutsui-Kimura (2022).

A similar pattern shows up again with regards to ambiguity aversion. While our results in model (1) and (2) show that on average our sample is averse to ambiguity (H0: ρ=1, p<0.001), participants are significantly more ambiguity averse during our *Pre-Covid-19* measurement, and less ambiguity averse during *Lockdown*, than in the *Later* period. Post estimation t-tests show that participants' ambiguity aversion parameters are significantly different between *Pre-Covid-19* and *Lockdown* (p<0.001) and *Pre-Covid-19* and *Post-Lockdown* (p<0.001), but are not significantly different between *Lockdown* and *Post-Lockdown* (p=0.374). Our participants are thus less ambiguity averse during the Covid-19 crisis, and ambiguity aversion reaches its lowest level during *Lockdown* and *Post-Lockdown* periods. Likewise, when considering models (3) and (4), we find that this result is carried by participants with more external locus of control. This result is consistent with our other findings in at least two ways. First, given that risk and ambiguity aversion are often positively correlated across individuals, one might also expect them to be positively correlated over time for any individual. This could explain why the two parameters seem to vary in parallel in our estimations. On the other hand, the direction of the ambiguity effect is contrary to that found in the previous literature summarized in Table 8. We conjecture that this reflects differences in the underlying shock that generates the effect. For instance, both Cavatorta and Groom (2020) and Moya (2018) study the effect of violent conflict, which has a material impact quite different from that of the general uncertainty characterizing the Covid-19 crisis. In addition, Shupp et al. (2017), who study the effect of a hurricane, find that the ambiguity effect only occurs among those who experienced material losses from the event. Since such losses were less common among our sample, the result serves as an interesting counterpoint to existing studies, suggesting that those material losses may be a key factor in explaining previous results. No study so far investigated the impact of Covid-19 on ambiguity, we therefore have no baseline to compare our specific results to.

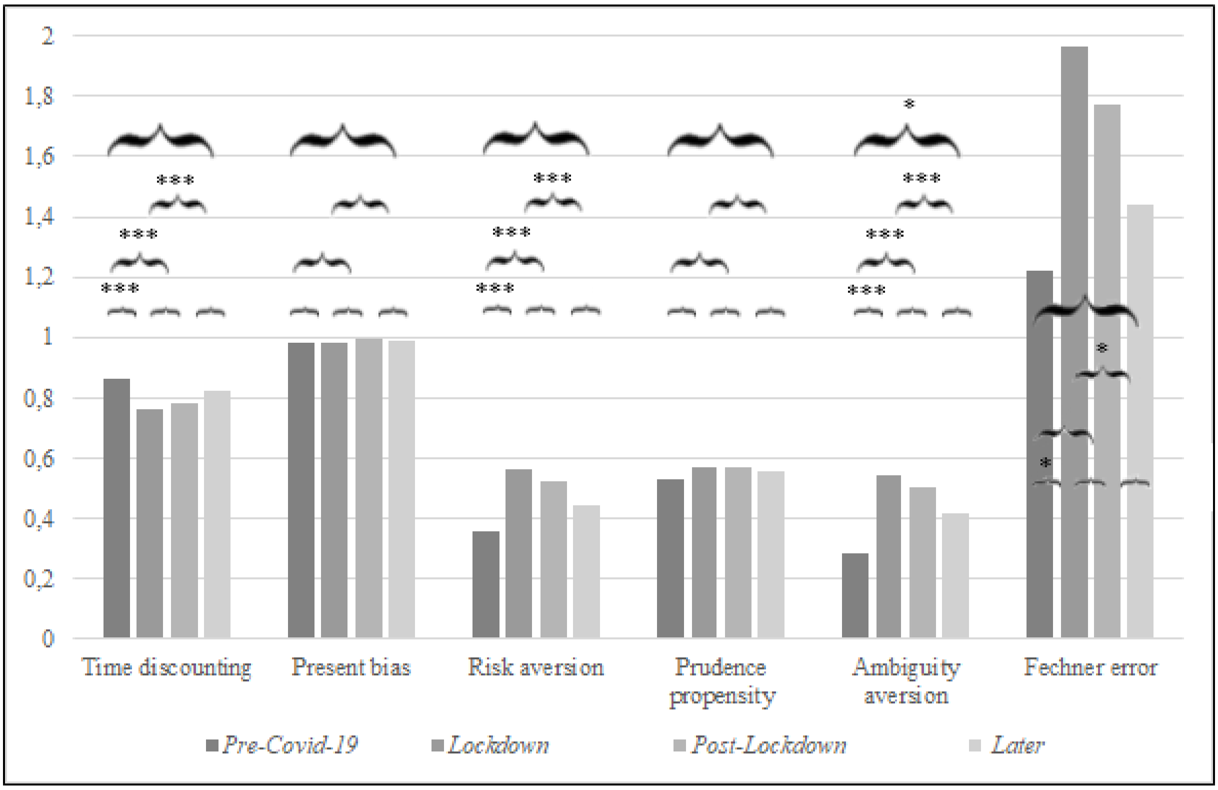
For prudence propensity, recall that our test turns on the *PP* variable, which will be different from 0.5 if the individual is more prudent than would be predicted by the form of their jointly-estimated risk aversion coefficient. We find across all models that on average our sample has some "excess prudence"

