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1 Introduction

We live in a connected world with unequal access to resources and large disparities. The root-cause of migration is the unequal geographic distribution of resources and opportunities. The ownership of resources, predominantly natural resources, and the protection of that ownership give rise to policies and actions to prevent trespassing by putting up signs, barriers, authorization schemes, etc. The unequal distribution of human resources required to add value to raw products and to develop a service economy gives rise to global quest for talent and a variety of recruitment policies.

The study of migration addresses the questions of why people migrate (motives), who migrates (selectivity), how people arrive at the decision to leave or stay, and what the consequences of migration are for individuals, families, communities, and society-at-large at origin, destination and transit (so what question). To better understand the motives of migration and predict how individuals and families respond to policy measures and other signals, we must focus on the migration decision process. The interest in the decision process is not new. Rossi (1955), Wolpert (1965) and the authors in the book edited by De Jong and Gardner (1981) shaped the research decades ago. Their findings received little attention in migration research, but that is changing due to a growing dissatisfaction of migration scholars with the way migration research evolved over the years (see e.g. Penninx, 2006; Carling and Schewel, 2018, p. 949; Levy, 2020; Levy et al., 2020; de Haas, 2021).

People make relocation decisions in a complex environment with many unknowns. A plethora of factors and actors influence the decision process. Time matters too because it is often in short supply. This paper takes an actor-based approach to migration. Individuals are actors, but they are not the only actors. Institutions and organizations are actors too. Actors live and operate in a context consisting of several layers, from household and family to nation-states and international organizations. The world is operationalized as a system and general system theory is used to shed light on the nature of the system, its structure, its functioning and its dynamics. Actors have agency and they interact with other actors producing a social system of interconnected elements. The social system is embedded in an environment with which it usually interacts (open system), but sometimes does not (closed system). Systems are abstract logical structures that evolve according to universal principles. The universal principles are the subject of system theory. General system theory was developed by von Bertalanffy (1968), who acknowledges the influence of Lotka (1925) who applied basic principles of physics to biological systems. Lotka approached all living organisms on earth, together with their environment, as one system. In his view, organisms, species and their environment evolve together. They are inseparable, although higher organisms made themselves (largely) independent of their immediate environment (Lotka, 1925, pp. 16-17). Von Bertalanffy (1968) introduced system theory (also referred to as systems theory) as a mathematical field closely linked with computer science to cope with new problems but emphasized in his book general principles rather than the mathematics. System theory is evolving. Systems are increasingly viewed as networks. The network perspective emphasizes interactions and connectivity. Techniques of network analysis are becoming popular tools of systems analysis. In this paper, system and network are used interchangeably. Migration systems are migration

networks¹. Second, system elements are not static, but evolve continuously. To emphasize change and sequences of events, interacting system elements are replaced by interdependent processes (generative processes) and the systems structure is viewed as an outcome of processes (structuration processes, morphogenesis, developmental processes). The approach emphasizes structuration and development (becoming) over structure (being). To emphasize processes, system theory is sometimes referred to as process theory. Processes are pivotal in this paper under the motto *panta rhei* (everything flows; becoming versus being). This processual approach has gained interest in the social sciences (e.g. Abbott, 2001), also in migration research (Bakewell, 2010; Carling and Schewel, 2018, p. 959).

In this paper, the world is viewed as a system or network of actors: individual actors, institutions and organizations. They include families, communities, public and private organizations, e.g. actors that constitute the migration industry, nation-states and international organizations. Systems and networks emerge, evolve and may eventually disappear as the result of actions of actors and interactions between actors. Actors act for a purpose, i.e. action is instrumental to attain a goal. Social theories of action, developed by Max Weber, Durkheim, Parsons, Luhmann and others emphasize actions that sustain social order and the stability of the social system. They focus on an actor's position in the social system, the associated role and social norms rather than on individual desires and aspirations. Adam Smith in economics and George Herbert Mead in sociology (symbolic interactionism) oppose that perspective on humans. They advocate the primacy of the individual and emphasize (a) the individual actor and its capability to interpret the world, form opinions and make decisions and (b) the ability of actors to influence their immediate context. In short, they add agency. In this paper, the latter perspective is adopted. Note that the perspective on theories of action adopted in this paper is not normative but positive, i.e. the focus is on actual decision processes. A plethora of theories of actions exist, each emphasizing a particular aspect of behaviour. Although the theories seem to differ considerably, they have basic elements in common. The common elements are emphasized in the paper. Several years ago, Burch (1979, p. 288) drew attention to the core similarities between theories of action.

Actors come and go. They enter a system by birth and immigration and leave it by emigration or death. Actors have the capacity to reproduce and generate offspring. The cohort replacement mechanism, which is a renewal process, is a driver of social change amid technological and economic transformations (Ryder, 1965). Actors have a life cycle or life course. The life course is structured by significant events (transitions) occurring by choice or chance. Migration is such a critical transition. The decision to migrate is intertwined with other life choices. As a consequence, migration cannot be isolated from the life course. Over the years, the life course has become a dominant and particularly useful framework for the study of mobility, first residential mobility and later other types of relocation, including international migration (Wolpert, 1965; Courgeau, 1985; Willekens, 1987; Mulder, 1993; Kley, 2011; Wogensatz et al., 2011; de Jong and de Valk, 2019). The recent review of the determinants of migration aspirations by Aslany et al. (2021) demonstrates its usefulness because life stages exert major influences on the desire to migrate.

