Eliciting Utility Functions for Migration Decisions

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Abstract

Migration is a highly complex and uncertain process that has the potential to have large impacts on societies around the world. Agent-based models provide a key tool for modelling complex systems, providing the potential to develop a greater understanding of the causal mechanisms and interactions involved in migration. One key aspect of an agent-based model is the decision making process of the agents. Most agent-based models rely on simplistic decision rules or a decision making process that assumes rational agents. However, a considerable body of research in psychology and behavioural economics raises doubts about such assumptions. To help inform an agent-based model of migration, we elicited and compared non-parametric utility functions for both finance and migration decisions. This allowed us to directly test whether the aspects of prospect theory that are commonly found in utility functions elicited within a financial context were also present for migration decisions. Additionally, we varied the stake sizes used within the financial and migration decisions to test whether the utility functions elicited were consistent or varied depending on the size of the values involved.

1 Introduction

Agent-based models have considerable potential to provide insight into complex systems. Therefore, agent-based models are a highly applicable tool for improving our understanding of complex and uncertain demographic processes such as migration. One crucial component of agent-based models is the characteristics assigned to the agents. Within this paper, we outline a plan to use insights from the existing psychological and behavioural economics literatures, supplemented with new data from our own experimental work, to develop theoretically and empirically grounded characteristics that can be assigned to agents within an agent-based model. Specifically, we focus on the decision making process of agents. Most previous agent-based models have assumed that agents follow a rational decision making process (Groeneveld et al., 2017; Klabunde and Willekens, 2016; Schlüter et al., 2017). However, a large body of research in behavioural economics and psychology has shown that human decisions regularly violate assumptions of rationality (Barberis, 2013; Kahneman, 2003; List, 2004).

Prospect theory is a prominent theory that can account for the systematic deviations from rationality that have been found in human decision making. Prospect theory was initially developed by Kahneman and Tversky (1979) and was later updated in the form of cumulative prospect theory (Tversky and Kahneman, 1992). Prospect theory accounts for aspects of human decision such as loss aversion, overweighting and underweighting of probabilities, framing effects, and differential response to risks (i.e., risk seeking in some situations and risk aversion in others). All of these aspects of human decision making violate rationality but are commonly found in experimental settings. Since its initial development, a large body of research has demonstrated support for the key tenets of prospect theory (for reviews see Barberis, 2013; Wakker, 2010).

Because of this wide body of existing research, a decision making process that is consistent with prospect theory is a promising candidate for improving the psychological realism of agents in agent-based models. For example, de Castro et al. (2016) recently examined decision making in agent-based models of a financial market, finding that a model in which agents made decisions in line with prospect theory matched real market data significantly better than a model in which agents followed expected utility.

The vast majority of the previous theoretical and empirical developments regarding prospect theory have occurred within the financial domain rather than in the area of migration. Therefore, it is important to establish whether these effects will generalise beyond the financial domain to migration decision making. Several studies have found support for prospect theory when the outcome of a risky decision was health related, number of lives saved, or measured in time, suggesting there is reason to be optimistic that prospect theory will generalise to migration (Abdellaoui and Kemel, 2014; Attema et al., 2013, 2016; Kemel and Paraschiv, 2018).

Some previous research has also specifically applied prospect theory to migration. Czaika (2014) outlined a model for applying prospect theory to migration and then analysed intra-European migration inflows into Germany to test whether the migration patterns showed evidence of prospect theory. Czaika found that after controlling for absolute differences in living standards, changes in economic prospects influenced migration flows (suggesting reference dependence) and there was also evidence of both loss aversion and diminished sensitivity. However, this analysis was conducted using macro-level data and therefore relies on inferring that individual migrants were behaving according to prospect theory based on these macro-level patterns.

In addition to using macro level data it is also important to examine the migration related decision making of individuals. Two recent papers by Mironova and Whitt (2017) and Ceriani and Verme (2018) examined the risk preferences of migrants and non-migrants in conflict zones. Both papers found that those who migrated away from conflict zones were more risk averse than those who stayed. These findings may initially seem surprising, as previous research on economic migration has generally found the opposite pattern, with non-migrants being more risk averse than migrants (Akgüç et al., 2016; Jaeger et al., 2010). However, one likely explanation for this pattern is that whether migrating or staying is more risky is highly context-dependent. Therefore, if within conflict zones migrating is generally judged to be the less risky option, it is not surprising that risk aversion would increase the likelihood of migrating.