(H0: *PP*=0.5, p<0.001). However, participants' prudence is not significantly different during our *Pre-Covid-19, Lockdown* and *Post-Lockdown* measurement compared to *Later*. Post estimation t-tests show no significant differences (at 5% level). Moreover, participants' locus of control does not affect their prudence propensity. These results show an overall stability of participants' prudence during the crisis. This could only be further confirmed if an additional measurement would be run after the pandemics is over.

With respect to the Fechner error terms, our results in models (1) and (2) indicate that participants make significantly more errors during the *Lockdown* periods compared to *Later*. Post estimation t-tests show significant differences between *Pre-Covid-19* and *Lockdown* (p=0.011), but not significant between *Pre-Covid-19* and *Post-Lockdown* (p=0.059) or between *Lockdown* and *Post-Lockdown* (p=0.507). As this measure is taken across tasks for each individual, higher average scores during *Lockdown* and *Post-Lockdown* indicate greater behavioral heterogeneity in these periods, resulting in more noise around our estimates. Furthermore, when considering models (3) and (4), we can see that this result is driven by participants scores consistent with an external locus of control. These therefore appear to have been the subsample particularly affected by the crisis, which is consistent with the literature on differences in coping mechanisms and stress that an external locus of control can induce (Elkind, 2008; Scott et al., 2010; López-Vásquez and Marván, 2012 ; Mather and Lighthall, 2012; Diotaiuti et al., 2021).

Readers may have noted that our *Pre-Covid-19* sample is hard to compare directly to the later waves, having been recruited differently, and from a more general population. Naturally, the unpredictable nature of this crisis made a perfect panel of measurements rather difficult, and like most other Covid-19-related research we have been forced to work with the data available. We selected the *Pre-Covid-19* sample to be as close as possible as our later waves, but it cannot be ignored that numerous factors may still be affecting our results. Nevertheless, we underline that the observed shifts of time discounting, risk aversion and ambiguity aversion between the *Lockdown, Post-Lockdown* and *Later* waves are independent of the *Pre-Covid-19* levels. The *Pre-Covid-19* simply highlights the interpretation of these results as a return to pre-existing levels, rather than as a shift to a "new equilibrium". Fig. 2 illustrates the findings of this section based on model (2). It shows a similar pattern for time discounting, risk aversion, ambiguity aversion and Fechner error: an important shift during *Lockdown* that slowly return towards the pre-Covid level.

Fig. 2 Preferences evolution during the Covid-19 crisis (Model 2)



Notes: This figure features t-test differences of means. Significant levels are the following: * p<0.05; ** p<0.01; *** p<0.001. Interpretation of the average of each sample: for time discounting the further below 1 the more impatient; for present bias the further below 1 the more biased toward present; for risk aversion the further below 1 the more risk averse; for ambiguity aversion the further below 1 the more ambiguity averse; and for the Fechner error term the higher means more noise.

A.4. Self-selection into the experiment

In this section we will focus on a possible concern that participants decided whether to participate in our experiment depending on their preferences. To control if our results are robust to self-selection into the experiment, we simply run the estimation again on the subsample of participants who participated multiple times. The results are reported in Table 10.

To control for some self-selection bias at play, we use the participants who participated 3 times as a benchmark. There are two possibilities: i) if these participants are more likely to be affected by self-selection bias, then we should observe significant differences in participants' average preferences between *Later* for all participants versus participants who participated 3 times; ii) if these participants are less likely to be affected by self-selection bias, then we should observe significant differences between *Lockdown* for all participants versus participants who participated 3 times.