The structure of the paper is as follows. Section 2 is a brief discussion of systems theory. Section 3 is a discussion of core elements of theories of action drawing from the behavioural and social sciences perspective. Our focus is on the common origin of these theories and on what the theories have in common. One of the most widely used theories of action, the theory of reasoned action of Fishbein and Ajzen (TRA) (2010) and its companion, the theory of planned behaviour (TPB)

¹ Migration networks should not be confused with migrant networks (see later).

(Ajzen, 2011), are discussed in more detail. Section 4 shifts the attention to consequences of actions and utilities attached to actions. The treatment is also more formal. An important aspect is the Bayesian approach to the TPB, with its emphasis on the updating of beliefs in light of new evidence. In Section 5, process theories of action are briefly covered. The TPB is extended to a process theory consisting of several stages of decision-making and action. Section 6 concludes the paper.

Actors are embedded in a multi-layered system composed of other actors (individuals, institutions and organizations) and characterized by multiple structural factors or drivers of migration. To gain insight in the embedded migration decision process, simulation is proposed. The presentation of the model is beyond the scope of this paper, but since the model specification is based on this paper, Annex A highlights the main features of the model. The model is the subject of a second paper in the QuantMig project.

2 Systems theory: an introduction

A system is a set of interconnected elements. It is an abstract logical structure that evolves according to universal principles. The principles are applicable to any system, mechanical, natural, biological and social. Elements have attributes and interactions between the elements are key determinants of the system's dynamics. To emphasize the interactions, systems are increasingly viewed as networks. Systems theory is about the functioning of systems, e.g. how elements process information, communicate, control and learn, and how systems maintain stability under changing conditions (homeostasis) and preserve their identity when parts are replaced, or new parts created (autopoiesis). Feedback mechanisms are essential. Systems have a nested structure (structure within structure). The world is a system, but the nation-state, local communities, individual organisms and cells of an organism are systems too. The nested structure underlies the multi-layered or multi-level structure of systems. A system may have several dimensions, e.g. biological, cognitive, social, economic, cultural and political. System theory is particularly useful to make sure that a complex set of interrelated elements is logically consistent.

An important distinction is between the structure and the functioning of a system. Structure refers to the elements, the environment, and relations between them. Functioning refers to the functions the elements perform and the functions of the interactions between elements and the relationships they produce. A model of the system's structure identifies its elements, their properties and the interactions between the elements. The model may take the format of a set of simultaneous equations or a graph (Wunsch et al., 2014). The system structure facilitates the functioning of the system. It is the functioning, however, that generates the observed system properties and determines the overall performance of the system. An abstract and conceptual model of the functioning of a system and its components is called the functional architecture of the system. The system architecture reveals how these functions operate together to perform the system mission(s) and produce the phenomena we are able to observe. The distinction between the structure of a system and its functional architecture was emphasized by Franck (2002). Betzel and Bassett (2017) distinguish between structural connectivity and functional connectivity and illustrate the distinction in reference to the structure and functioning of the brain, an illustration also often used by Franck. Modelling the functional architecture of a system or network is a necessary step in understanding the processes that generate observable phenomena (Franck, 2002; Wunsch et al., 2014; Courgeau et al., 2017; Bijak, 2021). Consider the life course. It may be approached as a system consisting of several interdependent stages. The structure of the life course concerns the sequence of stages and the timing of the transitions between stages. The life course, however, is also a

developmental process. Each stage of the process prepares the decision-maker for the next stage in the completion of the process, causing the process to be functionally connected or functionally integrated. The functional architecture concerns the functions of stages and transitions governing the life course and path dependencies that produce the life course as observed. Note that components of a system may perform a same function using different mechanisms. Wunsch et al. (2014) give the example of an artificial heart. An artificial heart performs the same function as a natural heart, but the actual mechanisms are quite different. In the context of migration, passport control at borders can be performed manually or automatically by scanning machine-readable electronic IDs or by facial recognition systems or iris scanning.

General system theory originated in the 1920's in biology when von Bertalanffy advocated a holistic perspective on the development of an organism (Von Bertalanffy, 1969). The perspective caught on in most disciplines, which used to focus on isolated phenomena. Parsons and Luhmann introduced it into sociology and Boulding into economics. Mabogunje (1970) introduced it into the study of migration. In migration research, a system is a network of places (regions, countries) connected by migration flows. Interactions between places are revealed by flows of information, goods, services and people. The interactions create the conditions that facilitate the initiation and perpetuation of migration flows (Fawcett, 1989). Migration systems link people, families, and communities over space in transboundary, e.g. transnational, communities. Arango (2000), Castles et al. (2009, p. 43) and Bakewell (2014) view systems theory as a way to deepen our understanding of how migration is embedded in broader processes of social transformation and development. These scholars adopted von Bertalanffy's perspective on systems as a conceptual framework. Rogers (1968, 1975) introduced mathematical system theory into the study of migration, extending the work of Lotka and others by incorporating geography (place). Around the same time, Rees and Wilson (1977) and Haag and Weidlich (1980) contributed to a system theory of migration. The level and composition of migration flows in the system or network depend on push, pull factors, personal factors and intervening factors, consistent with Lee (1966) and the gravity model, the oldest specification of a spatial interaction model. Mathematical system theory is particularly useful in the study of how populations change and interact across space and how connectivity across space drives migration and population change (see Raymer et al., 2019 for a recent discussion). Using techniques of network analysis, Abel et al. (2021) recently showed that in the period 1990-2015 international migration networks have been remarkably stable over time.

