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Modelling refugee migration under cognitive biases: Experimental evidence and policy☆

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ABSTRACT

In this paper, we develop a model for refugee migration. As refugees' migration choices are made in a risk-laden environment, we compare two different theoretical frameworks of decision making under risk, namely Expected Utility Theory (EUT) and Cumulative Prospect Theory (CPT). This last framework accounts for a reference point, loss aversion, and probability distortion. We estimate refugees' risk and time preference parameters using field experimental data and show CPT better explains refugees' risk behaviour on average. We also investigate policy implications based on simulations. We show that, under CPT, compared to standard EUT, the value of migrating is consistently lower and the migration decision is more sensitive to policy changes. Our results suggest refugees may self-select based on their risk preferences, those exhibiting more loss aversion or less probability sensitivity being more likely to renounce migration as a reaction to migration policies.

1. Introduction

In the continuing of the recent refugee crisis, thousands of individuals need to flee their countries, facing risky choices between different routes and destinations. The United Nations High Commissioner for Refugees (UNHCR)[1] for example, estimates that the total number of persons dead and missing in the Mediterranean between 2014 and October 2019 was 18 500, approximately 1% of arrivals. Western policy makers are very keen to find solutions to the refugee crisis by proposing different policies and regulations. However, unintended consequences may hamper the effectiveness of existing measures. For example, Czaika and Hobolth (2014) show that restrictive asylum policies have led to an increase in irregular migration in the European Union.[2]

All countries that are signatories to the 1951 Refugee Convention have similar objectives[3]: providing protection for those in need while simultaneously preventing irregular immigration. These goals would be compatible if asylum migration was distinct from irregular migration, which is true for refugees entering in a European country via the European resettlement programme. However, resettlement concerns a tiny minority: only 2% of asylum applications in 2017.[4] The vast majority of persons seeking asylum in the European Union migrate irregularly.

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[1] See https://data2.unhcr.org/en/situations/mediterranean.

[2] See also Brekke et al. (2017) on deflection effects.

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Defining 'refugees' as 'people fleeing conflict or persecution',[5] it follows that any policy aiming to combine refugee protection in the European Union with curbing irregular migration should have a differentiated impact on refugees and on other migrants.

In this perspective, in order to predict the effects of a policy, models that are able to take into account different incentives and which are able to explain observed behaviour are required. For example, why do people risk their lives by boarding unseaworthy boats to cross the Mediterranean? Why do almost 85% of forced migrants stay in their region of origin? To answer this kind of questions and regulate refugee flows, an accurate understanding of refugee migration decisions and their reactions to policies is needed.

Refugees may behave differently from other types of migrants as a result of experiencing traumatizing events, especially when confronted with risk. Since the seminal work of Von Neumann and Morgenstern (1944), the Expected Utility Theory (EUT) is the main and most widely used theoretical framework to describe and explain decisions in a risky environment. However, since Allais (1953), it has been shown that EUT, which considers the individual as a rational utility maximizer, is not always appropriate for predicting all decisions that individuals can make under risk. As a result, Tversky and Kahneman (1992) developed Cumulative Prospect Theory (CPT), which aims at modelling different cognitive biases into the decision process of individuals. The existence of a reference point, loss aversion, and probability distortion explain seemingly irrational patterns of behaviour.

Refugees' migration choices are made in a risk-laden environment. Cognitive biases related to risk, such as those included in Prospect Theory, can therefore have a significant impact on their decisions. As a consequence, when trying to understand refugees' decisions, it is crucial to study population specificity in terms of cognitive bias and decision making under risk. Research has shown both that risk preferences may also vary across individuals[6] and that similar traits can be found according to individual characteristics such as country of origin or whether they are migrants or not.[7]

In this paper, we develop a simple theoretical model of refugee migration under two different decision frameworks, namely EUT and CPT. We then measure the risk preferences of a sample of refugees. In the years 2017–2018, we gathered information from 218 refugees arriving in Luxembourg, and risk preferences were measured using the protocol developed in Tanaka et al. (2010). The elicited risk preferences and other socio-demographic information gathered then served for running numerical simulations, based on our two theoretical frameworks.

Our work contributes to the existing literature by proposing a decision migration model, based on the CPT framework. Czaika (2009b), Schaeffer (2010), and Djajić (2014) develop migration models exclusively based on EUT. Ceriani and Verme (2018) compare EUT and Quantile Maximization framework. Czaika (2015) uses CPT features in an empirical study which aims to explain determinants of intra-European aggregate migration inflows to Germany.

Our experimental results show that subjects behave according to CPT at the aggregate level: on average, they exhibit a concave utility function in the gain domain, they are loss averse, and they tend to overweight low-probability extreme events. We thus offer evidence that the inclusion of cognitive biases through CPT may be relevant for analysis of policy effects on refugee migration. The simulation results show that the net value of moving West is consistently lower under CPT than under standard EUT, whatever the policy context. Moreover, the CPT framework generally shows a greater sensitivity of the migration decision to policy changes than EUT. Last, we observe thresholds in the policy effects under both frameworks. Our results suggest that there may be self-selection of refugees who decide to migrate, based on their risk preferences. Persons with higher loss aversion and/or lower probability sensitivity are more likely to be discouraged from migrating, irrespective of the validity of their potential asylum claim.

In what follows, we briefly review the literature on refugee migration, risk preferences and cognitive biases (Section 2). We then develop the two versions of our model of refugee migration in Section 3, before explaining the experimental setup (Section 4), and discussing the experimental results in Section 5. Then we run simulations in Section 6, before offering some concluding remarks (Section 7).

2. Refugee migration, risk, and cognitive biases

The migration decisions of refugees, as distinct from those of other types of migrants, are theoretically modelled in Czaika (2009b), Schaeffer (2010), and Djajić (2014) as a combination of economic and non-economic push and pull factors that influence individuals' decisions. Refugees decide to migrate to a Western country, a third safe country, or a refugee camp close to their country of origin on the basis of the value of the different options. Furthermore, individual differences between refugees leading some persons to migrate and others not to are explained in Czaika (2009a) by heterogeneous persecution levels. Similarly, in Schaeffer (2010) the decision to flee is found to depend on the severity and credibility of the threat relative to alternatives. Neither model allows for an explanation of why persons who face a similar threat, such as the inhabitants of a town that is involved in fighting in a civil war, make different migration choices. While Djajić (2014) allows for a universal threat in a conflict zone, migration decisions only depend on differences in skill levels. This begs the question of why persons with the same skill level make different choices. The predictive power of all of these models is limited because they only include some of all the characteristics that can lead to individual migration patterns.

Refugees may not share the same risk preferences of other populations, including other types of migrants. First, they are forced migrants: leaving their homes does not result from choice but from necessity.[8] The lack of choice regarding whether to migrate or not may undermine the classical process of self-selection on observable characteristics such as skills, for example. As suggested by Umblijs (2012), forced migration may be a process of self-selection in which the least risk-averse individuals migrate. Second, many refugees migrate without visas and can thus be characterized as illegal immigrants. In a study comparing illegal to legal migrants in Senegal, Arcand and M'Baye (2013) find that the willingness to migrate illegally is affected by risk aversion, whereas Mbaye (2014) shows that potential illegal immigrants are willing to accept a substantial risk of death when they decide to migrate. The third characteristic that may be significant in distinguishing refugees from other migrants is the experience of traumatizing events. Experimental studies since Lerner and Keltner (2001) have shown that trauma and conflict may alter risky choices and preferences.[9] For example, Eckel et al. (2009) and Voors et al. (2012) show that the experience of trauma may lead to risk-seeking behaviour, while for Li et al. (2011) risk-seeking behaviour occurs only in the gain domain and there is an opposite effect in the loss domain. As a consequence, while migrants may or may not be different than other populations in terms of risk behaviour, refugee experiences of violence may exacerbate a risk-seeking behaviour or diminish it.[10]

In this paper, we argue that taking into account individuals' risk preferences may explain the differing behaviour of persons who have

[6] See, for example, Guiso and Paiella (2004) and Williams and Baláž (2014).

[7] For example, Hsee and Weber (1999) find significant differences in cross-national risk preferences. For a review of demographic differences, see Holt and Laury (2014).

[8] See, for example, Schmeidl (1997).

[9] The psychological trauma investigated in the literature can be induced by natural causes or can be man-made and can be experienced personally or in proximity.

[10] Most respondents in our study reported having lost someone close in the war or during the journey, or to have suffered from other traumatic experiences.

similar observable characteristics and face the same risks. There exist some studies that evaluate migrants' risk preferences, although most of the analyses are based on surveys including a non-incentive-compatible question on how a person considers his risk preferences.[11]

Differently from previous studies, our work makes use of an experimental setup in order to measure refugee risk preferences. The experimental approach is basically grounded on the inherent advantages of experiments, which make it possible to test the predictions of existing theories, gain insight into how to improve these theories, and investigate the effects of the framing of decisions. Furthermore, experiments may avoid difficulties such as multifactor causes (risk perception, social norms, absence of incentives, etc.) that are common to studies using household surveys. The experimental approach has the additional advantage of providing detailed insight into individuals' decision making under risk. Most of the aforementioned studies focus on risk aversion, using the EUT framework. But in the past decades, several critiques, such as the Allais paradox (Allais, 1953), showed that EUT may present an insufficient explanation of human behaviour in many cases involving risk. CPT is widely considered as the most compelling alternative theory for describing individuals' choices under risk.[12]

Cognitive biases related to risk, such as those included in CPT, can indeed have a significant impact on the decision-making process. In particular, CPT allows taking into account the endowment effect (Thaler, 1980), which is a preference of individuals for the current state. In other words, the disutility of giving something up is greater that the utility of acquiring it. CPT incorporates this bias into the concept of loss aversion, the asymmetry of value between gains and losses. Value is not assigned to final assets but rather to gains and losses relative to a reference point. The utility function, which is empirically found to be concave for gains and convex for losses, is also steeper for losses than for gains when individuals are loss averse. Furthermore, objective probabilities are replaced by subjective decision weights. It allows overweighting low-probability outcomes, and underweighting high-probability outcomes to represent how people perceive risks.

There is some empirical literature that applies different forms of risk modelling to migration choices.[13] However, to our knowledge there is only one study that uses data to test the risk preferences of refugees: Ceriani and Verme (2018) point out the limits of EUT for the decision to flee and compare its predictive power to that of a Quantile Maximization model. They find that Quantile Maximization fits the data for Nigerian forced migrants best: risk-averse individuals make their decision as a function of the worst outcome, while risk-lovers focus on the best outcome. However, their study is limited by the use of a household survey using non-incentive-compatible questions on how a person considers his risk attitude.

In addition, the migration literature has not invested much in experimental methods to study migrants' risk preferences (Baláž & Williams, 2017). To our knowledge, the only exceptions are experiments based on the setup developed in Fox and Tversky (1995), applied by Baláž and Williams (2011) and Hao et al. (2014), who study whether migrants show increased risk tolerance compared to non-migrants. The probability distortion of migrants is studied experimentally by Bah and Batista (2017), who find that potential illegal migrants overestimate both the risk of dying en route to Europe and the probability of obtaining residency status.

CPT was empirically tested and found to be a good fit for explaining German migration flow data (Czaika, 2015). Furthermore, Baláž et al. (2013) show that there is no significant difference between Slovak migrants and non-migrants when comparing their CPT parameters. Both of these studies suggest the pertinence of CPT for understanding decisions taken by migrants.

The current literature thus offers enough evidence that alternative decision models may question the relevance of EUT, and there is enough proof that CPT may play an important role in the migration decisions of refugees.

3. Model of refugee migration

In what follows, we develop a simple model of migration, under two alternative decision frameworks. Basing one the same timing and story (3.1), the first version uses the EUT framework (3.2), and the second one the CPT framework (3.3). We highlight how decision is altered by different contexts and policy parameters.

3.1. Story and decision structure

We assume that all material and immaterial aspects of living conditions have a revenue equivalent. We further suppose that the decision maker is situated in a country of first asylum, noted as a safe country. Indeed, we assume that the decision maker needed to flee his home country urgently and so has not had time to plan the migration before arriving in the safe country of first asylum. We thus focus here on the decision taken in relative safety, in this safe country where it is possible for the decision maker to gather information and consider his options.

We suppose that the decision maker faces two alternatives (See Fig. 1):

1. Staying in this safe country and earning y_S for the rest of the time horizon;
2. Trying to migrate to a Western country. This alternative is costly and risky: different outcomes can be obtained depending on the realization of probabilistic lotteries. Both a very good outcome (a new life in a relatively wealthy country) and very bad outcomes (rejection or even death) must be envisaged.

The final payoff in the West depends on the realization of two lotteries (see Fig. 2).

With probability $(1 - p_1)$, migration to the West fails. This may be because of a fatal accident or due to internment in a reception camp. In this case, the lowest income is earned and we normalize it to zero.

With probability p_1, the trip is successful. In this case, we suppose that the decision maker applies for asylum. This leads to a second lottery: with probability p_2, the decision maker is granted asylum and obtains a periodic revenue of y_W for the rest of the time horizon. Probability p_2 of obtaining asylum is thus conditional on having made a successful trip.

With the complementary probability $(1 - p_2)$, the decision maker's claim is rejected. In that case, he is deported to a third country, where he receives a lower revenue than in the safe neighbouring country: $y_T = \rho y_S$, with $0 \leq \rho < 1$. Parameter ρ expresses different degrees of suffering, and may reflect the difficult living conditions of staying in this third (and less wealthy) country and/or the psychological cost of having failed to obtain asylum. We assume both p_1 and p_2 to be exogenous for the decision maker.