The studies listed above examined risk attitudes and asylum migration. However, they did not examine whether other aspects of prospect theory were related to asylum migration. In another recent paper, Bocquého et al. (2018) addressed these unexamined issues. Bocquého et al. used the parametric method proposed by Tanaka et al. (2010) to elicit a utility function[1] from a group of asylum seekers in Luxembourg. The data were more consistent with prospect theory than expected utility. However, the asylum seekers exhibited lower loss aversion, less probability distortion, and less curvature of the utility function than had been found in previous studies with more general populations.

Although previous studies have examined risk preferences and elicited utility functions from migrants, the decision-making tasks used have all been related to a financial context and have not specifically asked about migration decisions. Therefore, we build upon this research by eliciting separate utility functions for migration and finance decisions. This allowed us to test whether the utility function for migration decisions is similar to the one for finance or if the two functions differ in important ways. We used a non-parametric methodology adapted from Abdellaoui et al. (2016), in which participants made a series of choices between two alternatives (for more details see the Method section of the current paper as well as Abdellaoui et al., 2016). An

[1] In their work on prospect theory, Kahneman and Tversky (1979; Tversky and Kahneman, 1992) used the term value function rather than utility function. However, for consistency with the broader literature we have used the more common term utility function.

advantage of the Abdellaoui et al. (2016) methodology is that it is empirical and does not require making any a priori assumptions about the shape of the utility function. We elicited six points of the utility function for gains and six points of the utility function for losses. These points were then analysed to establish the shape of the utility function (e.g., concave utility for gains, convex utility for losses).

For the purposes of this study, we consider migration decisions to consist of two key aspects. One key aspect of the decision is deciding whether to leave the initial country. The second key aspect of the decision is deciding which country to migrate to. Within the current experiment, participants responded to items that related specifically to the second step of the migration decision process, choosing a country to migrate to. This allowed us to use changes in monthly income as the potential outcomes of choosing a country to migrate to, in line with the economic explanations for migration. This setup has also meant that there was less risk that participants would consider other aspects that may influence a migration decision but were not part of the current study. That is, because participants were choosing which of two countries to migrate to it is more likely that they focused solely on the changes in monthly income and did not consider external factors that were not part of the study but might influence a migration decision (e.g., relationships with friends and family). This methodology allowed us to manipulate whether the decision took place in a financial or migration context but keep all other aspects of the elicitation items identical. Additionally, focusing on the choice of country to migrate to means that the decision process involved can generalise across both forced and non-forced migration decisions because this aspect of the decision is likely to be similar regardless of the motivation for leaving the original country.

2 Method

2.1 Participants

One-hundred and fifty undergraduate students were recruited for the study. Participants who took less than 10 minutes or more than 40 minutes to complete the study were excluded.

2.2 Design

This study used a 3 (financial stake size: small, medium, large) × 2 (context: investment, migration) mixed-model design, with stake size as the between-subject factor and context as the within-subject factor. The design and procedure were vetted and approved by the University of Southampton Ethics Committee (ERGO number 45553).

2.3 Materials

Within this study, participants were presented with a series of choices between two gambles and these choices were used to elicit six points of the utility function for gains and six points of the utility function for losses. Before eliciting these points, several values within the gambles had to either be prespecified or elicited in an earlier step. To test the effect of the prespecified values on the elicited utility functions, participants were randomly assigned to complete the study with small, medium, or large prespecified values. Table 1 shows the full list of the gambles used to elicit the utility functions as well as the prespecified values used. After each choice, the value being elicited was either increased or decreased so that either the non-chosen gamble increased in value or the chosen gamble decreased in value, increasing the relative value of the non-chosen gamble. The elicited value was increased or decreased by 50% of the initial value after the first choice and the increment of change halved with each subsequent choice (e.g., increased or decreased by 25% of initial value at step 2, 12.5% at step 3 etc.). For each elicited value (15 value elicitations for migration and 15 for finance) participants made up to six choices between the two gambles. After making three choices, for choices four through six, participants also had the option to respond "I have no preference" to indicate that they were indifferent between the two gambles. An example of an elicitation for a point of the gain utility function in a migration context is presented in Figure 1.