Migration systems emerge as consequences of actions and interactions of individuals and other actors. Rogers and Rees and Wilson studied migration at the population- or macro-level. Haag and Weidlich concentrated on micro-macro linkages. They described the dynamics of a migration system in terms of individual motivations and decisions (without elaborating any decision theory) (see also Weidlich and Haag, 1988). Kanaroglou et al. (1986) extended the latter approach by using random utility theory to model migration decision making. Recently, there is an interest in relaunching the use of system theory in the analysis of migration systems (Bakewell, 2014; DeWaard and Trang Ha, 2019; Abel et al., 2021).

In this paper, systems consist of actors. Actors have attributes, values and resources (cognitive, social, cultural, economic and financial). Actors interact, build relationships, networks and communities. Interaction is more likely between actors that are similar (homophily) and more frequent between members of a network and actors that are nearby (proximity)². Network

² These facts motivated Bourdieu to emphasize the concept of social space and to view society as a system of relations. He introduced the relational mode of thinking as a way to understand society. People who are close together in the social

members differ in the influence and power they have over members. Actors may share some of their resources with other network members and develop mutual support, a shared identity and social cohesion. Networks are dynamic. They are formed, evolve and may be dissolved. During network formation, external boundaries emerge that separate the network from other parts of the system, regulate membership and protect the network from outside influences. Boundaries cause networks to evolve into subsystems. Families, local communities, religious groups and nation states are nested subsystems in a global system.

Boundaries may evolve into borders to be protected. Borders imply exclusion from a place or territory (Espejo, 2020). Border control may take various forms, including the regulation of who enters and leaves the territory (place) of the subsystem by establishing authorization schemes that involve permits or certificates and rituals to mark entries and exits. In the study of migration, nation states are particularly important subsystems. The Treaty of Westphalia in 1648 marking the end of the Eighty Years War in Europe introduced the concept of nation state as part of a new system of political order in Europe based on territorial sovereignty and integrity. It established states as the sole legitimate actor. The Treaty, which is upheld in the UN Charter and altered the face of the world, offers the legal basis to control national borders and regulate international migration (Betts 2011). The justification of border control solely on the basis of state sovereignty is questioned by Abizadeh (2008). Migration, including international migration, is essentially a transfer of individual actors between subsystems and a change of membership (Zolberg, 1981). In a world characterized by widely varying conditions and unequal access to resources, international borders serve to maintain global inequality, in particular when welfare states limit social protection to members (citizen), when alien acts make it more difficult to obtain a membership, and when states select immigrants with the skills they need, i.e. serve a purpose to the nation state and its members (Zolberg, 1989, p. 406; Zolberg, 2006). The nation state continues to be viewed as a natural social and political form of the world, an assumption Wimmer and Schiller (2002) designate as methodological nationalism. The perspective continues to influence the study of migration. The welfare state is an extension and consolidation of the nation state (Sciortino and Finotelli, 2015).

Institutional and physical barriers are designed to impede mobility or as selection mechanisms to encourage the mobility of those with desired characteristics and prevent or discourage the mobility of those without the desired characteristics. Meritocracy is such a selection mechanism. In meritocratic societies, and in the name of social justice, talent and achievement determine status rather than descent, wealth or social class. Wealth-based rules of immigration are designed to attract financial capital and to spur investments. The golden visa (citizenship by investment or residency by investment³) issued by many countries is a wealth-based selection mechanism.

space (e.g. are similar) “tend to find themselves” (Bourdieu, 1989, p. 16) leading to segregation socially and geographically. Homophily leads to social differentiation and may lead to segregation and polarization.

³ It does not need to be expensive to get a residence permit that gives access to all Schengen countries. Greece offers residence permits to individuals and their families (without stay requirement) on the purchase of a house of at least 250 thousand euros (mortgage availability under same conditions as apply for Greek citizens) (<https://www.schengenvisainfo.com/eu-golden-visas/greece-golden-visa/>). The European Commission acknowledges that investor citizenship schemes is a threat to all citizens of Europe. In 2020 it launched infringement procedures against Malta and Cyprus over their “will continue to monitor the situation” (EU 2020 EU citizenship report 2020, Brussels: EU/Justice https://ec.europa.eu/info/sites/default/files/eu_citizenship_report_2020_-_empowering_citizens_and_protecting_their_rights_en.pdf). Monitoring is definitely not enough at a time when investigative journalists are murdered and refugees and others, who also want to enter and improve their living

Family reunification programmes represent another selection mechanism. Admission is not based on merit or wealth, but on kinship. Because of these and other, overt and hidden, barriers, actual migration is much lower than intended, aspired or desired migration. Some systems, such as point-based immigration systems combine several selection criteria.