We created a variable *Panel* (=0 if the participants only participated 1 time and =1 if participants participated 3 times). We then run an estimation with *Post-Lockdown* as a baseline to easily interact *Lockdown* and *Later* with *Panel*. The results are reported in Table 10. We then run post-estimation test to see if there are significant differences between participants who participate 1 time versus participants that participated 3 times, during *Lockdown* and *Later*. For time discounting, no significant differences (p=0.669) during the *Lockdown*, no significant differences (p=0.108) during *Later*. For present bias, there is no significant difference during *Lockdown* (p=0.724) and during *Later* (p=0.795). For risk aversion, there is no significant difference during *Lockdown* (p=0.614) and during *Later* (p=0.822). For prudence, there is no significant difference during *Lockdown* (p=0.890) and during *Later* (p=0.103). For ambiguity aversion, there is no significant difference during *Lockdown* (p=0.537) and during *Later* (p=0.893). For the Fechner error term, there is no significant difference during *Lockdown* (p=0.982) and during *Later* (p=0.475). Overall, our results are not significantly impacted by a self-selection bias.

Table 10 Joint ML estimation of time discounting, present bias, risk aversion, prudence propensity, ambiguity aversion depending of the Covid-19 sanitary condition with interaction terms for participants who have participated multiple times

Model	*Time discounting: β*	*Present bias: γ*	*Risk aversion: α*	*Prudence propensity: PP*	*Ambiguity aversion: ρ*	*Fechner error: s*
Lockdown=1 & Panel=0	-0.059*	-0.001	0.124*	0.002	0.141*	0.477
	(0.016)	(0.936)	(0.032)	(0.880)	(0.017)	(0.201)
Lockdown=1 & Panel=1	-0.045	-0.005	0.086	-0.000	0.093	0.069
	(0.121)	(0.561)	(0.181)	(0.989)	(0.159)	(0.844)
Later=1 & Panel=0	0.020	-0.000	-0.012	-0.014	0.002	-0.139
	(0.449)	(0.975)	(0.827)	(0.348)	(0.979)	(0.624)
Later=1 & Panel=1	-0.039	0.003	0.006	0.019	0.003	0.123
	(0.222)	(0.777)	(0.935)	(0.315)	(0.964)	(0.768)
Constant	0.828***	0.987***	0.434***	0.564***	0.400***	1.448***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	21544					
Log. Likelihood	-10,677.786					

Notes: This estimation is similar to the one presented in Table 9 in Model 1. Robust standard errors in parentheses are clustered at the subject level. Significant results are reported: * p<0.05; ** p<0.01; *** p<0.001.

A.5. Full questionnaire (English version)

[Welcome/Screening]

Welcome to our survey and thank you for your participation!

Please read each question carefully before answering. The instructions will help guide your responses.

Procedures

You will be asked to complete an online questionnaire. After answering a question, please press the "Next" button. In order to move on, a question (or question block) must be answered in its entirety. Once you advance to the next section, returning to a prior question will not be possible.

Payment

You will be paid a fee of three euros (3€) for completing this survey. In addition, you will have the opportunity to earn additional money, up to two hundred and twenty-two euros (222€ exactly), through the individual questions you provide. Payment will be made through your Lydia account.

Recurrent participation

This experiment will involve several different waves of questionnaires. You are invited to participate in all of them. Each will have a separate fixed fee, and each will also present opportunities to earn more money through your answers. At the end of the questionnaire, we will ask you to choose a confidential password to participate in future waves.

Confidentiality

All information provided will remain confidential and will only be reported as group data with no identifying information.

Participation

Participation in this research study is voluntary. You have the right to withdraw at any time or refuse to participate.

By clicking on “Next” below, you acknowledge that you have read and understood the above consent, and that you are participating voluntarily in this survey.

Thank you for participating in this survey. The survey takes less than 30 minutes.

[MPL presentation]

PART A - Choice Task

In the first part of this survey, we invite you to make a series of financial choices. In this part you can earn a considerable amount of real money. How much money you can win depends on your choices. Therefore it is in your best interest to read all instructions carefully. The choices are simple and not meant to test you - the only correct answers are the ones you really think are best for you.

In all financial choices, we offer you the choice between two payment Options: A and B. All choices involve monetary amounts that you receive at different points in time or with different chances of winning. For example a choice might look like this:

Option A	Option B
Receive 180€ in 6 months	Receive 200€ in 12 months

In the above example, if you choose Option A, you receive 180€ in 6 months. If you choose Option B you receive 200€ in 12 months.