2.4 Procedure

First, participants read an information sheet for the study and provided informed consent. Participants then completed the Brief BioSocial Gambling Screen (Gebauer et al., 2010). Any participant who was identified as being at risk of problem gambling was redirected to a screen which stated that they were ineligible to participate in the study and provided information about available support services. After completing the Brief BioSocial Gambling Screen, participants who were not at risk of problem gambling began the main elicitation task. Participants were randomly assigned to a stake size condition. The order of the elicitation for the migration and finance contexts was also randomized. That is, for half of the participants the migration utility function was elicited first and a financial utility function second. For the other half of participants the order was reversed. To minimise the potential for order effects, the order of elicitation for gains and losses was also randomised. Therefore, after completing steps 1-3 (necessary for later elicitations), participants were randomly assigned to either complete steps 4-15 in order or to first complete steps 10-15 and then steps 4-9 (see Table 1 for more details). After participants had completed both elicitation tasks they were fully debriefed.

3 Analysis Plan

There are many different methods that can be used to analyse the elicited utility functions. We will analyse the area under the curve to establish whether the non-parametric utility function exhibits the S-shaped utility predicted by prospect theory (concave for gains, convex for losses). We will also conduct parametric estimation using a power function, x^{α}. This function is commonly used (Abdellaoui et al., 2016) and has previously been shown to be the best fitting function for value/utility (Stott, 2006). Various other models and approaches, including Bayesian and nonparametric ones, will be also considered for estimation.

Loss aversion will be analysed according to the definitions of Kahneman and Tversky (1979) and Köbberling and Wakker (2005). According to the Kahneman and Tversky definition of loss aversion, for equivalent utility, the value of elicited gains is larger than the value of elicited losses (e.g., $x_2^+ > x_2^-, x_3^+ > x_3^-$), suggesting that losses are subjectively experienced as more aversive than numerically equivalent gains. We will obtain an aggregate measure of loss aversion by regressing the points elicited in the gain domain on the points elicited in the loss domain (i.e., regress x^+ on x^-). Values of $\beta > 1$ indicate loss aversion, $\beta < 1$ indicate gain seeking, and $\beta = 1$ indicates loss neutrality. Köbberling and Wakker defined loss aversion based on the kink of the utility function at the reference point. Therefore, according to their definition $x_1^+/x_1^- > 1$ indicates loss aversion, $x_1^+/x_1^- = 1$ indicates loss neutrality, and $x_1^+/x_1^- < 1$ indicates gain seeking.

Having used the elicited utility function to calculate these various measures, we will then test whether there is a significant effect of context and stake size on: area under the curve, the outcomes of the parametric estimation, and the two measures of loss aversion by conducting a series of separate 3 (financial stake size: small, medium, large) × 2 (context: investment, migration) mixed-model ANOVAs. Bayesian equivalents of these mixed-model ANOVAs will also be conducted using JASP with default priors (JASP Team, 2018).

4 Future Directions

Following on from this study, we plan to collect a larger sample of data from the general population using Amazon's Mechanical Turk (MTurk). The data collected from the initial 150 participants will be used to inform potential adaptations to the current methodology and analysis plans prior to collecting data from MTurk. We plan to use this larger data set collected from MTurk to estimate prospect theory parameters for migration decisions. These parameter estimates will then be incorporated into our agent-based model of migration. There is also considerable potential for incorporating and combining these prospect theory parameters with other decision process models used in agent-based modelling. For example, prospect theory parameters such as loss aversion and utility curvature may influence the way that agents assess gains and losses and these insights could be applied to the formation of agents' intentions to migrate within a decision process model based on the Theory of Planned Behaviour (Ajzen, 1991; Fishbein and Ajzen, 2010; Klabunde and Willekens, 2016).

Additionally, in future experiments we plan to elicit a utility function for migration decisions about staying or leaving a home country. The specific case study we are modelling is based on asylum migration and in those circumstances the decision to leave is likely to involve consideration of danger to life and health rather than a consideration of financial outcomes. Therefore, the elicitation of utility functions related to these migration decisions will likely use life duration or number of lives as the potential outcomes rather than financial gains or losses. Previous research has successfully elicited utility functions for both life duration and number of lives (Attema et al., 2013, 2016; Kemel and Paraschiv, 2018). In addition to these outlined future directions, we are also highly interested in feedback on other aspects of migration where there is the potential for important insights and understanding to be gained via psychological experiments.