To aid the functioning of the social network, members may engage in activities they are good at and leave other activities to others in the network. The division of labour motivates trade. In addition, members may delegate tasks that benefit primarily the collective to one or a few of its members or some members may grab power. Governing tasks cover the allocation of shared resources, the formulation of the shared values, the development of norms and rules of conduct, and the protection of network boundaries. The division of labour and the delegation of authority imply less individual autonomy. It may also lead to individual differences in resource accumulation, social hierarchy and social domination (soft power, Bourdieu). With authority comes power to determine what network members should believe and how they should act. Members may disagree with that formulation and resist compliance with the rules imposed (norms, regulations). That may trigger reaction by other members of the network or the authority to enforce compliance and maintain social order. Social control mechanisms introduced to ensure the stability and continuity of the subsystem and the system as a whole may seriously reduce the autonomy of individual actors. Social scientists are divided about the role individual agency plays or should play in the evolving social system. Sociologists such as Durkheim, Parsons (1951), Luhmann (1984) and other exponents of functionalism conceive society as an integrated social system concerned with the integrity and coherence of the system (homeostatis). Individual actors occupy a social position and play a role expected by society. George Herbert Mead and his followers (Chicago School in sociology; symbolic interactionism) oppose the view that the system dictates individual conduct. They advocate the primacy of the individual and adopt a social-psychological perspective with a primary focus on (a) the individual actor and its capability to interpret the world, form opinions and make decisions (agency) and (b) micro-level interactions between actors. The debate between the schools of thought is mainly about the role of government in social systems.

As a system evolves, different social networks and subsystems emerge and interact. While networks protect their resources, wealth and identity, they are generally much less concerned about the protection of the resources, wealth and identity of other networks. Networks may try to gain access to resources of actors that are less capable of protection, leading to exploitation and discrimination. It includes access to mineral resources, land⁴ and human resources). Imperialism is the extension of power and domination over other networks or subsystems in the system. Hegemony refers to the existence of one core state outstripping the rest. In the world system, the

conditions, are pushed back. Daphne Caruana Galizia, who investigated and criticized the Maltese scheme, was killed in 1917.

⁴ Transnational land acquisition and land grabbing exist around the world. Governments lease to foreign interests' land that was previously occupied by poor local and indigenous populations who have little control over such land transfers and are confronted with a loss of livelihood and migration is often the only option. Schewel (2018) describes the practice using the Dutch flower-farm Afriflora Sher in Ethiopia (the largest rose farm in the world, producing a quarter of the world's roses) as an illustration. Bitzer found that, overall in Ethiopia, "the wages on the flower farms are below what is needed for a living wage in their respective localities ... below the international extreme poverty line of US\$ 1.9 per day" (Bitzer, 2019, p. 24 and p. 12). Dutch companies constitute the heart of Ethiopia's flower sector, which accounts for 11 percent of Ethiopia's export revenues (Bitzer, 2019) (see also <https://www.1854.photography/2020/02/adriano-marzi-valentines-day-ethiopia-roses/>). For a recent overview of the global practice, see Yang and He (2021) and for Africa, see Aryeetey and Lewis (2010).

basic linkages between subsystems is economic (Wallerstein, 1974) and politico-strategic (Zolberg, 1981, p. 262). Zolberg views the world as an economic system and a political system. Political structures serve the prevailing socio-economic positions. For instance, development aid is used to gain influence and access to resources, including human resources, and to change policies, e.g. the EU's *New Pact on Migration and Asylum*, in which cooperation with partner countries is conditional on readmission of citizens. Other instruments include blocking visas for countries refusing to take back asylum seekers. Actors with power not seldomly use threats, coercion and force (in addition to negotiation) to maintain access to resources and to persuade actors, in casu states, to adopt a desired behaviour or to make concessions. Actors (states) without the traditional means increasingly use threats of mass migration to get what they want from relatively strong actors (Greenhill, 2010, 2016). It is not important whether migrants are a real threat. If they are perceived as threatening a country's security, culture and livelihood, anxious and motivated actors will mobilize to oppose their acceptance (Greenhill, 2010, p. 44) (see also Greenhill, 2021).

This is the context in which individuals make decisions to migrate or stay. Due to the size and the complexity of the migration system, actors cannot interact with all other actors in the system and not even with all actors in a network or subsystem. Instead, actors use information on other actors and subsystems that is summarized in indicators, e.g. economic and social indicators. For instance, an actor interested in employment and considering a job abroad usually lacks full information on vacancies but may know a few indicators such as the rate of unemployment or some anecdotal data on employment opportunities (e.g. from network members). The indicators inform actors about structural conditions within which people make decisions to migrate or stay (Van Hear et al., 2018, p. 932). Structural conditions are characteristics of a system or subsystem. They are external to the actor and, to understand their influence on the migration decision, they must be translated into motives, which are internal⁵. Czaika and Reinprecht (2020) distinguish 24 structural factors (drivers) grouped in nine driver dimensions (demographic, economic, environmental, human development (education, health), individual (personal resources and experiences, attitudes and aspirations), politico-institutional (including governance), security, socio-cultural (social networks and norms), and supranational. They influence the migration decision directly or indirectly. An indirect effect occurs when the effect of one driver depends on the presence and intensity of another driver (Bijak and Czaika, 2020, p. 10) (for a general discussion of indirect effects and mediation, see VanderWeele, 2015). Drivers are permanent or transitory and their scope is from local to global. Not all drivers affect all societal groups in the same way and to the same extent. Importantly, drivers affect each stage of the decision process differently and they are perceived differently in different stages of the life course. The authors refer to these differential perceptions and effects as endogeneity of driver perceptions (and effects). The assessment of effect of drivers on individual actors requires a life course perspective and multistage decision-making process perspective. Structural conditions impact on individual actors and their capabilities to take advantage of opportunities, mobilize resources and remove barriers (agency). To understand the effect of drivers on individuals, they must be translated into motives. The psychological theory of human motivations links motives to universal human needs (Maslow, 1943), values and goals people wish to attain. De Jong and Fawcett (1981) consider seven