If you prefer to receive 180€ in 6 months, choose option A.

If you prefer to receive 200€ in 12 months, choose option B.

Every 100th participant wins! At the end of the survey, one in one hundred participants will be chosen by chance, to receive money according to their choices. If you are among the winners, one of the choices you made will be picked at random, and whatever option you have chosen in this choice will actually be implemented; you will receive the respective amount, and at the date, specified. All of the choices that you face have the same probability of being picked. It is therefore in your best interest to carefully think about each choice.

At the end of the survey, you will be informed whether you are one of the winners, and, if you are, which of your choices has been implemented.

If you are selected as one of the winners, a Lydia transfer with the determined amount will be made to your Lydia account. As explained above, these additional prizes will be awarded on top of the standard earnings awarded for completing the questionnaire.

[MPL examples]

All choices are organized in tables, where each line represents a different choice. For example, a table may look like the one you see below.

Lines	Option A	I prefer	Option B
1	Receive 195€ today	□A □B	Receive 200€ in 12 months
2	Receive 190€ today	□A □B	Receive 200€ in 12 months
3	Receive 185€ today	□A □B	Receive 200€ in 12 months
4	Receive 180€ today	□A □B	Receive 200€ in 12 months
5	Receive 175€ today	□A □B	Receive 200€ in 12 months
6	Receive 165€ today	□A □B	Receive 200€ in 12 months
7	Receive 145€ today	□A □B	Receive 200€ in 12 months

Notice Option B is always the same, but Option A gets lower as you go down through the choices. What we are interested in is to learn at which line you start preferring Option B over Option A.

Example: Sam generally prefers to receive money today, but, when the amount received today gets too low, Sam prefers Option B over Option A. Assume that receiving 182 EUR today would be exactly as good to Sam as receiving 200 EUR in 12 months. Sam would choose Option A in lines 1-3 because these lines give more than 182 EUR today under Option A. In line 4, however, Option A gives less than 182 EUR today. In that case, Sam would prefer 200 EUR in 12 months, and switches to Option iiB. Since the amount received today is even lower in the remaining lines, Sam sticks to B for the remaining lines. In that example, Sam’s responses would look like the table below:

Lines	Option A	I prefer	Option B
1	Receive 195€ today	☑A □B	Receive 200€ in 12 months
2	Receive 190€ today	☑A □B	Receive 200€ in 12 months
3	Receive 185€ today	☑A □B	Receive 200€ in 12 months
4	Receive 180€ today	□A ☑B	Receive 200€ in 12 months
5	Receive 175€ today	□A ☑B	Receive 200€ in 12 months
6	Receive 165€ today	□A ☑B	Receive 200€ in 12 months
7	Receive 145€ today	□A ☑B	Receive 200€ in 12 months

[MPL 1 Time Preferences]

For each of the following lines, please choose your preferred option by selecting either A or B.

Payments that are due "today" (e.g. Option A below) will be processed as soon as possible, and sent out to you via Lydia transfer within approximately one week after you have completed the survey. Payments that are due in the future (e.g. Option B below), will be processed with the same time delay. That is, payments that are due in 6 months, for instance, will be sent out to you within approximately one week after 6 months have passed.

Lines	Option A	I prefer	Option B
1	Receive 98€ today	□A □B	Receive 100€ in 6 months
2	Receive 94€ today	□A □B	Receive 100€ in 6 months
3	Receive 90€ today	□A □B	Receive 100€ in 6 months
4	Receive 86€ today	□A □B	Receive 100€ in 6 months
5	Receive 80€ today	□A □B	Receive 100€ in 6 months
6	Receive 70€ today	□A □B	Receive 100€ in 6 months
7	Receive 55€ today	□A □B	Receive 100€ in 6 months

b

[MPL2 Time consistency]

For each of the following lines, please choose your preferred option by selecting either A or B.