[11] See Akgüç et al. (2016), Bonin et al. (2009), Dohmen et al. (2011), Dustmann et al. (2017), Gibson and McKenzie (2011), Jaeger et al. (2010).

[12] Barberis (2013) gathers a lot of experiments that assess the predicting power of CPT, and shows it can be more accurate than EUT for describing decisions under risk. However, Harrison and Rutström (2009) show that the predicting power of EUT *vs.* CPT depends on the context and people's demographic characteristics. No theory always dominates the other one. Harrison et al. (2016) even suggest that Rank Dependent Expected Utility (an extension of EUT that includes probability distortion) performs better than CPT in a wide range of situations. However, all these studies were conducted with US students, a rather homogenous population, and having not suffered trauma to the same extend than refugees.

[13] See Akgüç et al. (2016), Bonin et al. (2009), Dohmen et al. (2011), Dustmann et al. (2017), Gibson and McKenzie (2011) and Jaeger et al. (2010).

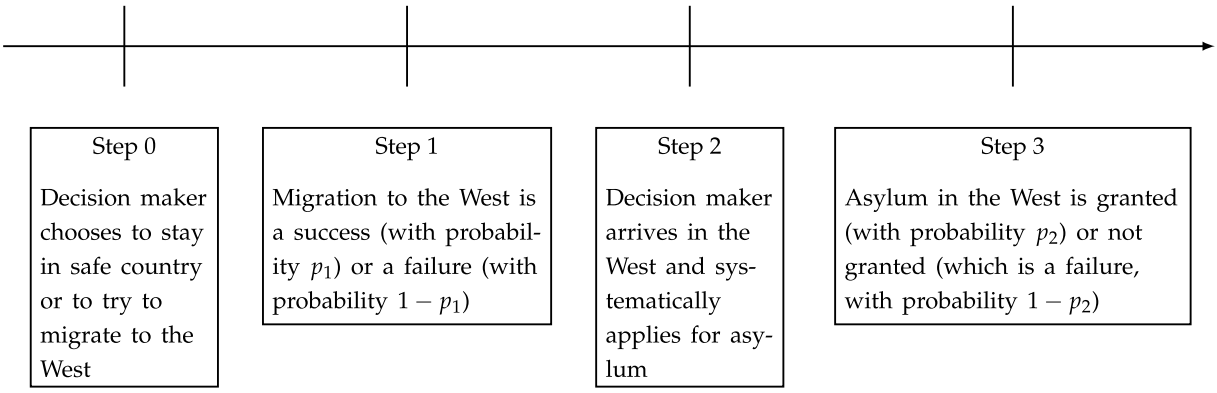

Fig. 1. Storyline.

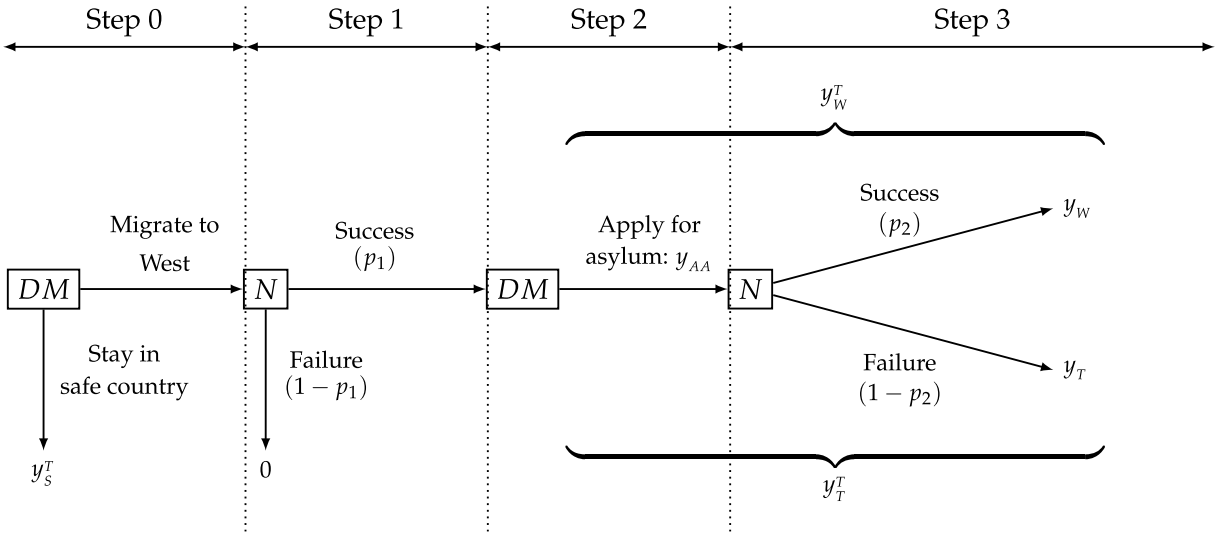

Fig. 2. Decision tree with payoffs.

We suppose a time horizon of T. The decision maker discounts future incomes. Thus, in the safe country the decision maker's lifetime expectation of revenue is:

$$y_S^T = \int_0^T y_S.D(r,t).dt,$$

with r being the discount rate and $D(r,t)$ the discounting function, which can take one of the two main forms found in the literature: exponential discounting or hyperbolic discounting.[14] The exponential discounting function is $D(r,t) = e^{-rt}$.[15]

Applying for asylum is a legal procedure which, depending on the country, can last a long time (6 months to 1, or even 2 years, or more until a final decision is made). We denote by T_A the response time to the asylum application. During this time, the applicant receives a periodic subsidy, y_{AA}, which may be higher or lower than y_S.[16]

As a consequence, taking into account this response time leads to the following different lifetime expectations. The expected payoff in case of being granted asylum in a Western country is

$$y_W^T = \int_0^{T_A} y_{AA}.D(r,t).dt + \int_{T_A}^T y_W.D(r,t).dt, \tag{1}$$

and in case of an unsuccessful asylum application and deportation to a third place it is

$$y_T^T = \int_0^{T_A} y_{AA}.D(r,t).dt + \int_{T_A}^T y_T.D(r,t).dt$$
$$= \int_0^{T_A} y_{AA}.D(r,t).dt + \int_{T_A}^T \rho y_S.D(r,t).dt. \tag{2}$$

We assume $y_T^T < y_S^T < y_W^T$. We do not presuppose the ranking between y_{AA} and y_S, but we suppose that $y_{AA} > y_S$ cannot lead to $y_T^T > y_S^T$ because of the suffering in the third country. In other words, the value of ρ is sufficiently low to ensure $y_T^T < y_S^T$.[17] In contrast, $y_{AA} < y_S$ cannot lead to $y_W^T < y_S^T$ whatever the value of ρ: enjoying y_W (which is higher than y_S) in case of success in the asylum application ensures $y_W^T > y_S^T$.

Trying to move to a Western country is costly: we suppose that the decision maker has to pay an initial lump-sum amount C^{Te} that he may have to borrow.[18] As a consequence, choosing this alternative supposes repaying the loan, and this reduces the lifetime expectation

[14] See Benhabib et al. (2004), Carrillo and Mariotti (2000), Phelps and Pollak (1968) and Tanaka et al. (2010).

[15] Alternatively, the hyperbolic discounting function is $D(r,t) = \frac{1}{1+rt}$. The hyperbolic discounting function needs to be used when there is a present bias.

[16] For example, in France the *allocation pour demandeur d'asile* is of 6.80 euros per day for a single adult (Service-Public.fr, 2018).

[17] Moreover, assuming $y_T^T < y_S^T$ makes it more difficult to decide to migrate to the West, which makes it possible to highlight sufficient (but not necessary) conditions for deciding migration (see the propositions below).

[18] In our sample, only 54% of the first 100 respondents financed their journey using their own resources. An additional 28% were financed by their family.

of this alternative by an amount

$$C^{Te} = \int_0^{Te} c.D(r,t).dt,$$

with Te being the repayment horizon and c the periodic amount of repayment. Note that this repayment has to be made whatever the outcome of the asylum process.

In the next two subsections, we develop the decision model, first in the EUT framework, and then in the CPT one. We highlight the conditions for which the decision maker decides to migrate. A comparison of these two frameworks is provided.

3.2. Expected utility theory framework

Consider first that the decision maker is an EUT-maximizer. We assume the decision maker has a power utility function $U(x) = x^{\alpha}$, with $\alpha > 0$. This type of utility function covers cases of a risk-averse (if $\alpha < 1$), risk-neutral ($\alpha = 1$), and risk-loving decision maker ($\alpha > 1$). The parameter α is thus directly linked to the degree of risk aversion, through the curvature of the utility function (respectively concave, linear, convex). The decision maker exhibits a decreasing absolute risk aversion: the wealthier he is, the less he is affected by an additional risk to his wealth.[19]

The decision maker decides to migrate to the West instead of staying in the safe neighbouring country as soon as the value of migration, $V_{EUT}(West)$, is higher than that of staying in the safe country, $V_{EUT}(Safe)$. We obtain the following net value of migration to the West for an EUT-maximizer:

$$V_{EUT}(West) - V_{EUT}(Safe)$$
$$= p_1.p_2(y_W^T - C^{Te})^{\alpha} + p_1.(1-p_2)(y_T^T - C^{Te})^{\alpha} + (1-p_1)(0)^{\alpha} - (y_S^T)^{\alpha}. \quad (3)$$

Migration is decided as soon as this value is positive. We obtain the following results.

Proposition 1. *(i) The following condition is a sufficient (but not necessary) condition for a EUT decision maker to prefer trying to leave for the West over staying in the safe neighbouring country:*

$$\alpha > \frac{-ln(p_1) - ln(p_2)}{ln(y_W^T - C^{Te}) - ln(y_S^T)}.$$

(ii) For a given probability of success in the asylum application (p_2), the effect of a variation in the waiting time to the granting/rejection of an asylum application (T_A) depends on both the degree of risk aversion and the revenue y_W. The higher is y_W, the more likely risk-averse individuals ($\alpha < 1$) (risk-loving individuals ($\alpha > 1$)) will be positively (negatively) affected by an increase in T_A.

(iii) Increasing the revenue when waiting for the granting/rejection of an asylum application y_{AA} always increases the net value of migration. However, for a given degree of risk aversion (α) the strength of this effect depends on the probability of success of the asylum application (p_2). The higher the value of p_2, the lower the positive effect for a risk-averse individual ($\alpha < 1$) and the higher the positive effect for a risk lover ($\alpha > 1$). The reverse holds: the lower is the value of p_2, the higher the positive effect for a risk-averse individual ($\alpha < 1$) and the lower the positive effect for a risk lover ($\alpha > 1$).

(iv) An increase in the conditional probability of obtaining asylum (once arrived in the West), p_2, provides higher incentives to go to the West.

Proof. see Appendix A.

Proposition 1 point (i) states that the higher the value of α, i.e., the more convex (or the less concave) the utility function of the decision maker, the higher the likelihood of the decision maker preferring to go to the West over staying in the safe neighbouring country. A higher convexity of the utility function means the marginal utility (of wealth) is increasing (with the level of wealth). Because going to the West is associated with the highest—but not a certain—payoff, this prospect is more valued by the decision maker in case of a more convex utility function. This can also be interpreted in terms of preference towards risk: more convexity leads to lower risk aversion. As a consequence, in case of a risky alternative associated with a high-payoff prospect and a low-payoff prospect, a less risk-averse decision maker focuses more on the opportunity to reach the high payoff than the threat of the low payoff. This result confirms the observations in Ceriani and Verme (2018). Note that as $0 < p < 1$, an increase in p leads to a decrease in $ln(p)$: if the probability of obtaining refugee status in the West is higher, then more risk-averse persons decide to try to flee to the West.

3.3. Cumulative prospect theory framework

Under EUT, individuals' preferences towards risky prospects are entirely captured by the degree of convexity of the utility function $U(x)$ (i.e. the value of α, for $U(x) = x^{\alpha}$). Instead, under Tversky and Kahneman (1992)'s CPT which we consider now, subjects' preferences depend on the interplay between three features. First, individuals assess the value of prospects relatively to a reference point, which we note z. A prospect x will be considered as a gain if $x > z$, and it will be considered as a loss if $x < z$. Net gains or losses, say y with $y = x - z$, are both evaluated via the application of a utility function $v(y)$. This function is notably characterized by a power σ, with $\sigma > 0$ (see below).[20] A second feature of preference is loss aversion, which is represented by a coefficient λ (with $\lambda > 0$). In case of $\lambda > 1$, subjects are more sensitive to losses than to gains. As a result, a prospect y has a utility $v(y)$ which is:

$$v(y) = \begin{cases} y^{\sigma} & \text{if } y > 0 \\ 0 & \text{if } y = 0 \\ -\lambda(-y)^{\sigma} & \text{if } y < 0. \end{cases} \quad (4)$$

With this specification, in gains, σ is an anti-index of concavity of that value function, and in losses σ is an anti-index of convexity of that value function. Finally, a third and last feature of preference lies in probability distortion. This is represented by the application of a weighting function $\omega(.)$ over objective cumulative probabilities. All-in-all, the value V_{CPT} of any binary lottery $\tilde{L} = (y_1, y_2; p, (1-p))$, with y_1 and y_2 being two different prospects and $0 < p < 1$ being the probability of getting y_1, is as follows:

$$V_{CPT}(\tilde{L}) = \begin{cases} \omega(p).v(y_1) + [1-\omega(p)].v(y_2) & \text{if } y_1 \geq y_2 \geq 0 \text{ or } y_1 \leq y_2 \leq 0 \\ \omega(p).v(y_1) + \omega(1-p).v(y_2) & \text{if } y_1 < 0 < y_2, \end{cases} \quad (5)$$

with $\omega(.)$ strictly increasing from the unit interval into itself and satisfying $\omega(0) = 0$ and $\omega(1) = 1$. As regards the specification of $\omega(.)$, we will follow Prelec (1998) who proposes: $\omega(p) = exp[-(ln(1/p))^{\gamma}]$. The parameter γ, which takes value in $[0, +\infty]$, defines the nature of the probability distortion, and acts as an index of probability sensitivity: when $\gamma = 1$, then $\omega(p) = p$, meaning that there is no probability distortion. When the value of γ tends to 0, then the individual tends to perceive all probabilities as all being equal (i.e., all values of p lead

[19] The use of the power function is widely recognized in the economic literature, and it has the advantage of giving us the ability to directly interpret α as an indicator of risk aversion: the Arrow–Pratt indicator of absolute risk aversion ($-\frac{u''(x)}{u'(x)}$) associated with a utility function $U(x) = x^{\alpha}$ reduces to $-\frac{(\alpha-1)}{x}$.