⁵ Drivers are input to a complex process and actions are output. Drivers and actions may be related statistically without being related behaviourally or causally. Statistical analysis relating macro-level indicators and individual motives and behaviour is subject to ecological fallacy (see e.g. De Haas, 2011, p. 16 and Prike et al., 2021, p. 99). It is a core issue in trying to unravel micro-macro links (see e.g. Raub and Buskens, 2011 and Billari, 2015). Individual actions invalidate predictions made at the macro level (Bijak, 2021), although they may predict the probabilities of individual actions. The divide between micromotives and macrobehaviour was demonstrated by Schelling (1971) using microsimulation.

psychologically meaningful categories of values or goals that people wish to attain. They are labeled wealth, status, comfort, stimulation, autonomy, affiliation and morality. Figure 1 lists the values/goals, together with value indicators that measure the degree to which individuals attain the values or goals. The list is illustrative only. Some formulations may be out of date, some indicators could be added, and the list may reflect a western bias. Actors weight the value indicators differently, i.e. they associate different levels of importance with the indicators. De Jong and Fawcett refer to Maslow (1943)'s hierarchy of needs, but do not arrive at a hierarchy of values or goals. In recent years and in particular in attempts to understand and measure happiness (absence of a gap between aspirations and attainments; Myers and Diener, 2018), there seem to be a revival of interest in Maslow's hierarchy. Czaika et al. (2021) start from Maslow's hierarchy of needs to arrive at a hierarchy of aspirations as precursors of migration decisions.

Figure 1. Values and goals related to migration	
General values/goals	Indicators of values/goals
Wealth	<ul style="list-style-type: none"> • having a high and stable income • having economic security at old age • being able to afford basic needs and some luxuries • having access to welfare payments and other economic benefits
Status	<ul style="list-style-type: none"> • having a prestigious job • being looked up to in the community • obtaining a good education • having power and influence
Comfort	<ul style="list-style-type: none"> • having an "easy" job • living in a pleasant community • having ample leisure time • having comfortable housing
Stimulation	<ul style="list-style-type: none"> • having fun and excitement • doing new things • being able to meet a variety of people • keeping active and busy
Autonomy	<ul style="list-style-type: none"> • being economically independent • being free to say and do what you want • having privacy • being on your own
Affiliation	<ul style="list-style-type: none"> • living near family and friends • being part of a group/community • having a lot of friends • being with spouse/ prospective spouse
Morality	<ul style="list-style-type: none"> • leading a virtuous life • being able to practice religion • exposing children to good influences • living in a community with a favourable moral climate
Source: De Jong and Fawcett, 1981, p. 50	

3 Theories of action: agency and structure (*lives in context*)

Theories of action originated across disciplines in the social and behavioural sciences, and the life sciences. They have common roots, evolved in different directions, enhanced by the emergence of disciplinary boundaries and the protection of territories, resulting in a plethora of theories of action. A back-to-the-roots approach is enlightening because (a) the common roots highlight what theories of action have in common and what can be attributed to niche protection and the need to get noticed in the scientific arena, and (b) the political debate on migration today divides society in a way that is remarkably similar to the polarization trend during the era that produced the foundation for today's theories of action.

The theories of action discussed in the paper are not limited to applications in the study of migration, following De Haas' advice that "considerable theoretical progress can be achieved by further embedding migration studies within broader theories of social change. This can, for instance, be done through applying insights from fields such as social psychology and behavioural economics." (De Haas, 2021, p. 31). That is not to say that migration scholars have not embraced theories of action that originated in social psychology and economics. De Jong and Fawcett (1981) proposed the Value-Expectancy model from social psychology for the study the migration decision and Haberkorn (1981) used other behavioural theories. Their work did not receive the attention it deserved. Referring to work by de Jong, Fawcett, Gardner and others in population studies, Carling and Schewel (2018, p. 949) conclude that "today's migration scholars have generally not picked up where their predecessors left off". The reason Penninx (2006) gives is the fragmentation of migration research with different clusters and little interaction⁶ (see also Arango, 2000).

The structure of this section is as follows. The common roots of theories of action are highlighted in Subsection 2.1. Subsection 2.2 is a brief review of several theories of action, highlighting their commonalities. Because the theories have been developed in different disciplines, theories use different labels to denote the same concept or mechanism. Conceptual clarity is essential for engaging in an transdisciplinary dialogue. Subsection 2.3 distinguishes a few essential building blocks for a process theory of action, i.e. a theory that views decision making and the turning of a decision into action as a developmental process. Subsection 2.4 discusses one theory of action, the theory of planned behaviour, in greater detail and shows the linkages with other theories of action. That discussion demonstrates that the differences between the many theories of action presented in scholarly literature are rather limited and that it should be possible to develop a theory of action that incorporates insights from different disciplines. A comprehensive theory of action is beyond the scope of this paper.