Lines	Option A	I prefer	Option B
1	Receive 98€ in 6 months	□A □B	Receive 100€ in 12 months
2	Receive 94€ in 6 months	□A □B	Receive 100€ in 12 months
3	Receive 90€ in 6 months	□A □B	Receive 100€ in 12 months
4	Receive 86€ in 6 months	□A □B	Receive 100€ in 12 months
5	Receive 80€ in 6 months	□A □B	Receive 100€ in 12 months
6	Receive 70€ in 6 months	□A □B	Receive 100€ in 12 months
7	Receive 55€ in 6 months	□A □B	Receive 100€ in 12 months

[MPL3 Risk Aversion]

In the following task, all paymbents occur today, but depend on the outcome of a “virtual coin flip”. The computer will generate one of two outcomes, called HEADS and TAILS. These occur with exactly 50% probability each. We will call this a “coin flip” in the instructions for simplicity.

For example, you might be asked to choose between the following options:

Option A		Option B	
Coin shows HEADS	Coin shows TAILS	Coin shows HEADS	Coin shows TAILS
50€	40€	62€	10€

If you choose Option A then if the coin shows HEADS, you win 50€; if the coin shows TAILS, you win 40€.

If you choose Option B then if the coin shows HEADS, you win 62€; if the coin shows TAILS, you win 10€.

For each of the following lines, please choose your preferred option by selecting either A or B.

Lines	Option A		I prefer	Option B	
	Coin shows HEADS	Coin shows TAILS		Coin shows HEADS	Coin shows TAILS
1	50€	i	□A □B	54€	10€
2	50€	40€	□A □B	58€	10€
3	50€	40€	□A □B	62€	10€
4	50€	40€	□A □B	66€	10€
5	50€	40€	□A □B	70€	10€
6	50€	40€	□A □B	74€	10€
7	50€	40€	□A □B	78€	10€
8	50€	40€	□A □B	82€	10€
9	50€	40€	□A □B	87€	10€
10	50€	40€	□A □B	97€	10€
11	50€	40€	□A □B	112€	10€
12	50€	40€	□A □B	132€	10€
13	50€	40€	□A □B	167€	10€
14	50€	40€	□A □B	222€	10€

[MPL4 Ambiguity]

In this task, all payments occur today and depend on a random draw of one ball from one of two "virtual bags", A or B. The "virtual bag" A is generated by computers in a way analogous to the real bag described. Bag B contents is predetermined but unknown. We will refer to them as balls and bags for clarity.

Each bag contains <u>10 balls</u>.

Bag A contains <u>5 red balls</u> and <u>5 blue balls</u>.

Bag B either contains either <u>10 red balls and 0 blue balls</u> or <u>0 red balls and 10 blue balls</u>. The actual contents of bag B are unknown to you.

The choices on the next screen represent bets on the color of the ball drawn. The prizes for the bets vary from choice to choice but for each, you must choose whether to make the bet associated with Bag A or that associated with Bag B.

First, however, you must decide which color you would like to bet on. If your chosen color is drawn you win the bet, otherwise you lose. You will easily see that the information here gives you no reason to prefer one color over the other.

Please choose the color you prefer to bet on:

RED BLUE

(mark which one you are betting on, even if you are indifferent – that is why it is a bet!)

For each of the following lines, please choose your preferred option by selecting either □A or □B.

Lines	Bag A: 5 red balls and 5 blue balls — If a [color you bet on] ball is drawn	Bag A: 5 red balls and 5 blue balls — If a [color you didn't bet on] ball is drawn	I prefer	Bag B: Either 10 red balls and 0 blue balls or 0 red balls and 10 blue balls — If a [color you bet on] ball is drawn	Bag B: Either 10 red balls and 0 blue balls or 0 red balls and 10 blue balls — If a [the color you didn't bet on] ball is drawn
1	140€	0€	□A □B	100€	0€
2	130€	0€	□A □B	100€	0€
3	120€	0€	□A □B	100€	0€
4	110€	0€	□A □B	100€	0€
5	105€	0€	□A □B	100€	0€
6	102€	0€	□A □B	100€	0€
7	100€	0€	□A □B	100€	0€
8	98€	0€	□A □B	100€	0€
9	95€	0€	□A □B	100€	0€
10	90€	0€	□A □B	100€	0€
11	85€	0€	□A □B	100€	0€
12	80€	0€	□A □B	100€	0€
13	70€	0€	□A □B	100€	0€

14	60€	0€	□A □B	100€	0€

According to you, what is the chance that you end up receiving 0€ is if you choose Bag B? ____% (Enter a number between 0 and 100)

Out of 100 subjects, how many do you think will win the bet after choosing Bag A? ____% (Enter a number between 0 and 100)

Out of 100 subjects, how many do you think will win the bet after choosing Bag B? ____% (Enter a number between 0 and 100)

[MPL 5 Prudence]

In this task all payments occur today. Again, you have to choose repeatedly between two options, A or B. In both options, your payment will be determined by flipping two coins. Both coins are fair. There is an equal chance of observing HEADS or TAILS.