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Table 1

Procedure for eliciting utility functions

Step	Elicitation Equation	Value Elicited	Prespecified Values
1	$G_{(p)}L \sim x_0$	L	All stakes: $x_0 = 0, p = 0.5$
2	$x_1^+ \sim G_{(p)}x_0$	x_1^+	Small stakes: $G = 250, l = 50, g = 50$
3	$x_1^- \sim L_{(p)}x_0$	x_1^-	Medium stakes: $G = 500, l = 100, g = 100$
4	$x^+_{1(p)}\mathscr{L} \sim x_{0(p)}l$	$\mathscr{L}$	Large stakes: $G = 1000, l = 200, g = 200$
5	$x^+_{2(p)}\mathscr{L} \sim x^+_{1(p)}l$	x_2^+	
6	$x^+_{3(p)}\mathscr{L} \sim x^+_{2(p)}l$	x_3^+	
7	$x^+_{4(p)}\mathscr{L} \sim x^+_{3(p)}l$	x_4^+	
8	$x^+_{5(p)}\mathscr{L} \sim x^+_{4(p)}l$	x_5^+	
9	$x^+_{6(p)}\mathscr{L} \sim x^+_{5(p)}l$	x_6^+	
10	$\mathscr{G}_{(p)}x_1^- \sim g_{(p)}x_0$	$\mathscr{G}$	
11	$\mathscr{G}_{(p)}x_2^- \sim g_{(p)}x_1^-$	x_2^-	
12	$\mathscr{G}_{(p)}x_3^- \sim g_{(p)}x_2^-$	x_3^-	
13	$\mathscr{G}_{(p)}x_4^- \sim g_{(p)}x_3^-$	x_4^-	
14	$\mathscr{G}_{(p)}x_5^- \sim g_{(p)}x_4^-$	x_5^-	
15	$\mathscr{G}_{(p)}x_6^- \sim g_{(p)}x_5^-$	x_6^-	

Note: Elicitation procedure taken from Abdellaoui et al. (2016) with some prespecified values altered. The step column shows the order in which values are elicited from participants. The elicitation equation shows the structure used for each elicitation. The value elicited column shows the value that is being elicited at that step. Elicited values were initially set so that both gambles had equivalent utility. The prespecified values column shows the values within the elicitation equations that are prespecified rather than being elicited. The size of the prespecified values were chosen to be approximately equidistant in terms of utility rather than in terms of raw values. Therefore, there is a larger gap between the medium and large stakes than between the medium and small stakes to account for diminishing sensitivity for values further from the reference point. x_0 = reference point, x_1^+ through x_6^+ = the six points of the utility function elicited for gains, x_1^- through x_6^- = the six points of the utility function elicited for losses, p = probability of outcomes, G = a prespecified gain, L = an elicited loss equivalent to G in terms of utility, l = a prespecified loss, $\mathscr{L}$ = an elicited loss, g = a prespecified gain, $\mathscr{G}$ = an elicited gain.

A

Country A	Country B
50% chance of £219	50% chance of £339
50% chance of -£100	50% chance of -£220

Imagine that you are going to migrate to a new country and as a result of this move your monthly income will change.

Which country would you prefer to migrate to?

Country A Country B

→

B

Country A	Country B
50% chance of £219	50% chance of £509
50% chance of -£100	50% chance of -£220

Imagine that you are going to migrate to a new country and as a result of this move your monthly income will change.

Which country would you prefer to migrate to?

Country A Country B

→

C

Country A	Country B
50% chance of £219	50% chance of £424
50% chance of -£100	50% chance of -£220

Imagine that you are going to migrate to a new country and as a result of this move your monthly income will change.

Which country would you prefer to migrate to?

Country A Country B

→

D

Country A	Country B
50% chance of £219	50% chance of £382
50% chance of -£100	50% chance of -£220

Imagine that you are going to migrate to a new country and as a result of this move your monthly income will change.

Which country would you prefer to migrate to?

Country A | I have no preference | Country B

→

E

Country A	Country B
50% chance of £219	50% chance of £403
50% chance of -£100	50% chance of -£220

Imagine that you are going to migrate to a new country and as a result of this move your monthly income will change.

Which country would you prefer to migrate to?

Country A | I have no preference | Country B

→

F

Country A	Country B
50% chance of £219	50% chance of £392
50% chance of -£100	50% chance of -£220

Imagine that you are going to migrate to a new country and as a result of this move your monthly income will change.

Which country would you prefer to migrate to?

Country A | I have no preference | Country B

→

Figure 1. Figure 1 shows an example of the second gain elicitation (x_2^+) within a migration context and with medium stakes. As shown in panel A, x_2^+ is initially set so that both gambles have equivalent utility. The value of x_2^+ is then adjusted in panels B to F depending on the choices made, eliciting the value of x_2^+ that leads to indifference between the two gambles.