[20] Recall that EUT does not make any distinction between gains and losses, since all prospects are valued as regards the level of final wealth, which takes into account all the subject's wealth. As a consequence, the utility function $U(x)$ is defined in $[0, +\infty]$, with 0 being the case of no wealth at all — or even death.

to the same value of $\omega(p)$). And when the value of γ tends to $+\infty$, then probabilities are perceived as extremely contrasted, resulting in probability weights of either 0 or 1 depending, respectively, on whether the objective probability is lower or higher than a threshold value Z (with $0 < Z < 1$). In symbols, in that case we have $\omega(p) = 0 < p$ for $p < Z$, $\omega(p) = 1 > p$ for $p > Z$.

Coming back to our study case, we define the lifetime expected revenue y_S^T as the reference point because it is from the safe country that the refugee considers the perspective of migration. With respect to this reference point y_S^T, both y_T^T and 0 represent negative prospects (i.e. losses) because $y_T^T - y_S^T < 0$, $0 - y_S^T < 0$. Indeed, in the case of a rejected asylum application, going to a third place may lead to a loss (relative to staying in a safe neighbouring country). *A fortiori*, to die during the trip to the West is a loss relative to living in a safe neighbouring country.

On the contrary, success in obtaining asylum in a Western country leads to a positive prospect: even in the case where the subsidy y_{AA} the decision maker receives (while waiting to hear of the status of his application for asylum) is lower than the revenue he can earn in the safe neighbouring country y_S. We assume that earning y_W for the rest of the time horizon always ensures that $y_W^T > y_S^T$.[21]

The decision maker decides to migrate to the West instead of staying in the safe neighbouring country as soon as the CPT value of migration, $V_{CPT}(West)$, is higher than that of staying in the safe country, $V_{CPT}(Safe)$. We obtain the following net value of migration to the West for a decision maker responding to CPT:

$$\begin{aligned} &V_{CPT}(West) - V_{CPT}(Safe) \\ &= \omega(p_1.p_2)((y_W^T - C^{Te}) - y_S^T)^\sigma + \\ &[\omega(1 - p_1p_2) - \omega(p_1(1 - p_2))](-\lambda)(-(0 - y_S^T))^\sigma \\ &+\omega(p_1(1 - p_2))(-\lambda)(-((y_T^T - C^{Te}) - y_S^T))^\sigma - (y_S^T - y_S^T)^\sigma, \end{aligned} \tag{6}$$

with $\omega(p) = exp[-(ln(1/p))^\gamma]$ and $\omega(1 - p) = exp[-(ln(1/(1 - p)))^\gamma]$. Migration to the West is decided as soon as this value is positive. We obtain the following results.

Proposition 2. *The following condition is a necessary (but not sufficient) condition for a CPT decision maker to prefer trying to leave for the West over staying in a safe neighbouring country:*

$$\sigma > \max\{A, B\}, \tag{7}$$

with

$$A = \frac{ln\left(\omega(p_1(1 - p_2))\right) + ln(\lambda) - ln\left(\omega(p_1p_2)\right)}{ln\left((y_W^T - C^{Te}) - y_S^T\right) - ln\left(-((y_T^T - C^{Te}) - y_S^T)\right)},$$

$$B = \frac{ln\left(\omega(1 - p_1p_2) - \omega(p_1(1 - p_2))\right) + ln(\lambda) - ln\left(\omega(p_1p_2)\right)}{ln\left((y_W^T - C^{Te}) - y_S^T\right) - ln\left(-(0 - y_S^T)\right)}.$$

Proof. see Appendix A.

We attempt to distinguish between different effects in the two following propositions. For this purpose, Proposition 3 concerns the specific case where no probability distortion holds (i.e. $\gamma = 1$) and Proposition 4 highlights the effects of probability distortion.

Proposition 3. *In the case where no probability distortion holds (i.e. $\gamma = 1$, $\omega(p) = p$):*

(i) The higher the loss-aversion (λ), the fewer incentives an individual has to migrate to the West;

(ii) Increasing the waiting time for an asylum application (T_A) has different effects, the importance of which depending on the value of σ: the higher is y_W, the more likely an individual characterized by $\sigma < 1$ ($\sigma > 1$) will be positively (negatively) affected by an increase in T_A;

(iii) Increasing the revenue received when waiting for an asylum application to be decided upon (y_{AA}) increases the net value of migration. In the case of an individual characterized by $\sigma < 1$, the magnitude of this effect is high when p_2 is low and the loss-aversion parameter λ is high. When $\sigma > 1$, this effect is high when p_2 is high.

Proof. see Appendix A.

Proposition 4. *(i) When $\gamma < 1$, a variation in the conditional probability of success in the asylum application (p_2) has a lower impact on the net value of migration than if no probability distortion exists only in cases where the concerned states of nature are associated with an objective probability lying in a given interval of values (see details in Appendix A). Otherwise, the effect is greater.*

However, the impact of a variation in payoffs (e.g. through a variation in y_{AA} or in T_A) crucially depends on the value of the objective probabilities that are associated with them (see details below).

(ii) When $\gamma > 1$, a variation in the conditional probability of success in the asylum application (p_2) has a higher impact on the net value of migration than if no probability distortions exist only in cases where the concerned states of nature are associated with an objective probability lying in a given interval of values (see details in Appendix A). Otherwise, the effect is lower.

The impact of a variation in payoffs (e.g. via a variation in y_{AA} or in T_A) crucially depends on the value of the objective probabilities that are associated with them (see details below).

Proposition 3 highlights the pure effect of a variation in payoffs (via a variation in y_{AA} or in T_A), and the effect of loss aversion (λ), independent of any probability distortion. The effect of a variation in λ is trivial since it only affects one of the two possible alternatives (the second alternative—the safe neighbouring country—being the reference point). Concerning the (pure) effects of variations in y_{AA} or in T_A, we remark that these effects are very similar to those highlighted under EUT: they crucially depend on the convexity of the utility function in the gain domain, here represented by the parameter σ. Individuals with a concave utility function in the gain domain (i.e. $\sigma < 1$) exhibit a decreasing marginal valuation of wealth: they are more affected by a variation in wealth when the initial wealth is low than when it is high. So we again find that the higher is y_W, the more likely an individual with $\sigma < 1$ will be positively affected by an increase in T_A, which allows him to reduce the number of periods of suffering y_T. This effect is reinforced by the loss-aversion parameter λ, which is associated with this prospect.

As regards the effect of an increase in y_{AA}, again, this effect always increases the value of the prospect of going to the West. Increasing y_{AA} implies an increase in the payoff associated with the prospect of not obtaining asylum, and this takes high values for an individual characterized by $\sigma < 1$. As in the case of EUT, this effect is reinforced if p_2 is low, but under CPT this effect is even more reinforced if λ is high: improving the outcome in the worst prospects leads to high values under CPT.

While the effects highlighted by Proposition 3 hold in the case of no probability distortion (i.e. $\gamma = 1$), these effects may be distinctly altered by how individuals perceive probabilities. Proposition 4 underlines the role of the weighting function in individuals' perceptions of variations in other variables. In point (i), note that in the case of $\gamma < 1$ individuals tend to overestimate low probabilities and to underestimate high probabilities (inverse S-shaped weighting function). All probabilities tend to be equally perceived, i.e., to all have a weight of $\frac{1}{n}$, with n being the number of states of nature (this is strictly the case for $\gamma = 0$ and so, in that case, a variation in objective probabilities is not perceived). As regards the impact of a variation in payoffs, consider as an example the outcomes associated with objective probabilities that are lower than $\frac{1}{n}$. These probabilities are thus overestimated. As a consequence, they

[21] In other words, the asylum claim treatment time, T_A, is short enough to ensure $y_W^T > y_S^T$ in the case where $y_{AA} < y_S$.

also lead the associated payoffs to be more weighted in the individuals' valuation functions than if no probability distortions exist. As a result, a variation in these payoffs has a higher impact on individuals than in the case of no probability distortion. The opposite reasoning holds for objective probabilities higher than $\frac{1}{n}$, which are underestimated. In our study, we have $n = 3$: in the case of $\gamma < 1$, any variation in payoffs associated with objective probabilities lower than $\frac{1}{3}$ has a higher impact on individuals than if no distortion exists.

In point (ii), in the case $\gamma > 1$ the weighting function is S-shaped: small objective probabilities are lowered and high objective probabilities are raised. In the extreme case of $\gamma \to \infty$, all objective probabilities lower than a threshold Z are perceived as zero and all objective probabilities higher than the threshold Z are perceived as one, with Z being approximately equal to 0.368 with the Prelec specification (when $\gamma = 1000$). In that (extreme) case, a variation in objective probabilities which remain higher or lower than Z is not perceived. As regards a variation in payoffs, to ease the explanation let us first denote by m the number of states of nature that are associated with an objective probability higher than Z (and so $n-m$ states have an objective probability lower than Z). Because objective probabilities higher than Z are raised (and tend to be similar, equal to 1 when $\gamma \to \infty$), the m states of nature (and their payoffs) associated with objective probabilities higher than Z tend to be over-weighted in individuals' valuation functions. The reverse holds with objective probabilities lower than Z, which tend to be under-estimated relative to the no probability distortion case. As a result, for the $(n - m)$ states which are associated with an objective probability lower than Z, a variation in their payoff has a lower impact on individuals (relatively to the case where no probability distortion holds).

We discuss more specifically the impact of a variation in the conditional probability of obtaining asylum (p_2), for the case $\gamma > 1$, in Appendix A.4. Nevertheless, we can note that when $\gamma < 1$ changing 'extreme' (i.e., probabilities close to 0 or 1) have a higher impact than when no probability distortion holds (while changing 'medium' probabilities has a lower impact). Conversely, when $\gamma > 1$ a variation in 'extreme' probabilities is almost not perceived by an individual, whereas a variation in 'medium' probabilities has a high impact. Hence, when $\gamma < 1$, for instance, tightening the policy of access to asylum (i.e. reducing p_2) has an impact when this policy is already strict and a lower impact when the policy is 'lax'. The opposite holds when $\gamma > 1$.

To summarize these findings, the asylum policy effects go in the same direction for the EUT and CPT frameworks. However, the amplitude of the effect depends on the risk parameters. Thus, both frameworks agree that migration to the West becomes more attractive as the sensitivity to high outcomes increases (corresponding to lower risk aversion, or a higher value of α in the EUT framework and a higher value of σ in the CPT framework). The effect of a modification of the duration of the asylum process is ambiguous in both cases and depends on the level of income available to refugees after the acceptance of their claim. However, while an increase in income during the claim always increases the attraction of the West in the EUT framework, in CPT the amplitude of its impact depends on the values of the objective probabilities. The same is true for the probability of asylum acceptance, which is positively correlated to the value of the West in the EUT framework. In CPT, the amplitude of its impact depends on the sensitivity to probabilities.

4. Experimental setup

4.1. Sample and descriptive statistics

We sampled asylum seekers who had arrived in Luxembourg and of whom the socio-demographic characteristics are representative of asylum seekers in the European Union.[22] Asylum seekers are refugees who have not yet been granted recognition status. Obtaining legal refugee status takes several years, during which risk attitudes might change. Recognized refugees were thus excluded from the sample. Focusing on persons who succeed in migrating is of interest because this complements studies in countries of origin on persons who have not migrated.[23] The risk preferences of asylum seekers can also provide valuable information on the choices of persons who do become forced migrants. Underlying this approach is the idea that the choices the asylum seekers make in our experiment can shed light on the choices they made when migrating. Akgüç et al. (2016)'s finding that the risk preferences of migrants are unchanged by substantial changes in the environment, and Dohmen et al. (2011) and Highhouse et al. (2017)'s results show that there exist general traits underlying risk preferences. Their studies provide evidence that there is consistency in risk preferences across situations. We therefore assume that there is a strong correlation between choices made in the experimental context and during the migration. We elicited preferences from 218 asylum seekers aged 18 and over who stayed in Luxembourg during the procedure of recognition of their asylum claim in autumn and winter 2017–2018. We sampled only asylum seekers who had arrived in Luxembourg, and recognized refugees were excluded from the sample. This is because of the longer time the latter had spent in Luxembourg and because the relative security of their status may differentiate their risk preferences from asylum seekers.[24]

Interviews were completely anonymous and took place at the University of Luxembourg, as this setting conveyed a sense of safety to the interviewers and the interviewees. It also underlined the scientific nature of the study. Asylum seekers were randomly recruited from refugee reception centres and mosques by a research assistant and were invited to be interviewed at their convenience. Persons under the age of 18 and those who indicated being aware of having psychological problems were excluded from the study.