First, the first coin is flipped: if TAILS you receive a high amount

if HEADS you receive a low amount.

In Option A, if in the first coin flip the result was a TAILS and you received a high amount, then a second coin is flipped:

if TAILS you receive an additional amount

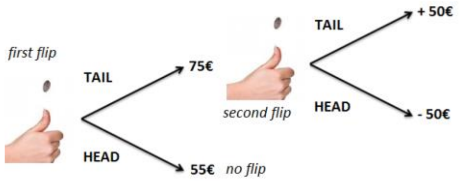
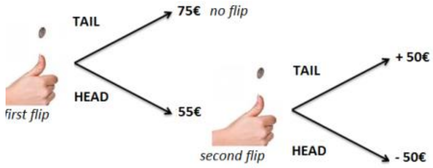
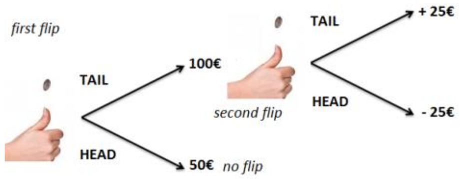
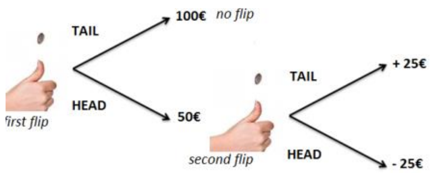
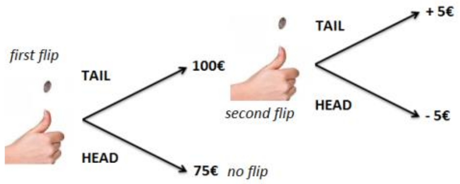
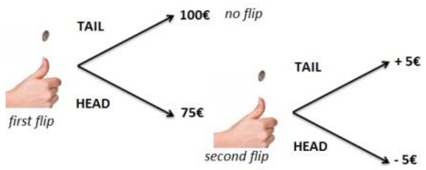
if HEADS you lose a part of the gains from the first coin flip.

In Option B, if in the first coin flip the result was a HEADS and you received a low amount, then a second coin is flipped:

if TAILS you receive an additional amount

if HEADS you lose a part of the gains from the first coin flip.

For each of the following lines, please choose your preferred option by selecting either A or B.

<table>
<tr><th>Lines</th><th>Option A</th><th>I prefer</th><th>Option B</th></tr>
<tr><td>1</td><td>
</td><td>□A □B</td><td>
</td></tr>
<tr><td>2</td><td>
</td><td>□A □B</td><td>
</td></tr>
<tr><td>3</td><td>
</td><td>□A □B</td><td>
</td></tr>
</table>

[Controls for opportunity cost of time/money]

According to you how long will the current Covid-19 crisis will have an impact on your life?

- no impact
- a week
- a month
- 6 months
- a year or more

What percent of your normal (monthly) income did you receive this month? (from No adverse impact to 100%)

Tick the box if you do not earn an income

1. How much of your income did you lose due to confinement this month?
2. How much do you expect to lose over the period?
3. How much has your spending diminished in the past week, compared to a normal week?
4. How much do you expect it to diminish over the period?

[Values Attitudes and Traits]

PART B – Information about you.

We are now going to ask you some questions about yourself. Please keep in mind that all of your answers are confidential and anonymous.

How willing are you to give up something that is beneficial for you today in order to benefit more from that in the future? (Not at all willing to Very willing)

In general, how willing are you to take risks? (Not at all willing to Very willing)

In general, how patient are you? (Not at all willing to Very willing)

Click on the button next to the one statement that best describes how you feel.

1. Many of the unhappy things in people's lives are partly due to bad luck.
   People's misfortunes result from the mistakes they make.
2. One of the major reasons why we have wars is because people don't take enough interest in politics.
   There will always be wars, no matter how hard people try to prevent them.
3. In the long run, people get the respect they deserve in this world.
   Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.
4. The idea that teachers are unfair to students is nonsense.

Most students don't realize the extent to which their grades are influenced by accidental happenings.