3.1 All theories of action have common roots

All theories of action can be traced back to the Age of Enlightenment in Europe during the 17th and 18th century. An early manifestation is René Descartes' 1637 philosophy of *Cogito, ego sum* ("I think, therefore I am"). The new movement centered on the capacity of human beings to reason, in

⁶ Rinus Penninx, the founding coordinator of the IMISCOE Network, acknowledges the role of the EU Commission: "It was the 6th Framework Programme for research of the European Union that offered the possibility to try to overcome the fragmented nature of research (by funding the IMISCOE Network), and in doing so provide a coherent and more comprehensive analytic and empirical basis for policies and the public discourse on international migration and integration." (Penninx, 2006, p. 13).

particular to reason with hypotheses or propositions that may be true or false and use logic to combine new or existing information (experiences, testimonies) in argumentation and learning. Particularly influential has been the Scottish Enlightenment philosopher David Hume (1711-1776). In his *Treatise of human nature* (1739-1740), Hume argues that humans act for a purpose or reason and based on experience. Actions are outcomes of mental processes. Hume inspired many social scientists and had a major influence on his disciple and friend Adam Smith (1723-1790), who was in the same debating society as Hume. Smith is at the origin of economics as a science. In *The theory of moral sentiment* (1759), he identified sympathy for others (benevolence) along with love of self (self-interest) as the strongest motivating factors in human action. In *The wealth of nations* (1776) he applied his ideas to an economic setting. Capital accumulation should not be the driver of economic development, but the expansion of the capabilities (or freedoms) of people to control their own lives, much in the same way as Amartya Sen (1999) advocated centuries later. Sen's capability approach, which sees the advancement of the freedom individuals enjoy as the ultimate aim of development, is built on Smithian fundamentals. Sen's capability approach gained attention in migration theory. In an attempt to understand how development may affect migration and to explain that development may lead to more migration, de Haas (2014) applied Sen's capability approach.

Adam Smith had a strong influence on the Austrian School in economics and Max Weber in sociology. The two emphasized that (a) individual actions shape the economy and society and (b) the actions are outcomes of mental processes of decision-making (Austrian School) and meaning-giving (Weber). That view on the link between regularities at the macro-level and actions at the micro-level became known as methodological individualism⁷, a term coined in 1905 by Schumpeter of the Austrian School. The value or utility people attach to goods and services are subjective. Weber's theory of action is fundamental in sociology and inspired many sociologists, including Talcott Parsons, James Coleman (1990) and adherents of the subfield of analytical sociology. Weber influenced the anthropologist Clifford Geertz, which led to interpretive anthropology. As Weber, Geertz made the individual actor central to his methodology (Keyes, 2002). Cultural systems must be "actor-oriented" (Geertz 1973, p. 14). Schewel (2018, p. 3) adopted Geertz's perspective in a study of the social, economic and cultural contexts in which migration decision-making takes place.

3.2 Theories of action

All theories of action have common roots. They also share the same set of five basic principles (axioms or postulates). They are:

⁷ Methodological individualism should not be confused with rational choice and neoclassical economics. In Schumpeter's and Weber's thinking, it is fully consistent with the view that social structures are outcomes of individual actions (and agency). They emerge from individual actions and interactions, and, when the structures are established, they have their own dynamics and exercise control over individual actions and interactions (feedback). That view is not different from that advocated by Bakewell (2010). His criticism that "the rational choice theory and methodological individualism that underpin neoclassical and NELM approaches have little place in world systems theory." should not apply to methodological individualism as conceived by Weber and Schumpeter.

1. *Actions serve a purpose*, something the actor wants to achieve (outcome) because of its meaning or value attached to it. Actions are aimed at reaching desired outcomes or goals. Depending on the discipline, purpose is captured by terms such as preference, utility, aspiration, desire, goal, motive and intention. Purpose represents a personal interest to carry out an action to attain a goal or to acquire something of interest to the actor (that interest may cover the needs and desires of others; it is not necessarily egocentric). Carling uses the umbrella term aspiration, defined as a belief⁸ that migration is preferable to non-migration (Carling, 2002, p. 9; Carling and Schewel, 2018, p. 946).
2. *Outcomes of actions are uncertain*. An action may produce different outcomes, but all possible outcomes are not equally probable. Probability distributions describe the probabilities of the different outcomes. The probabilities are assigned by actors based on empirical evidence, e.g. experience, or intuition, beliefs or judgements. The Bayesian interpretation of probabilities is that probabilities are subjective *degrees of belief* that an action will generate a particular outcome. All theories of action assume that probabilities are subjective, but few make an explicit link with Bayesian.
3. *A single action may produce multiple outcomes and different actions may produce a same outcome*. Multiple outcomes may often be classified in main effects and side-effects. All effects are uncertain and some may be unexpected. Actions that produce a same outcome differ in the effort or resources they require and in the likelihood of the desired outcome.
4. *Actions are contextualized and socially conditioned*. Actors act differently in different circumstances. The values or utilities actors attach to outcomes may also change.
5. *Actors have agency*. Actors have a (limited) capability to decide freely and to influence the context of decision making. Consequently, they have some capability to affect the probability of a given outcome. That capability is denoted by *agency*. In sociology, the context of actions is denoted by structure. The confidence of an actor in their ability to make a difference is *self-efficacy*. It is a person's belief in his or her ability to succeed in a particular situation or condition. Persons with a strong belief that things that happen to them are greatly influenced by their own abilities and actions are said to have an internal *locus of control*. Those who believe that others, environmental factors or chance are responsible for the events that occur in the individual's life have an external locus of control

⁸ A belief that migration is preferable to non-migration varies in degree. Aspiration is an umbrella term to cover mental constructs, including desires, intentions, plans and expectations for migration. Aspirations “encompass ambitions, attitudes, expectations, intentions, plans, preferences, wants and wishes, desires, dreams, hopes, longings, and yearnings; as well as the seemingly more hesitant, uncertain or neutrally oriented notions of considerations, imaginings, needs, necessity, obligations, and willingness to migrate.” (Aslany et al., 2021, p. 6). Aspirations are also referred to as a mindset, which covers a wide range of mental states (Carling and Mjelva, 2021, pp. 24ff; Aslany, 2021, p. 8). A broad umbrella concept, that is not clearly defined, complicates any analysis and has little predictive power. Aslany et al. (2021, p. 58) call for greater specificity: “Most basically, we would like to see more deliberate, more precisely discussed, and better documented measures of migration aspirations.” The aspiration concept does not seem to be different from the utility concept in the subjective expected utility theory and the attitude concept in the theory of reasoned action (see below). The mindset vis-à-vis migration seems to coincide with the attitude toward migration. The attitude concept has been criticized for being too general and therefore difficult to test empirically and to be used for prediction (see e.g. Haddock and Maio, 2012, p. 191). Aslany et al.’s (2021) remark seems to point in a similar direction.