Interviews consisted of a baseline questionnaire capturing socio-economic characteristics and their migration, health, future plans, and past experiences. Afterwards, they were asked to participate into two behavioural games: one about their risk preferences and one about their time preferences. The interviews were conducted face to face by the research assistant. Prior to the field work, the research assistant was tested on his comprehension of the questionnaire in Arabic and in English. The entire interview protocol was translated from English into Arabic and back into English by a different translator. The research assistant, accompanied by a member of the research team, registered the answers online. Interviews and experiments were held on a one-on-one basis and took approximately 3/4 of an hour to 1 h. The experiments were explained and tested several times in order to ensure subjects' understanding.

As Table 1 shows, the largest group of subjects originated from Syria (58%), followed by Iraq (22%). These are also the main countries of origin of asylum seekers in Luxembourg and in the European Union.[25] The majority of refugees in the sample (76%) were male, and their

[22] Even though our sample is mostly represented by Syrians and Iraqis, in the conclusion we discuss this weakness. More research incorporating heterogeneity in terms of nationality and education is required.

[23] See Voors et al. (2012) and Callen et al. (2014) on the risk preferences of persons who have stayed in war-torn areas that generated refugee flows.

[24] Our interview design was approved by the French Research Ethics Board, Comité d'Evaluation de l'Éthique de l'INSERM, CEEI-IRB, CEEI-IRB opinion number 17–366 as well as the Ethics Review Panel of the University of Luxembourg (ERP opinion on research project ERP 17-22). The collection of data was declared to both the French and the Luxembourg Commissions for Data Protection. France: CNIL reference 2039994v0 of 23 March, 2017; Luxembourg: CNDP reference R009671/T012217.

[25] Statistics from Eurostat (2019b) and the International Monetary Fund (2019).

Table 1
Descriptive statistics of covariates.

	Mean	Median	Std. Dev.	Nb. of obs.
Socio-demographics:				
Age (in years)	33.70	33.00	9.59	218
Dummy if female	0.24	.	0.43	218
Dummy if married	0.55	.	0.50	218
Number of children	1.62	0.50	1.99	218
Dummy if has children	0.50	.	0.50	218
Highest education level obtained:				
=No education	0.02	.	0.13	217
=Primary education	0.12	.	0.32	217
=Secondary education	0.50	.	0.50	217
=College or University education	0.35	.	0.48	217
=Other education	0.02	.	0.13	217
Dummy if born in Syria	0.58	.	0.50	218
Dummy if born in Iraq	0.22	.	0.41	218
Dummy if sunni muslim	0.84	.	0.36	218
Migration characteristics:				
Length of time since fled country (in years)	2.84	2.00	4.18	217
Length of journey to Europe (in days)	37.39	16.00	86.09	216
Dummy if reached Luxembourg with a visa	0.14	.	0.35	218

average age was 34 years, as compared to 75% of asylum seekers in the 18–34 age group arriving in the EU in 2016 (Eurostat, 2019b). The participants were well educated: 85% completed at least secondary education and 35% held a college or university degree. Over half, or 55%, were married.[26] A minority of subjects earned low incomes in their countries of origin, while 47% reported having earned more than 600 € per month before fleeing. The latter are relatively wealthy—for comparison, the average monthly income in Syria before the war was 234 €, in Iraq (2017) it was 413 €, and in Afghanistan 42 €.[27]

On average, subjects had fled their home country 2.8 years previously and their journey lasted 37 days. Only 14% reached Luxembourg with a valid visa.

4.2. Experimental protocol

4.2.1. Risk task

We adapt Tanaka et al. (2010)'s risk task to elicit asylum seekers' risk preferences parameters in the CPT decision framework. This experimental design has been used in a variety of non-migration-related settings, including in developing countries and rural areas. For instance, Liu and Huang (2013) study risk preferences and pesticide use by cotton farmers in China, Nguyen and Leung (2009) study the risk preferences of Vietnamese fishermen, and Campos-Vazquez and Cuilty (2014) experiment on the role of emotions in Mexican students' risk aversion. Bocquého et al. (2014) measure French farmers's risk parameters, and Bocquého et al. (2022) test students enrolled at a French university with several versions of the original design. The task is based on multiple price lists, which is one of the most used methods for eliciting risk preferences experimentally. Compared to self-declared attitudes, one may argue that multiple price lists are complex and may be subject to miscomprehension.[28] To address this potential issue, we implemented a one-to-one interview setup in which the interviewer could make sure that the method was understood prior to beginning the experiment. A comprehensive introduction of the method was given, including examples, and subjects were shown coloured balls to represent the probabilities of the payoffs of the lotteries.

In more detail, the risk task consists of three series of choices between two binary lotteries (Table 2). The monetary payoffs displayed are similar to those in Tanaka et al. (2010), except that they are expressed in *experimental currency units* or *ecus* (10 *ecu* = 1 €), instead of thousands of Vietnamese dong. Each pair of lotteries is composed of a safe option (lottery A) and a risky option (lottery B).[29] Initially, the expected value of lottery A is higher than that of lottery B (see column 4 of Table 2, not visible from participants). As one proceeds down the rows, the expected value of lottery B increases and surpasses that of lottery A. Participants are asked to switch only once from A to B. In the EUT framework, risk-neutral subjects are expected to choose lottery A first and switch to lottery B as soon as B's expected value gets higher. Risk-averse individuals will switch at a later row and may even never switch, because they value the relative safety of lottery A. On the contrary, risk lovers will switch earlier and may even switch as soon as the first row. The first two series of lotteries involve only positive payoffs, while the third series mixes positive and negative payoffs.

To characterize the CPT behaviour, we adopt the common functional forms described in Section 3.3, similar to those in the original Tanaka et al. (2010) study. For each respondent, the combination of the switching points from series 1 and 2 is used to jointly estimate the curvatures σ and γ of the utility and probability weighting functions respectively. Then, the switching point from series 3 gives individual loss aversion λ, conditional on the value of σ.[30] Note that the usual empirical finding is utility concavity in the gain domain ($\sigma < 1$), loss aversion ($\lambda > 1$), and an 'inverse S-shape' weighting function meaning the low-probability payoffs in the binary lotteries are overweighted ($\gamma < 1$).

The asylum seekers fulfilling the task received an initial endowment of 10 € in shopping vouchers[31] for their participation. We make the standard assumption that respondents' reference point corresponds to

[26] The data related to education level or marital status are not available for Luxembourg. The only available statistics are from https://www.oecd-ilibrary.org/sites/2767da57-fr/index.html?itemId=/content/component/2767da57-fr#figure-d1e1625.

[27] Data from the Ministère des Affaires étrangères et européennes (2019). The latest data for Syria is from 2010.

[28] For a discussion of the advantages and drawbacks of different designs for risk elicitation, see Charness et al. (2013).

[29] See our additional supplementary material with the entire questionnaire and an explanation of the experimental details at https://drive.google.com/file/d/1nLQRdvssGEwrsH6a-uWS4WGq9nKGaBZ4/view?usp=sharing.

[30] For a more detailed explanation of the elicitation technique, from the elicitation of parameter intervals to individual values, see Tanaka et al. (2010). The joint estimation of the three parameters using maximum likelihood methods, as suggested in Harrison and Rutström (2008), is available upon request.

[31] These SODEXO vouchers are valid in major supermarkets in Luxembourg as well as other shops that are accessible to asylum seekers. They are valid for one year, and the goods that can be bought cover most commodities. These were chosen as a close substitute for cash or bank transfers, which were not available for administrative reasons.

Table 2
Tables for the risk task.
Source: Tables adapted from Tanaka et al. (2010).

SERIES 1	Option A: 3 pink + 7 blue	Option B: 1 pink + 9 blue	Exp. payoff difference (A-B)
1	40 ecu if pink or 10 ecu if blue	68 ecu if pink or 5 ecu if blue	7.7
2	40 ecu if pink or 10 ecu if blue	75 ecu if pink or 5 ecu if blue	7
3	40 ecu if pink or 10 ecu if blue	83 ecu if pink or 5 ecu if blue	6.2
4	40 ecu if pink or 10 ecu if blue	93 ecu if pink or 5 ecu if blue	5.2
5	40 ecu if pink or 10 ecu if blue	106 ecu if pink or 5 ecu if blue	3.9
6	40 ecu if pink or 10 ecu if blue	125 ecu if pink or 5 ecu if blue	2
7	40 ecu if pink or 10 ecu if blue	150 ecu if pink or 5 ecu if blue	−0.5
8	40 ecu if pink or 10 ecu if blue	185 ecu if pink or 5 ecu if blue	−4
9	40 ecu if pink or 10 ecu if blue	220 ecu if pink or 5 ecu if blue	−7.5
10	40 ecu if pink or 10 ecu if blue	300 ecu if pink or 5 ecu if blue	−15.5
11	40 ecu if pink or 10 ecu if blue	400 ecu if pink or 5 ecu if blue	−25.5
12	40 ecu if pink or 10 ecu if blue	600 ecu if pink or 5 ecu if blue	−45.5
13	40 ecu if pink or 10 ecu if blue	1,000 ecu if pink or 5 ecu if blue	−85.5
14	40 ecu if pink or 10 ecu if blue	1,700 ecu if pink or 5 ecu if blue	−155.5
SERIES 2	Option A: 9 pink + 1 blue	Option B: 7 pink + 3 blue	Exp. payoff difference (A-B)
15	40 ecu if pink or 30 ecu if blue	54 ecu if pink or 5 ecu if blue	−0.3
16	40 ecu if pink or 30 ecu if blue	56 ecu if pink or 5 ecu if blue	−1.7
17	40 ecu if pink or 30 ecu if blue	58 ecu if pink or 5 ecu if blue	−3.1
18	40 ecu if pink or 30 ecu if blue	60 ecu if pink or 5 ecu if blue	−4.5
19	40 ecu if pink or 30 ecu if blue	62 ecu if pink or 5 ecu if blue	−5.9
20	40 ecu if pink or 30 ecu if blue	65 ecu if pink or 5 ecu if blue	−8
21	40 ecu if pink or 30 ecu if blue	68 ecu if pink or 5 ecu if blue	−10.1
22	40 ecu if pink or 30 ecu if blue	72 ecu if pink or 5 ecu if blue	−12.9
23	40 ecu if pink or 30 ecu if blue	77 ecu if pink or 5 ecu if blue	−16.4
24	40 ecu if pink or 30 ecu if blue	83 ecu if pink or 5 ecu if blue	−20.6
25	40 ecu if pink or 30 ecu if blue	90 ecu if pink or 5 ecu if blue	−25.5
26	40 ecu if pink or 30 ecu if blue	100 ecu if pink or 5 ecu if blue	−32.5
27	40 ecu if pink or 30 ecu if blue	110 ecu if pink or 5 ecu if blue	−39.5
28	40 ecu if pink or 30 ecu if blue	130 ecu if pink or 5 ecu if blue	−53.5
SERIES 3	Option A: 5 pink + 5 blue	Option B: 5 pink + 5 blue	
29	receive 25 ecu if pink or lose 4 ecu if blue	receive 30 ecu if pink or lose 21 ecu if blue	6
30	receive 4 ecu if pink or lose 4 ecu if blue	receive 30 ecu if pink or lose 21 ecu if blue	−4.5
31	receive 1 ecu if pink or lose 4 ecu if blue	receive 30 ecu if pink or lose 21 ecu if blue	−6
32	receive 1 ecu if pink or lose 4 ecu if blue	receive 30 ecu if pink or lose 16 ecu if blue	−8.5
33	receive 1 ecu if pink or lose 8 ecu if blue	receive 30 ecu if pink or lose 16 ecu if blue	−10.5
34	receive 1 ecu if pink or lose 8 ecu if blue	receive 30 ecu if pink or lose 14 ecu if blue	−11.5
35	receive 1 ecu if pink or lose 8 ecu if blue	receive 30 ecu if pink or lose 11 ecu if blue	−13

10 ecu = 1 euro.

the status quo. With the notations of Section 3.3, it can be interpreted as payoff x is the lottery payoff, reference point z is zero. In addition, to favour increased motivation, subjects earned a payment that depended on their choices in the lotteries: at the end of the interview, one lottery row was randomly selected and the corresponding lottery was played for vouchers. The theoretical payment was between 8 and 180 €.[32] An average of 14.5 € was paid at the end of the interviews (between 8 and 32 €). Given that asylum seekers in Luxembourg receive 25 € per month, in addition to housing and meals,[33] we believe that this payment offered a strong incentive to make thoughtful and careful decisions. Interviewees were informed that they could abandon the interview at any time and still receive the initial 10 € payment.

4.2.2. Time task

We elicit asylum seekers' time preferences basing on Harrison et al. (2002)'s discount rate tasks. The time task consists of two series of 10 choices between two dated payoffs that are set six months apart (Table 3). Payoffs are labelled in euros. In the first series, option A offers 500 € now and option B gives a higher amount but in six months. In the second series, we apply a one-month lag to the payoffs, while the amounts remain the same.[34] The payoffs of option B, M (in euros), are such that $500 = \frac{1}{(1+i)^6} M$, where i is the monthly discount rate in the standard discounting framework. The range of values for i corresponds to annual discount rates from 5 to 50% (see column 4 of Table 3, not displayed to participants). Subjects are expected to switch from option A to option B as soon as they perceive the discounted value of option B as higher than 500 €. We derive from each individual's switching points a pair of annual discount rates r, one for each series. If subjects display a 'passion for the present', the discount rate required to trade money in the future for money today should be higher than the discount rate trading two future payments. This case is characterized by 'quasi-hyperbolic preference structures' (Andersen et al., 2008).[35] However, if the difference between the discount rates is small or non-significant, exponential discounting specifications are better adapted to reflect time preferences.

Unlike in the risk task, we did not incentivize subjects, i.e. make their payments dependent on their choices. It was not possible for either the enumerator or the asylum seeker to predict how to contact each other in the future for a potential payment. Asylum seekers in Luxembourg have no bank accounts and do not know how long they might stay in the country.