5. Without the right breaks, one cannot be an effective leader.
   Capable people who fail to become leaders have not taken advantage of their opportunities.
6. No matter how hard you try, some people just don't like you.
   People who can't get others to like them don't understand how to get along with others.
7. I have often found that what is going to happen will happen.
   Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.
8. In the case of the well prepared student, there is rarely, if ever, such a thing as an unfair test.
   Many times exam questions tend to be so unrelated to course work that studying is really useless.
9. Becoming a success is a matter of hard work; luck has little or nothing to do with it.
   Getting a good job depends mainly on being in the right place at the right time.
10. The average citizen can have an influence in government decisions.
    This world is run by the few people in power, and there is not much the little guy can do about it.
11. When I make plans, I am almost certain that I can make them work.
    It is not always wise to plan too far ahead because many things turn out to be a matter of luck anyway.
12. In my case, getting what I want has little or nothing to do with luck.
    Many times we might just as well decide what to do by flipping a coin.
13. What happens to me is my own doing.
    Sometimes I feel that I don't have enough control over the direction my life is taking.

Please rate how often you think the following statements apply to you (from Almost never to Almost always):

1. I plan tasks carefully
2. I am self-controlled
3. I am a careful thinker
4. I save regularly
5. I like to think about complex problems
6. I am more interested in the present than the future

[Socio-Demographic Information]

PART C – Socio-Demographic.

Please indicate your gender:

1. Male
2. Female

How old are you? (in years)

In which city do you live?

What country are you from?

Please indicate your status in your current primary residence

1. Married or living as a couple (with or without children)
2. Living with parents or other relatives
3. Living alone
4. Living as a single parent
5. Sharing a house/flat with non-family members

Do you believe in God?

What is your field of study?

How would you rate the likelihood of you being infected by Covid19? (Not at all to Certainly) You can choose not to answer this question.

How would you rate of the current world health situation? (Not at all frightening to Very frightening). You can choose not to answer this question.

Are you currently in quarantine? You can choose not to answer this question.

Have you been infected by Covid-19? You can choose not to answer this question.

Is someone close to you infected by Covid-19? You can choose not to answer this question.

[Rewards scheme]

Whether you are a winner and will receive money according to your choices in the beginning of the survey will be determined by chance. On the scale below please pick a number between 1 and 100.

We will then randomly draw a number between 1 and 100. If the numbers are the same, you will be a winner and one of your choices will be drawn randomly to determine your additional payments.

Randomly draw a number between 1 and 100, and display it at the beginning of the next page. Also insure no one can reload the previous page or redraw another number.

If you do not want to take part in the lottery, please select the checkbox bellow. You will still be awarded with the standard incentive for completing the questionnaire.

[IF TICKED, SKIP TO END]

If the randomly generated number DOES NOT MATCH the one selected by the respondent

[Flow loosers]

Unfortunately the number that was drawn was not the same as the one you had picked. You were not selected for the additional payments. Please proceed to the end of the survey, to earn your participation reward. s

If the randomly generated number DOES MATCH the one selected by the subject

[Flow winners]

Congratulations! You have been selected! Now one of your choices (made during Part A-Decision Task) will be randomly selected and played. Click on the next button so that one of your choices is chosen by chance.

Randomly select a line played during PART A, then play the choice made by the respondent (when heads or tails is involved), then display the corresponding gains and delivery date.

[Random draw]

Your additional payments are: corresponding gains and delivery date

Please go to the next page in order to give us your telephone number linked to your Lydia account and receive your prize.

[Ending]

We thank you for your participation.

We would like to invite you to participate to other experiments where you can earn more money. Could you please provide us with your email address so we can invite you to other studies?

This survey is anonymous, and you can provide whatever email address you want. This email address will not be linked to your answers in this survey.

To be invited to the next experiments, we ask you to create an anonymous code. Please create it in the following way.

The first letter of your first name, the first letter from your name, your month of birth, your year of birth, and your year of study.

For example, for John Smith, born in march 1963, studying in Bach 3:

JS0319633

Please keep this code. This anonymous identification code will be asked again in the next studies.

For this study, you will be paid on your Lydia account with the previously specified time delay, please provide us your telephone number linked to your Lydia account.

If you do not have a Lydia account, please create one. To learn about how to create a Lydia account, please do it by clicking on: https://support.lydia-app.com/l/en/article/2314kswwsu-how-do-i-create-a-lydia-account.

In order to be paid, please fill carefully your phone number:

Please make sure to click on the “end” button to finish the survey and receive your participation rewards.