(Rotter, 1966). The concept is closely related to perceived behavioural control, but there are differences (Ajzen, 2020, p. 317). Persons with an external locus of control may be confident that they can influence the external factors. Confrontation with events and practices in the real world may shake or shatter these beliefs. Self-efficacy can be boosted by a process of developing one's ability to influence situations and outcomes, and the associated self-confidence, a process known as empowerment.

Actors have (a) different degrees of belief (subjective probability) that an action leads to the valued outcome(s) and (b) value possible outcomes of actions differently. That principle is common to all theories of action. Consider the behavioural theory proposed by De Jong and Fawcett (1981) for migration (see also Fawcett, 1985). Their value-expectancy model of migration decision-making started from a model of behaviour developed in instrumentality theory in psychology and applied a few years earlier by Chemers et al. (1978) in a study of rural-urban migration in Iran. Instrumentality theory views behaviour as instrumental to bringing about something an actor values⁹. Instrumentality is the degree to which a person engages in actions to reach an outcome (or goal). The attractiveness of an outcome (*valence*) determines the action. The model, known as the value-expectancy model, was proposed by Vroom (1964) in psychology. Mitchell and Biglan (1971) provide a thorough discussion of the theory and several applications at that time. Vroom's aim was to determine what motivates people to work. People work for several reasons, e.g. income, social contacts, intrinsic drive. The attractiveness of an outcome (*valence*) determines the action. Vroom's expectancy theory shows formal parallels to the expected utility model. In both the value-expectancy model and the subjective expected utility model, behaviour is instrumental to attain a goal or utility and an actor selects a behaviour based on its expected outcome. The more valued the outcomes and the more the subjective belief that a behaviour leads to the desired outcome(s), the more likely the person will engage in the behaviour.

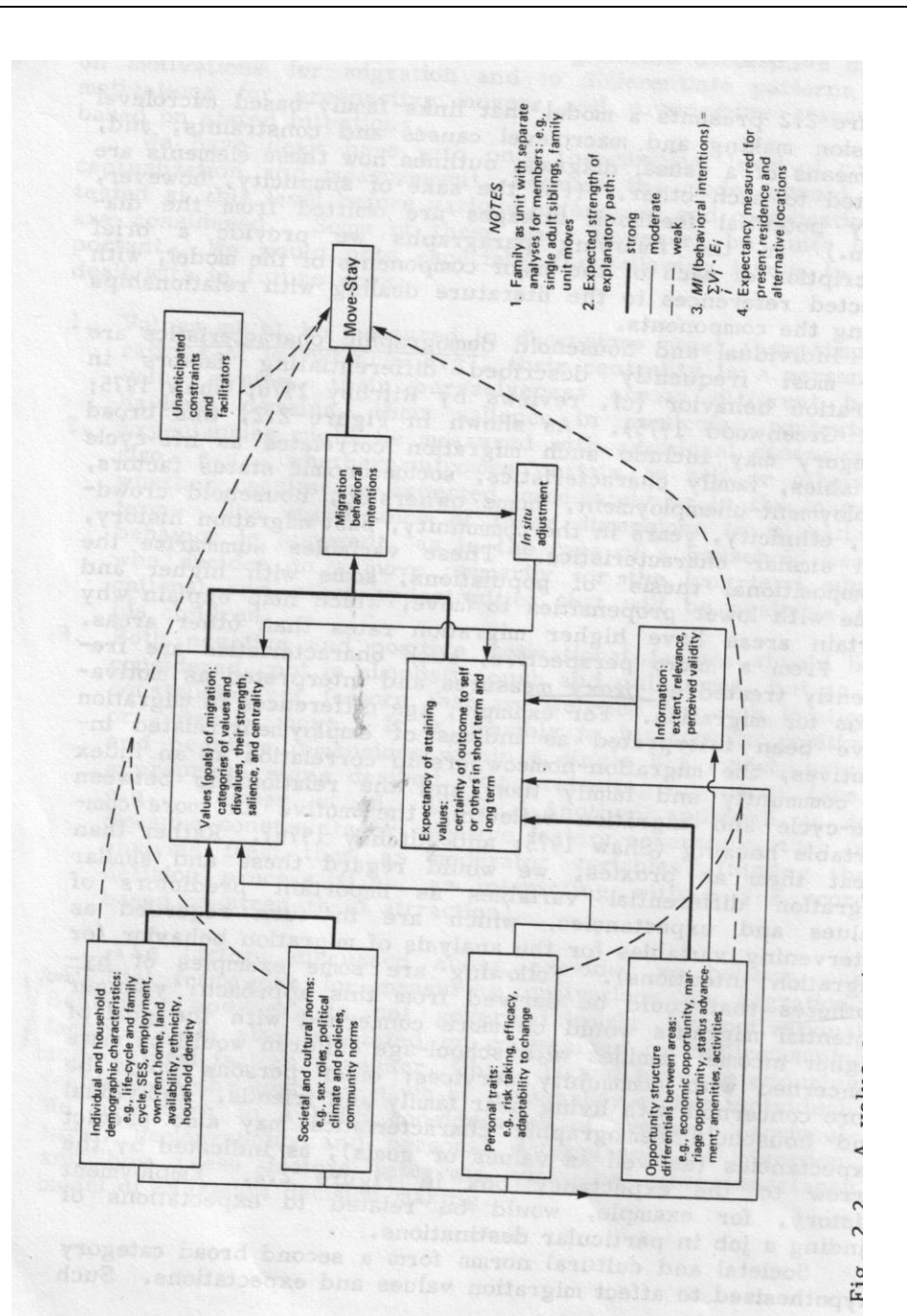
For centuries, the probabilities individuals attach to outcomes have been the subject of scholarly debate. For one group of scholars, the probabilities should be evidence-based (empirical). For another group, they are subjective. Von Neumann and Morgenstern (1944) interpreted probabilities as objective chances, based on evidence. The associated model is the *expected utility model*. Psychologists and a growing number of economists view the probability as a degree of belief or subjective probability, leading to the *subjective expected utility model* (e.g. Savage, 1954) (for a review of early developments see Edwards, 1954, 1961). A discussion of the debate is beyond the scope of this paper. The basic structure of the simulation model that is envisaged does not depend on whether the probabilities are objective or subjective.