[32] Monetary outcomes were rounded to the next full euro value for payment in vouchers.

[33] see (Luxembourg, 2012)

[34] We do not specify an interest rate in the experiment. Specifying the interest rate would be helpful to compare investments in the experiments with outside options and their annual interest rates. However, in our model no outside options are possible. We want to test only the sensitivity of individuals to waiting (and to making sacrifices) for a future payoff, without trade-offs between different alternatives. Coller and Williams (1999) suggest that when the implicit interest rate is not stated, the discount rates tend to be higher. Thus, it may be that our experiment elicits an upper range of the discount rate.

[35] For a review of time discounting models, see Frederick et al. (2002).

Table 3
Tables for the time task.
Source: Tables adapted from Harrison et al. (2002).

SERIES 1	Option A: Payment Today	Option B: Payment In 6 Months	Annual Discount Rate
1	500 EUR	512.35 EUR	5%
2	500 EUR	524.40 EUR	10%
3	500 EUR	536.19 EUR	15%
4	500 EUR	547.72 EUR	20%
5	500 EUR	559.02 EUR	25%
6	500 EUR	570.09 EUR	30%
7	500 EUR	580.95 EUR	35%
8	500 EUR	591.61 EUR	40%
9	500 EUR	602.08 EUR	45%
10	500 EUR	612.37 EUR	50%
SERIES 2	Option A: Payment in 1 Month	Option B: Payment in 7 Months	Annual Discount Rate
11	500 EUR	512.35 EUR	5%
12	500 EUR	524.40 EUR	10%
13	500 EUR	536.19 EUR	15%
14	500 EUR	547.72 EUR	20%
15	500 EUR	559.02 EUR	25%
16	500 EUR	570.09 EUR	30%
17	500 EUR	580.95 EUR	35%
18	500 EUR	591.61 EUR	40%
19	500 EUR	602.08 EUR	45%
20	500 EUR	612.37 EUR	50%

Table 4
Distribution of switching points.

Switching point	Proportion of respondents		
	Series 1	Series 2	Series 3
1	22.9	50.5	29.8
2	0.9	2.8	31.2
3	1.8	6.0	5.5
4	1.4	6.0	5.5
5	2.8	1.4	8.7
6	0.9	4.1	5.5
7	4.1	3.7	11.0
8	1.8	2.3	
9	1.4	2.3	
10	3.2	1.4	
11	3.2	2.3	
12	4.1	4.6	
13	5.5	0.5	
14	4.1	4.6	
never	41.7	7.8	2.8
Total	100.0	100.0	100.0
Number of observations	218	218	218

Table 5
Mean CPT parameters.

	Mean	Std. Err.	95% Conf. Int.	Wald test: parameter=1
σ	0.704***	0.032	0.640,0.768	0.000***
λ	2.202***	0.179	1.849,2.555	0.000***
γ	0.939***	0.024	0.891,0.986	0.011**
Nb. of obs.	218			

For Wald tests, the number displayed is the p-value.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5. Experimental results

Table 4 reports the distribution of respondents' switching points per series for the risk task.[36] The extremes, which correspond to subjects who switched as soon as the first row (very risk lovers) or never switched (very risk averse), gather a large proportion of participants. It is respectively 23% and 42% in series 1, 51% and 8% in series 2, 30% and 3% in series 3. Between the extremes, the distribution is quite homogeneous.

Such extreme answers are not uncommon with Tanaka et al. (2010)'s protocol, even if our numbers lie in the upper range for series 1 and 2. For instance, Nguyen and Leung (2009) report extreme switching points that represent in total 21%, 34% and 36% of the fishermen, respectively in series 1, 2, and 3. The corresponding shares for French farmers in Bocquého et al. (2014) are 53%, 59% and 33%, but series 1 consists of 12 rows only, instead of 14. Tanaka et al. (2010) and Liu and Huang (2013) give only graphical distributions. In the former, a series 1 × series 2 cross distribution shows the importance of at-the-margin answers. The prominent pairs are in decreasing order (never × never), (never × 1) and (1 × 1). In Liu and Huang (2013), the triplewise distribution includes series 3. The most numerous pairs are (never × never) again, the triplet (never × never × never) being especially represented, and (never × 1) though to a much lower extent, the triplet (never × 1 × 1) being especially important. In our case, the great majority of extreme pairs of answers (series 1 × series 2) are (never × 1) and (1 × 1), each approximating 17% of the respondents. The extreme pair (never × never) represents 7% of the respondents, while no respondent made the (1 × never) choice. Comparing these numbers with series 1 and series 2 total extreme choices (respectively 65 and 58%, see Table 4), we find that these three specific pairs explain around 2/3 of extreme choices by series (respectively 63 and 70%). If we combine further with series 3 choices, we find that extreme triplets are made by 17% of the respondents. Whether the corresponding asylum seekers actually understood the task at hand, despite the one-to-one setup, the introductory examples, and their high education level, is an important concern for the accuracy of the parameter estimates. Cognitive fatigue may have also arisen in relation to the repetition of choices.

Table 5 collates estimates of the mean CPT parameters. On average, parameter σ controlling utility curvature is 0.7, the loss-aversion parameter λ is 2.2, and the probability weighting parameter γ is 0.9. All three values lie in the expected ranges, the first two ones are significantly different from 1 at the 1% level, and γ at the 5% level only (last column of Table 5). These parameter values for our sample of asylum seekers are in the same range as those obtained from other populations using a similar experimental setup, identical assumptions on CPT functional forms and parameter specification, and an identical

[36] Out of 218 answers, 1 included a coding error. For the series with lines numbered 15 to 28, the switching point for subject 138 was coded as line 5. In the tables presented here, the answer was recoded to 19 (which corresponds to the fifth line of the table). The same tables were generated excluding subject 138. The results are identical, and the tables are available upon request.

Table 6
Regression (OLS) of **sigma** on several sets of covariates.

Covariate	(1)		(2)		(3)		(4)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Constant	0.704***	(0.032)	0.373*	(0.195)	0.335	(0.232)	0.303	(0.230)
Socio-demographics:								
Age (in years)			−0.000	(0.005)	−0.002	(0.004)	−0.000	(0.004)
Female			−0.082	(0.071)	−0.097	(0.078)	−0.086	(0.075)
Married			−0.057	(0.091)	−0.023	(0.087)	0.029	(0.108)
Number of children			0.000	(0.027)	0.011	(0.025)		
Has children							−0.050	(0.111)
Primary education			0.342**	(0.149)	0.324*	(0.169)	0.316*	(0.171)
Secondary education			0.361***	(0.128)	0.339**	(0.146)	0.322**	(0.148)
College or University education			0.454***	(0.128)	0.412***	(0.148)	0.389***	(0.148)
Other education			1.095***	(0.141)	0.980***	(0.183)	0.959***	(0.177)
Born in Syria					−0.044	(0.093)	−0.035	(0.093)
Born in Iraq					0.251**	(0.116)	0.259**	(0.116)
Sunni muslim					0.011	(0.098)	0.017	(0.098)
Migration characteristics:								
Length of time since fled country (in years)					0.007	(0.007)	0.007	(0.007)
Length of journey to Europe (in days)					0.000	(0.000)	0.000	(0.000)
Reached Luxembourg with a visa					0.058	(0.086)	0.063	(0.087)
Nb. of obs. /clusters	218/218		217/217		214/214		214/214	
Model adjusted R-squared	0.000		0.041		0.076		0.076	
RMSE	0.479		0.469		0.460		0.460	
AIC	298.496		295.661		289.455		289.428	
BIC	301.881		326.080		339.945		339.918	

Standard errors are clustered at individual level. *, ** and *** stand for significance at the 10, 5 and 1% level respectively. All monetary terms are in euros. RMSE stands for root mean squared error. AIC and BIC stand for Akaike and Schwarz's Bayesian information criteria respectively.

Table 7
Regression (OLS) of **lambda** on several sets of covariates.

Covariate	(1)		(2)		(3)		(4)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Constant	2.202***	(0.179)	2.044	(1.594)	2.180	(1.746)	2.078	(1.745)
Socio-demographics:								
Age (in years)			0.055**	(0.026)	0.066**	(0.027)	0.070***	(0.023)
Female			0.918**	(0.444)	0.850*	(0.486)	0.885*	(0.486)
Married			0.362	(0.409)	0.264	(0.433)	0.406	(0.535)
Number of children			0.036	(0.146)	0.043	(0.153)		
Has children							−0.105	(0.584)
Primary education			−2.080	(1.337)	−2.077	(1.444)	−2.112	(1.443)
Secondary education			−2.131*	(1.262)	−2.218	(1.393)	−2.276	(1.384)
College or University education			−2.303*	(1.240)	−2.546*	(1.387)	−2.624*	(1.359)
Other education			−3.514***	(1.321)	−3.704**	(1.502)	−3.771**	(1.504)
Born in Syria					0.476	(0.388)	0.505	(0.384)
Born in Iraq					0.332	(0.571)	0.355	(0.571)
Sunni muslim					−0.587	(0.587)	−0.568	(0.590)
Migration characteristics:								
Length of time since fled country (in years)					−0.038	(0.042)	−0.039	(0.040)
Length of journey to Europe (in days)					0.002	(0.003)	0.002	(0.004)
Reached Luxembourg with a visa					−1.051***	(0.393)	−1.031***	(0.394)
Nb. of obs. /clusters	218/218		217/217		214/214		214/214	
Model adjusted R-squared	0.000		0.085		0.099		0.099	
RMSE	2.644		2.534		2.528		2.529	
AIC	1043.628		1028.102		1018.732		1018.801	
BIC	1047.013		1058.521		1069.222		1069.291	

Standard errors are clustered at individual level. *, ** and *** stand for significance at the 10, 5 and 1% level respectively. All monetary terms are in euros. RMSE stands for root mean squared error. AIC and BIC stand for Akaike and Schwarz's Bayesian information criteria respectively.

estimation procedure—see the studies of Tanaka et al. (2010) on rural Vietnamese people, Liu and Huang (2013) on Chinese farmers, Bocquého et al. (2014) on French farmers, Campos-Vazquez and Cuilty (2014) on Mexican students, Bauermeister et al. (2017) on students in Germany, and Bocquého et al. (2019) on French students. However, our estimates appear to be closer to neutrality.[37] It means CPT is a more appropriate framework than EUT for describing asylum seekers' risk preferences at the aggregate level. It provides evidence of a concave value function in the gain domain (convex in the loss domain), of loss aversion, and of a slight over-weighting of low-probability extreme events.

In light of the above observations about extreme answers, we recalculate the mean parameter values for two nested subsamples (Table 9). The first one excludes 28 respondents who switched either at the first row or never switched for all three series (uniform extreme triplets). The second one excludes the 37 respondents who made an extreme choice, whatever it is, in all three series (all extreme triplets). Results are robust as we obtain 0.6 for σ, 2.3 for λ, and 1.0 for γ, which are close to the full-sample values.

[37] See Bocquého et al. (2022) for a graphical comparison of the studies listed.

Table 8
Regression (OLS) of **gamma** on several sets of covariates.

Covariate	(1) Coef.	Std. Err.	(2) Coef.	Std. Err.	(3) Coef.	Std. Err.	(4) Coef.	Std. Err.
Constant	0.939***	(0.024)	1.251***	(0.226)	1.252***	(0.247)	1.261***	(0.244)
Socio-demographics:								
Age (in years)			−0.007**	(0.003)	−0.007**	(0.003)	−0.007**	(0.003)
Female			0.073	(0.054)	0.047	(0.055)	0.037	(0.056)
Married			−0.025	(0.061)	−0.035	(0.058)	−0.114*	(0.059)
Number of children			0.038**	(0.016)	0.025	(0.016)		
Has children							0.185***	(0.063)
Primary education			−0.073	(0.211)	−0.151	(0.218)	−0.178	(0.214)
Secondary education			−0.159	(0.197)	−0.221	(0.204)	−0.228	(0.199)
College or University education			−0.152	(0.199)	−0.198	(0.207)	−0.215	(0.201)
Other education			−0.450**	(0.204)	−0.463**	(0.215)	−0.459**	(0.210)
Born in Syria					0.132**	(0.066)	0.130**	(0.065)
Born in Iraq					0.011	(0.078)	−0.002	(0.078)
Sunni muslim					0.034	(0.074)	0.032	(0.074)
Migration characteristics:								
Length of time since fled country (in years)					−0.004	(0.008)	−0.005	(0.008)
Length of journey to Europe (in days)					−0.000*	(0.000)	−0.000*	(0.000)
Reached Luxembourg with a visa					0.081	(0.071)	0.089	(0.068)
Nb. of obs. /clusters	218/218		217/217		214/214		214/214	
Model adjusted R-squared	0.000		0.042		0.075		0.092	
RMSE	0.355		0.348		0.344		0.340	
AIC	167.989		166.802		164.555		160.638	
BIC	171.373		197.221		215.045		211.127	

Standard errors are clustered at individual level. *, ** and *** stand for significance at the 10, 5 and 1% level respectively. All monetary terms are in euros. RMSE stands for root mean squared error. AIC and BIC stand for Akaike and Schwarz's Bayesian information criteria respectively.

Table 9
Mean CPT parameters for two subsamples.

	Mean	Std. Err.	95% Conf. Int.	Wald test: parameter=1
Excluding subjects with uniform extreme triplets				
σ	0.617***	0.030	0.559,0.675	0.000***
λ	2.251***	0.181	1.894,2.607	0.000***
γ	0.988***	0.026	0.938,1.039	0.652
Nb. of obs.	190			
Excluding subjects with extreme triplets				
σ	0.623***	0.031	0.562,0.684	0.000***
λ	2.304***	0.183	1.943,2.665	0.000***
γ	0.965***	0.026	0.915,1.016	0.182
Nb. of obs.	181			

For Wald tests, the number displayed is the p-value.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Tables 6–8 regress by Ordinary Least Squares (OLS) the individual σ, λ and γ parameters on several individual characteristics. The higher the level of education, the less concave the utility curvature is in the gain domain. An Iraqi origin seems to have the same effect. Older persons and women have a higher sensitivity to losses, while a high level of education and reaching Luxembourg with a visa, as opposed to illegal border crossing, tend to be associated with lower levels of loss aversion. The last table shows that an older age is linked with a lower sensitivity to probabilities. On the contrary, subjects who have children or are from Syria are more sensitive to probabilities than others.

Table 10 displays the average annual discount rates calculated from the time task. We obtain 45% for the series with choices between a payment now and a larger payment in 6 months, and 42% for the series with the two future payment options. The slight decrease could advocate for some present bias at the aggregate level, but the values are close, statistically different at the 10% level only (p-value of 0.065 by an unpaired t-test). In the literature, discount rates measured through experimental procedures are often very high, with values above 100% being widespread (Andreoni & Sprenger, 2012; Frederick et al., 2002). However, the estimates Harrison et al. (2002) report for a representative sample of the adult Danish population are somewhat lower than ours. For their 6-month horizon treatment, with an early payment option of 1 month, which corresponds to our series with two future payments, they find a mean discount rate of 35%.

Table 10
Mean annual discount rates.

	Mean	Std. Err.	95% Conf. Int.
Choose between *now* and *in 6 months*	0.448***	0.008	0.432,0.464
Choose between *in 1 month* and *in 7 months*	0.423***	0.010	0.403,0.444
Nb. of obs.	218		

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Hypothetical choices raise doubts about respondents' motivation or capacity to behave as in a real-choice setting. However, it is still unclear to which extent real rewards in experiments lead to more accurate preference estimates. In the context of risk choices, the debate has been considerable. One of the conclusions in Camerer and Hogarth (1999)'s review is that monetary incentives do not substantially change mean behaviour. If some authors do observe a systematic impact of real payments on choices, subsequent reviews stress that the impact is often null, and even sometimes negative (Etchart-Vincent, 2006). In the context of intertemporal choices, the literature is far less developed. In their review, Frederick et al. (2002) identified only two studies

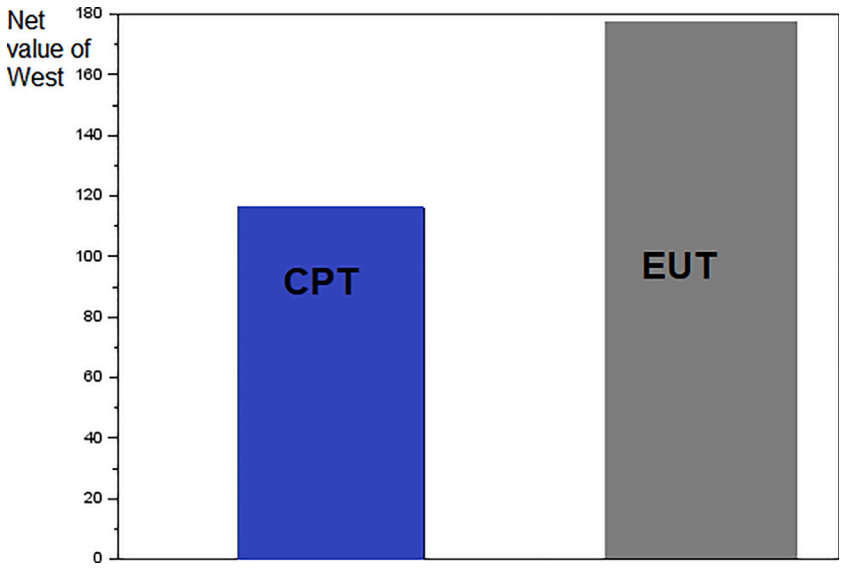

Fig. 3. Comparison of migration thresholds.

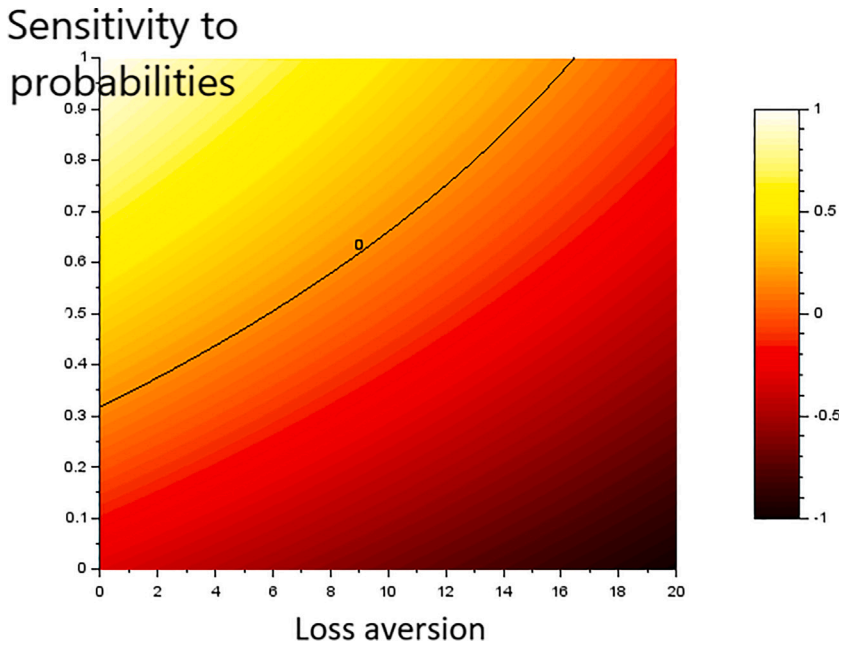

Fig. 4. Net migration value as function of CPT parameters.

comparing discounting between real and hypothetical rewards. In both of them, discount rates were lower in the hypothetical context, but control factors were not fully accounted for. The topic remains today controversial and challenging.

6. Simulations of migration decisions

In order to illustrate the policy difference between the EUT and CPT models of refugee migration policies, we simulate the net value of migrating to the West in Figs. 3, 4, 5 and 6. To set a baseline, we calibrate our models with data from different surveys. The values of the variables are summarized in Table 11.

Fig. 3 shows the value of moving to the West, net of the value of staying in a safe third country for the EUT versus CPT frameworks. The EUT framework predicts a higher net value of migrating to the West than the CPT framework.

The value of migrating depends on the risk parameters. Fig. 4 traces the net value of migration in the CPT framework dependent on the two cognitive biases that are specific to CPT: loss aversion and the sensitivity to probabilities. The net value of migration is positive only in the area above the dividing (zero) line. It becomes clear that the lower the sensitivity to probability and the higher the loss aversion, the lower the net value of migration. For a very loss-averse individual, migration has a positive net value only with a very high sensitivity to probabilities. For persons who are particularly insensitive to probability and/or are particularly loss averse, migration is never an option. Figs. 5 and 6 highlight the effects of γ and λ parameters on the net migration value under CPT, in comparison with EUT.

Fig. 7 shows the percentage of persons from our experimental sample (see Section 4) who would have migrated given their individual risk preferences, under EUT and CPT. The other variables are those of the baseline (first pair of bars on the left) or are modified in order to

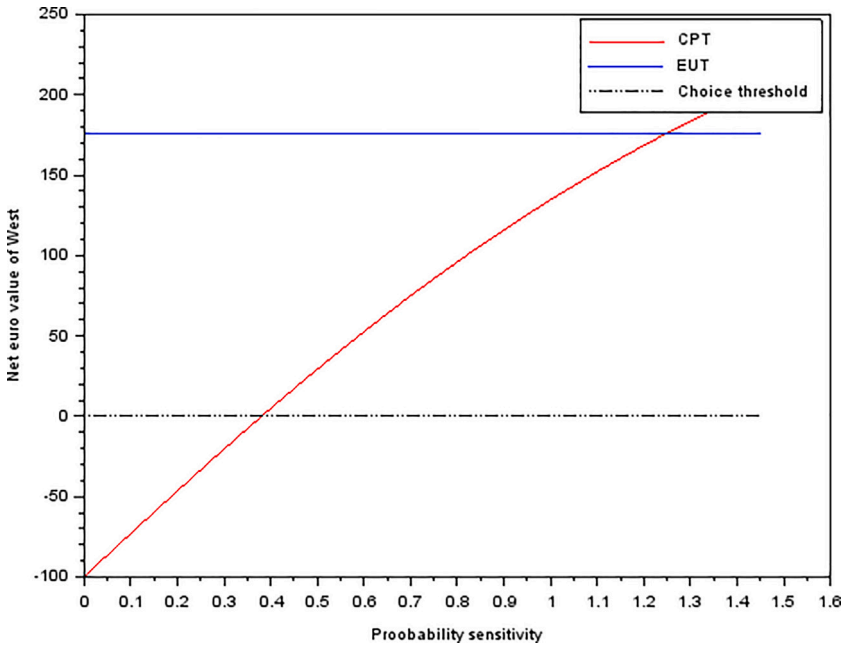

Fig. 5. Net migration value as a function of γ parameter under CPT and EUT.

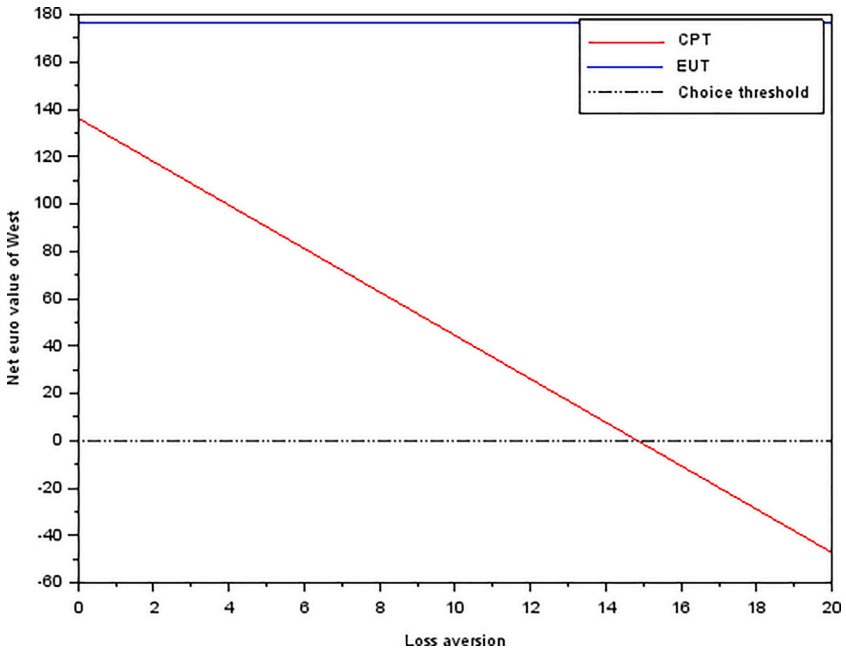

Fig. 6. Net migration value as a function of λ parameter under CPT and EUT.

reflect policy changes.[38] While in the baseline setting the percentage of persons who would have migrated is the same for the EUT and the CPT frameworks, we find that the CPT framework is more sensitive to policy changes. While doubling the income in the safe third country, reducing the probability of arriving in the destination country from 0.9 to 0.2, and reducing the probability of being awarded refugee status from 0.8 to 0.1 all decrease the percentage of persons who would have migrated in both frameworks, the decrease is always stronger in the CPT framework.

Looking at the sensitivity to policy in more detail, Figs. 8 and 9 illustrate the complexity of our results. These figures represent the percentage of persons from the sample that would have migrated respectively when the probability of arriving West varies from 0 to 1, and when the probability of being awarded asylum varies within the same range. From Figs. 8 and 9, we observe that while a reduction in the probability in obtaining refugee status always has a positive effect on simulated migration decisions, there seem to be threshold effects in both the EUT and CPT frameworks. Fig. 8 shows that reducing the probability of arriving West (p_1) from 0.8 to 0.7 has no effect on

[38] Note that subjects' migration decisions were taken in individual settings that may have been different from the baseline values, which explains why our model does not predict a 100% migration rate for our subjects.

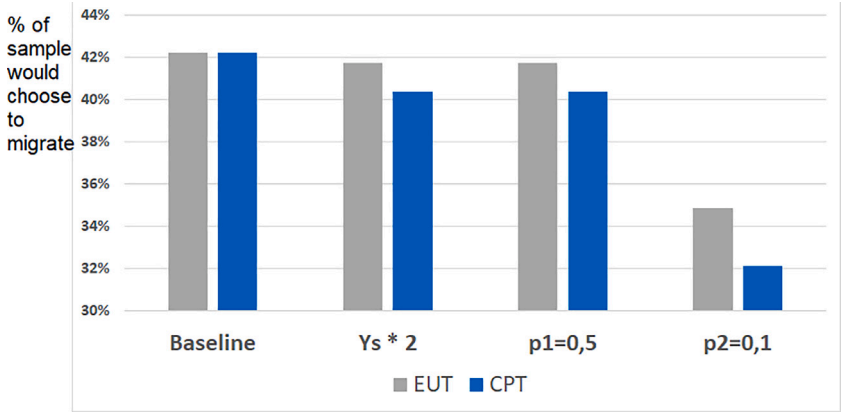

Fig. 7. Individual migration decisions in reaction to policy changes.

Table 11
Baseline values for simulation.

Name of variable	Notation	Unit	Value
Time horizon	T	years	10
Repayment horizon	T_e	years	5
Duration asylum claim	T_A	years	0.5
Discount rate	r	%	42
Prob. success migration	p_1		0.9
Prob. asylum	p_2		0.79
Income in Safe	y_S	euros/year	150
Income after rejection	$y_T = \rho * y_S$	euros/year	0.7*150 = 105
Income in West during asylum claim	y_{AA}	euros/year	1,650
Income in West after asylum	y_W	euros/year	10,000
Cost of trip to West	C^{Te}	euros	4,000
Utility convexity (EUT, CPT)	α, σ		0.7
CPT loss aversion	λ		2.2
CPT prob. weighting parameter	γ		0.9

Notes: While our model allows for payoffs to be both financial and non-financial (such as benefits from not being separated from family, or speaking the language of the country) we base our values on expected income only to avoid subjectivity issues.
Duration of asylum claim: see L'essentiel (2015).
Discount rate: from this study.
Probability of success of migration: the probability of surviving the Mediterranean crossing in 2017–2018 is estimated at 97%–98%.
Additional dangers such as violence or accidents lead us to estimate the probability at 90%. For data, see International Organization for Migration (2019) and Mbaye (2014).
The average acceptance rate for the top 6 countries of origin in Luxembourg was 79% in 2017 and 2018 Q1 (see UNHCR, 2019a).
Asylum seekers in Luxembourg receive 25 euros per month in addition to full board (Luxembourg, 2012).
The mean cost of trip to West in our sample is 4000 euros.

migration decisions in either the EUT or CPT framework, while effects are found when the probability is reduced below 0.5 under CPT or below 0.4 under EUT. From Fig. 9, we can see that reducing p_2 from 1 to 0.9 has nearly no effect, whereas a further reduction to 0.8 leads to a clear cut in the percentage of people who wish to migrate. Subsequent decreases in the probability of obtaining legal status again have very little effect—until they reach 0.4, which in our simulation is a threshold value in the CPT setting (0.3 in the EUT setting).

We may draw some policy conclusions from this graph. First, the reaction to policy changes concerning refugee recognition is nonlinear. Second, even an important reduction in recognition rates may have a modest impact on migration decisions. Third, the identified threshold values for an impact on migration decisions depend on the decision framework used. For example, for a current average EU recognition rate of asylum claims of 34% (e.g., $p_2 = 0.34$),[39] our simulation identifies a very low sensitivity to probability changes in the EUT framework, whereas in the CPT framework even a small change may influence migration decisions.

Finally, the probability of recognition of the asylum claim may be interpreted as a signal of the validity of the claim.[40] Thus, individuals who face a high probability of being given protection status are more likely to migrate than individuals whose recognition probability is low. However, as long as it is sufficiently high, the recognition probability has virtually no impact on the migration decision. Even for low values, such as those faced by persons migrating for reasons not covered by international protection, the percentage of persons who migrate is only reduced by a few percentage points. This reduction is due to two effects. As expected, some persons who do not have a valid claim refrain from migrating. On the other hand, persons who are truly in need of protection and who have a CPT cognitive profile will also be deterred from leaving for the West. Recognition rates are thus very imperfect policies for deterring non-refugee migrants.

7. Discussion and conclusion

In this paper, we argue that a sustainable solution to the refugee crisis needs to be based on an accurate understanding of refugee reactions to migration policies. Policies with costs that exceed their benefits are unlikely to be sustainable in the long run. Migration policies necessarily entail costs, such as increased border controls and loss of life. As a consequence, assessing sustainability implies comparing costs with benefits.

We provide a step towards improving our knowledge of these processes by modelling, estimating, and simulating refugee choices. We first propose an alternative way of modelling refugee migration accounting for cognitive biases using a CPT framework. Second, we collected data from a sample of refugees and measured their risk parameters under CPT, and time parameters. We showed that these subjects behave according to CPT at the aggregate level: on average, they exhibit a concave utility function in the gain domain, they are loss averse, and they tend to overweight low-probability extreme events. On average, they have a discount rate slightly above 40%, with an anecdotal but significant present bias. Third, we simulate migration decisions based on the preference parameter values previously elicited.

We find that the net value of moving West is consistently lower under CPT than under standard EUT, whatever the policy context.

[39] See https://www.easo.europa.eu/latest-asylum-trends, data updated 15 November 2019, consulted 22 November 2019.

[40] While recognition rates are comparatively higher for claims by people originating from countries that do not protect their citizens, they vary between countries. For example, in 2018 80% of claims by Syrian refugees were accepted in Germany, and 99% in Greece. See http://popstats.unhcr.org/en/asylum_seekers.

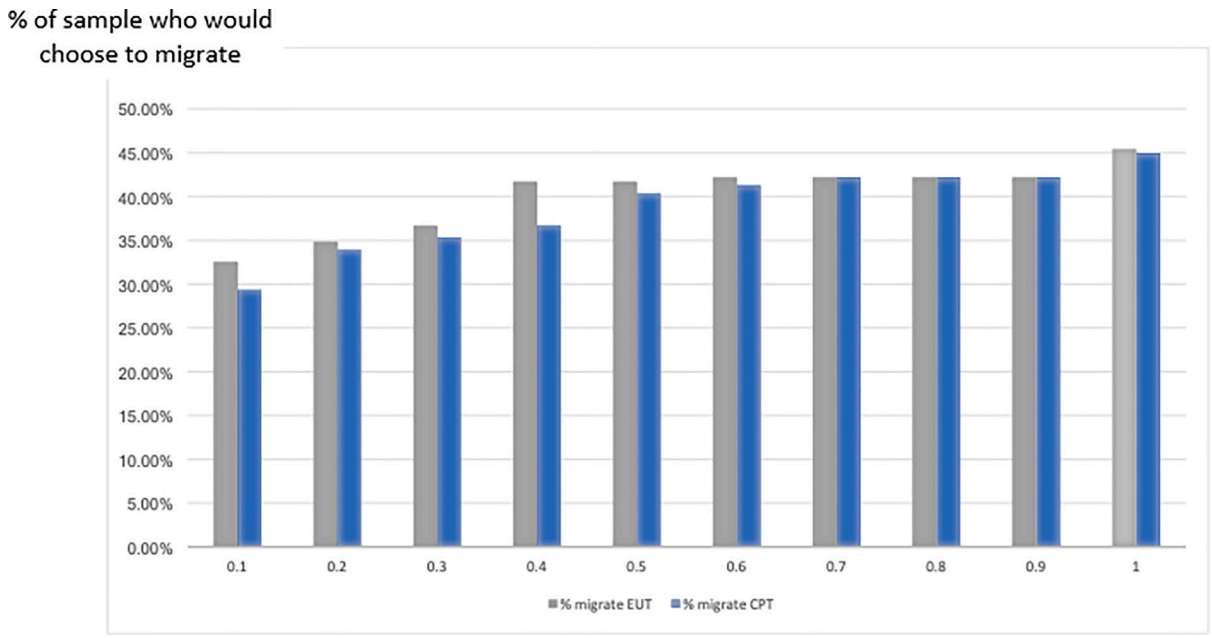

Fig. 8. Individual migration decisions in reaction to a change in p_1.

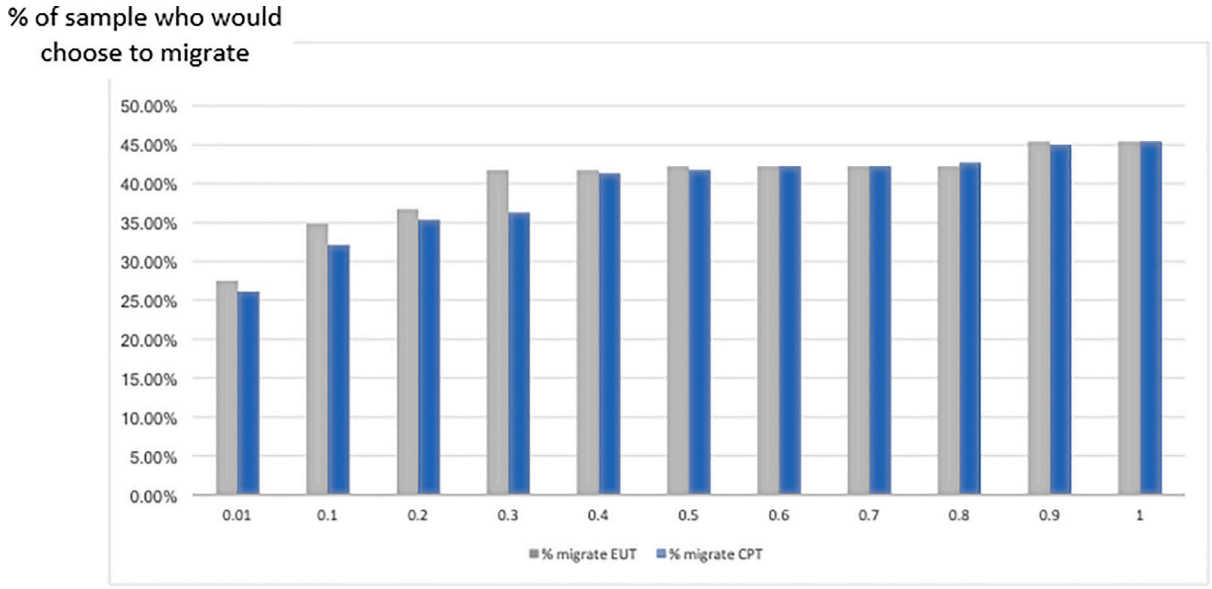

Fig. 9. Individual migration decisions in reaction to a change in p_2.

We also show that the value of migrating depends on the refugees' risk preference parameters. The higher the loss aversion and the lower the sensitivity to probability, the lower the net value of migration, and the lower the chance that potential migrants will choose to go West.

Furthermore, we find that the CPT framework is more sensitive to policy changes than EUT, such as the probability of arriving West and the probability of obtaining asylum. Decreasing these probabilities reduces the share of persons who would have migrated in both frameworks, but more importantly under CPT. However, the decrease is not linear. We observe thresholds in the policy effects. Reducing the probability of arriving West from 0.8 to 0.7 has no effect on migration decisions in either the EUT or CPT framework, while effects are found when the probability is reduced below 0.5 under CPT or below 0.4 under EUT. As regards the probability of obtaining asylum, threshold effects occur between 0.4 and 0.3 under CPT, but between 0.3 and 0.2 under EUT.

These results show that deterrence policies can indeed reduce migration. However, it does not lead to auto-selection on the basis of protection need but, rather, on the basis of risk preferences. This auto-selection may indeed represent anti-selection, as the traumatic experiences of refugees have been shown to increase loss aversion (Callen et al., 2014; Mironova & Whitt, 2020; Voors et al., 2012), thus making refugees less likely to attempt migration than other migrants. Such effects cannot be identified in an EUT frame as it does not include loss aversion and probability weighting. Above the threshold values, asylum recognition rates, which can be interpreted as an imperfect signal of protection need, do not affect migration decisions. This result evidences that the selection of those who migrate not only depends on their protection need.

This work is based on a very restrictive sample of only 218 refugees, mostly from Syria and Iraq, and our model simulations are grounded only on the parameters derived from this population. Ideally, in order

to fully understand migration choices, our sample should have also covered persons who had decided not to migrate. For this reason, our study is limited. Likewise, our models do not take into consideration heterogeneity in terms of gender or education, which could be a good starting point for future research.

However, our study does show the importance of using the right decision framework—in addition to accurate data—in order to determine the effects of policy changes. Using models of refugee migration based, for example, on CPT rather than EUT makes it possible to identify unwanted dissuasion effects. Being able to identify the basis of the auto-selection of migration is therefore necessary to assess the gains in terms of reaching policy goals, and thus their sustainability.

Clearly, further research is needed in order to refine refugee policies by accounting for cognitive biases and protection need. Also, studies that include real incentivized games for measuring time preferences of refugees and forced migrants will be also of great interest. We also call for more refined investigations about the cognitive processes at play in migration decisions, the heterogeneity of potential migrants, and more generally the determinants of migration.

Declaration of competing interest

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

Data availability

The data that has been used is confidential.

Appendix A. Appendix: Formal proofs

A.1. Proof of Proposition 1

Point (i). A VNM decision maker prefers trying to leave to West instead of staying in the safe-neighbour country iff:

$$V_{EUT}(West) > V_{EUT}(Safe)$$
$$\Rightarrow p_1.p_2(y_W^T - C^{Te})^\alpha + p_1.(1-p_2)(y_T^T - C^{Te})^\alpha$$
$$+(1-p_1)(0)^\alpha > (y_S^T)^\alpha$$

By assumption, we know $(y_T^T - C^{Te})$ to be lower than y_S^T. If we pose $(y_T^T - C^{Te})$ equal to zero in order to make it more difficult to satisfy the condition for West to be preferred over staying in the safe-neighbour country, then we obtain the sufficient (but not necessary) condition:

$$p_1.p_2(y_W^T - C^{Te})^\alpha > (y_S^T)^\alpha$$
$$\Rightarrow ln(p_1) + ln(p_2) + \alpha ln(y_W^T - C^{Te}) > \alpha ln(y_S^T)$$

After manipulations we obtain Point (i).

Point (ii). The waiting time for asylum application, T_A, only holds in the West option. As a result, it is sufficient to study the sign of $\frac{dV_{EUT}(West)}{dT_A}$. We have:

$$\frac{dV_{EUT}(West)}{dT_A} = p_1p_2\alpha\left[D(r,T_A)(y_{AA}-y_W)\right](y_W^T - C^{Te})^{(\alpha-1)} \quad (8)$$
$$+p_1(1-p_2)\alpha\left[D(r,T_A)(y_{AA}-\rho y_S)\right](y_T^T - C^{Te})^{(\alpha-1)}$$

with $D(r,T_A) = e^{-rT_A}$ in case of exponential discounting, and $D(r,T_A) = \frac{1}{1+rT_A}$ in case of hyperbolic discounting.

We know that $y_{AA} - y_W < 0$ and $y_{AA} - \rho y_S > 0$. So, the first-line effect is negative (fewer periods for benefiting from y_W when obtaining asylum) and the second-line effect is positive (fewer periods of suffering ρy_S when the asylum application fails). Remark that $\alpha(y_W^T - C^{Te})^{(\alpha-1)}$ and $\alpha(y_T^T - C^{Te})^{(\alpha-1)}$ are the marginal utilities of having earning $y_W^T - C^{Te}$ and $y_T^T - C^{Te}$ respectively (given the α-power function utility that we assume). In case of risk-averse individual ($\alpha < 1$), the marginal utility in wealth is decreasing. We verify that the higher y_W^T, the lower $\alpha(y_W^T - C^{Te})^{(\alpha-1)}$ and so the first-line effect is reduced. The opposite result holds for a risk-loving individual ($\alpha > 1$) because of increasing marginal utility of wealth. This is Point (ii).

Point (iii). The revenue the individual earns when waiting for asylum application, y_{AA}, only exists in the option "West". As a result, it is sufficient to study the sign of $\frac{dV_{EUT}(West)}{dy_{AA}}$. We have:

$$\frac{dV_{EUT}(West)}{dy_{AA}} = p_1p_2\alpha\left[\int_0^{T_A} D(r,t)dt\right](y_W^T - C^{Te})^{(\alpha-1)} \quad (9)$$
$$+p_1(1-p_2)\alpha\left[\int_0^{T_A} D(r,t)dt\right](y_T^T - C^{Te})^{(\alpha-1)}$$

The value of $\frac{dV_{EUT}(West)}{dy_{AA}}$ is undoubtedly positive: the two parts of this equation are positive. But their relative importance differ depending on the individual's degree of risk aversion (α), and the value of p_2 has a crucial impact on the weight of each part in the value of $\frac{dV_{EUT}(West)}{dy_{AA}}$. For risk-averse individuals ($\alpha < 1$), the marginal utility is decreasing in wealth so as to obtain: $\alpha(y_W^T - C^{Te})^{(\alpha-1)} < \alpha(y_T^T - C^{Te})^{(\alpha-1)}$. The opposite result holds for risk-loving individuals. Knowing that high values of p_2 provide high weight on the first part, and low values of p_2 provide high weight on the second part of the equation, we can deduce that the value of $\frac{dV_{EUT}(West)}{dy_{AA}}$ is the lowest (highest) possible for risk-averse individuals when p_2 is high (low). And the reverse holds for risk-loving individuals. This is Point (iii).

Point (iv). The conditional probability of obtaining asylum, p_2, only holds in the option "West". As a result, we focus on the value of: $\frac{dV_{EUT}(West)}{dp_2}$. We have:

$$\frac{V_{EUT}(West)}{dp_2} = p_1\left[(y_W^T - C^{Te})^\alpha - (y_T^T - C^{Te})^\alpha\right] > 0$$

This value is undoubtedly positive because $y_W^T > y_T^T$. □

A.2. Proof of Proposition 2

A CPT decision maker prefers trying to leave to West instead of going to a safe-neighbour country iff:

$$V_{CPT}(West) > V_{CPT}(Safe)$$
$$\Longrightarrow \omega(p_1.p_2)((y_W^T - C^{Te}) - y_S^T)^\sigma + \omega(1-p_1.p_2)(-\lambda)(-(0-y_S^T))^\sigma$$
$$+\omega(p_1(1-p_2))\left[(-\lambda)(-((y_T^T - C^{Te}) - y_S^T))^\sigma - (-\lambda)(-(0-y_S^T))^\sigma\right] > (y_S^T - y_S^T)^\sigma = 0$$

It is impossible to rank $\left[\omega(1-p_1.p_2) - \omega(p_1(1-p_2))\right](-\lambda)(-(0-y_S^T))^\sigma$ relatively to $\omega(p_1(1-p_2))(-\lambda)(-((y_T^T - C^{Te}) - y_S^T))^\sigma$ because it is possible to have $\left[\omega(1-p_1p_2) - \omega(p_1(1-p_2))\right] > \omega(p_1(1-p_2))$ and we have $(0-y_S^T) < ((y_T^T - C^{Te}) - y_S^T)$.

As a result, two necessary conditions (for West to be preferred over Safe) can be found. The first one is:

$$\omega(p_1.p_2)((y_W^T - C^{Te}) - y_S^T)^\sigma$$
$$+\omega(p_1.(1-p_2))(-\lambda)(-((y_T^T - C^{Te}) - y_S^T))^\sigma > 0$$

$$\Rightarrow \sigma > \frac{ln\left(\omega(p_1(1-p_2))\right) + ln(\lambda) - ln\left(\omega(p_1 p_2)\right)}{ln\left((y_W^T - C^{Te}) - y_S^T\right) - ln\left(-((y_T^T - C^{Te}) - y_S^T)\right)} = A$$

and the second one is:

$$\omega(p_1.p_2)((y_W^T - C^{Te}) - y_S^T)^\sigma$$
$$+ \left[\omega(1-p_1.p_2) - \omega(p_1(1-p_2))\right](-\lambda)(-(0-y_S^T))^\sigma > 0$$
$$\Rightarrow \sigma > \frac{ln\left(\omega(1-p_1.p_2) - \omega(p_1(1-p_2))\right) + ln(\lambda) - ln\left(\omega(p_1 p_2)\right)}{ln\left((y_W^T - C^{Te}) - y_S^T\right) - ln\left(-(0-y_S^T)\right)} = B$$

We only keep the more restrictive condition: $\sigma > \max\{A, B\}$. This is Point (i). □

A.3. Proof of Proposition 3

Recall that we suppose $\gamma = 1 \Rightarrow \omega(p) = p$.

Point (i). Point (i) is straightforward, since $\frac{V_{CPT}(West)}{d\lambda} = (1-p_1)(-1)(-(0-y_S^T))^\sigma + p_1(1-p_2)(-1)(-((y_T^T - C^{Te}) - y_S^T))^\sigma < 0$, $\forall\sigma$, and $\frac{V_{CPT}(Safe)}{d\lambda} = 0$.

Point (ii). The waiting time of asylum applications, T_A, only holds in the West option. As a result, it is sufficient to study the sign of $\frac{dV_{CPT}(West)}{dT_A}$. We have:

$$\frac{dV_{CPT}(West)}{dT_A} = p_1 p_2 \sigma \left[D(r,T_A)(y_{AA} - y_W)\right]\left[(y_W^T - C^{Te}) - y_S^T\right]^{(\sigma-1)} \quad (10)$$
$$+p_1(1-p_2)(-\lambda)\sigma\left[D(r,T_A)(-1)(y_{AA} - \rho y_S)\right]\left[-((y_T^T - C^{Te}) - y_S^T)\right]^{(\sigma-1)}$$

with $D(r,T_A) = e^{-rT_A}$ in case of exponential discounting, and $D(r,T_A) = \frac{1}{1+rT_A}$ in case of hyperbolic discounting.

We know that $y_{AA} - y_W < 0$ and $y_{AA} - \rho y_S > 0$. So, the first-line effect is negative (fewer periods for benefiting from y_W when obtaining asylum) and the second-line effect is positive (fewer periods of suffering ρy_S when the asylum application fails). Remark that $(y_W^T - C^{Te})^{(\sigma-1)}$ and $(y_T^T - C^{Te})^{(\sigma-1)}$ are decreasing in y when $\sigma < 1$, and are increasing in y when $\sigma > 1$. As a result, we can verify that the higher y_W^T, the lower $(y_W^T - C^{Te})^{(\sigma-1)}$ and so the first-line effect is reduced. The opposite result holds when ($\sigma > 1$). This is Point (ii).

Point (iii). the revenue the individual earns when waiting for asylum application, y_{AA}, only holds in the West option. As a result, it is sufficient to study the sign of $\frac{dV_{CPT}(West)}{dy_{AA}}$. We have:

$$\frac{dV_{CPT}(West)}{dy_{AA}} = p_1 p_2 \sigma \left[\int_0^{T_A} D(r,t)dt\right]\left[((y_W^T - C^{Te}) - y_S^T)\right]^{(\sigma-1)} \quad (11)$$
$$+p_1(1-p_2)\sigma(-\lambda)\left[(-1)\int_0^{T_A} D(r,t)dt\right]\left[-((y_T^T - C^{Te}) - y_S^T)\right]^{(\sigma-1)}$$

The value of $\frac{dV_{CPT}(West)}{dy_{AA}}$ is undoubtedly positive, as the two parts of this equation are positive. But their relative importance differs depending on the degree of concavity σ, and the value of p_2 has also a crucial impact. For $\sigma < 1$, we have: $\sigma\left[((y_W^T - C^{Te}) - y_S^T)\right]^{(\sigma-1)} < \sigma\left[-((y_T^T - C^{Te}) - y_S^T)\right]^{(\sigma-1)}$. The opposite result holds for $\sigma > 1$. Knowing that high values of p_2 provide a high weight on the first part, and low values of p_2 provide a high weight on the second part of the equation, we can deduce that the value of $\frac{dV_{CPT}(West)}{dy_{AA}}$ is the lowest (highest) possible for individuals with $\sigma < 1$ when p_2 is high (low). This effect is reinforced for high values of loss aversion parameter λ. The reverse holds for individuals with $\sigma > 1$. This is Point (iii). □

A.4. Proof of Proposition 4

Point (i). The first part of Point (i) states that, when $\gamma < 1$, any variation in p_2 has a lower impact on V_{CPT} than when $\gamma = 1$ if the objective probability p which is associated to the concerned state(s) of Nature lies in a given interval of values (say $[p^1_{min}, p^1_{max}]$). Otherwise, the impact is higher. To illustrate, p is $p_1 p2$ for the state "travelling to West with success (p_1), and obtaining asylum (p_2)".

When no probability distortion holds, a marginal variation in a probability p has an impact of 1 (times the payoff(s) which is/are associated to it). When a weighting function $\omega(p)$ holds, we have to consider $\omega'(p)$. Here we have :

$$\omega'(p) = \frac{\gamma}{p}\left[ln(\frac{1}{p})\right]^{\gamma-1} exp\left(-\left[ln(\frac{1}{p})\right]^\gamma\right) \quad (12)$$

and so, for $\gamma < 1$ and $p \in]0,1[$ (because $p = 0$ and $p = 1$ are never subject to distortion) we obtain:

$$\omega'(p) = \begin{cases} > 1 & if \quad p < p^1_{min} \\ < 1 & if \quad p \in [p^1_{min}, p^1_{max}] \\ > 1 & if \quad p > p^1_{max} \end{cases}$$

The values of $[p^1_{min}, p^1_{max}]$ vary with γ. $[p^1_{min}, p^1_{max}]$ tends to $]0,1[$ for $\gamma \to 0$: all probabilities are equally weighted, so that the marginal variation in $\omega(p)$ is null.

Some examples: for $\gamma = 0.1$ we have: $[p^1_{min} = 0.007, p^1_{max} = 0.965]$; for $\gamma = 0.2$ we have: $[p^1_{min} = 0.017, p^1_{max} = 0.935]$; for $\gamma = 0.5$ we have: $[p^1_{min} = 0.05, p^1_{max} = 0.9]$; for $\gamma = 0.8$ we have: $[p^1_{min} = 0.09, p^1_{max} = 0.8]$.

As the value of γ approaches 1, the interval $[p^1_{min}, p^1_{max}]$ is reduced (it is not defined for $\gamma = 1$) and values of $\omega'(p)$ for $p \notin [p^1_{min}, p^1_{max}]$, which are higher than 1, tend to reduce to 1 (recall that $\omega(p) = p$ for $\gamma = 1$).

Point (ii). The first part of Point (ii) states that, when $\gamma > 1$, any variation in p_2 has a higher impact on V_{CPT} than when $\gamma = 1$ if the objective probability p which is associated to the concerned state(s) of Nature lies in a given interval of values (say $[p^2_{min}, p^2_{max}]$). Otherwise, the impact is lower.

As in Point (i), we have to consider $\omega'(p)$:

$$\omega'(p) = \frac{\gamma}{p}\left[ln(\frac{1}{p})\right]^{\gamma-1} exp\left(-\left[ln(\frac{1}{p})\right]^\gamma\right)$$

and so, for $\gamma > 1$ and $p \in]0,1[$ we obtain:

$$\omega'(p) = \begin{cases} < 1 & if \quad p < p^2_{min} \\ > 1 & if \quad p \in [p^2_{min}, p^2_{max}] \\ < 1 & if \quad p > p^2_{max} \end{cases}$$

The values of $[p^2_{min}, p^2_{max}]$ vary with γ. $[p^2_{min}, p^2_{max}]$ tends to reduce to $p^2_{min} = p^2_{max} = Z$ as $\gamma \to +\infty$ (Z approximates 0.368 for $\gamma = 1000$): all probabilities lower than Z are weighted by 0, and all probabilities higher than Z are weighted by 1. Except for Z, marginal variations in $\omega(p)$ are null.

Some other examples: for $\gamma = 1.1$ we have: $[p^2_{min} = 0.116, p^2_{max} = 0.75]$; for $\gamma = 1.2$ we have: $[p^2_{min} = 0.125, p^2_{max} = 0.745]$; for $\gamma = 1.5$ we have: $[p^2_{min} = 0.15, p^2_{max} = 0.715]$; for $\gamma = 2$ we have: $[p^2_{min} = 0.179, p^1_{max} = 0.674]$.

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