De Jong and Fawcett link the subjective probabilities of outcomes and the values attached to the outcomes to structural factors at the individual level, e.g. stage in the life course, and the societal level, e.g. community norms and political climate. For the sake of simplicity, they omit feedback linkages from micro to macro, that is individual actions do not influence the macro-level causes and constraints. The value-expectancy model proposed by De Jong and Fawcett is shown in Figure 2. Information about opportunities in alternative locations, i.e. information on the geography of opportunities or opportunity structure, is particularly important. It influences an individual's

⁹ The instrumentality of migration received much attention until today. Carling and Collins (2018, p. 917) consider migration a means to an end, while de Haas (2021) asserts that some people migrate for the intrinsic value, i.e. the value attached to the migration experience in and of itself, such as 'Gap years', 'lifestyle migration', and the joy and pleasure derived from exploring new societies, the *bright lights* of the city, and to derive social prestige from migration. One may question whether these factors are really intrinsic to the migration itself and are not goals one expects to attain by migration or, with less energy, by travel.

subjective probability that migration will lead to the anticipated outcome. The expected value of migration determines the intention to migrate. Actions do not follow automatically from intentions, however. Unanticipated factors may prevent or inhibit the implementation of intentions. They may also facilitate migration. Unanticipated factors may be changes in the life course (e.g. divorce, or job loss or job offer, change in health status), the inability to mobilize sufficient resources to cover the costs of migration, or different than expected social support (De Jong and Fawcett, 1981, p. 56). The authors emphasize that the decision to migrate is not the only possible behavioural outcome of the decision-making. The alternative is the decision to stay and to adjust in place (*adjustment in situ*).

Figure 2. Value-expectancy-based model of migration decision-making behaviour



Source: De Jong and Fawcett, 1981, p. 54

3.3 Building blocks of a process theory of action: aspirations (attitudes), choices and actions

Migration is one of several actions individuals and families may consider to change their living conditions and their life course. The entire life course, including migration, is shaped jointly by structural factors and individual agency (see Heckhausen and Buchmann, 2019, for a recent discussion from the perspective of psychologists; Hitlin and Kirkpatrick Johnson, 2015, for perspective from sociologists; and de Jong and de Valk, 2019, for a discussion in the context of migration decision-making). Individuals often face trade-offs between work, family, and migration that require the weighing of consequences of purposive actions. Heckhausen and Buchmann use the metaphor of the epigenetic landscape: individuals move through the life course, navigating through the fields of social opportunities and constraints established by the historical context, social institutions, and the social structure. A multitude of factors enter the decision to migrate and numerous actors may be involved in the decision process and the implementation of the outcome of that process. The distinction between decision and action is important, although it is not often made in the literature. In this paper a distinction is made between decision, choice and action. A *decision* is a mental process; a *choice* is the outcome of that process; and *action* is the implementation of the choice. Decision theory is the study of how choices are made (positive or descriptive theory) or should be made (normative or prescriptive theory) to achieve a goal. The decision process may have a number of possible outcomes, often denoted as options or alternatives. Permanent migration is one of several options. Other theoretical options are staying (immobility), short-term migration, circular migration and traveling back and forth (commuting). Possible destinations represent alternatives too. A choice implies a selection of one of the alternatives. Decision processes and their outcomes are influenced by inhibiting and facilitating factors and actors. The context, which is not static but changes continuously, influences the process and hence its outcome. Changes in context are captured by time-varying drivers or, preferably, a process perspective on social transformation. A choice is usually, but not always, followed by an action. An action is the implementation of a choice. The use of the concepts 'decision', 'choice', and 'action' differ by discipline. (Willekens et al., 2017).

The unpredictability of the changes in the individual's life course and in contextual factors is a source of uncertainty. Uncertainty is due to ignorance (epistemic uncertainty), but it is also due to intrinsic randomness (aleatory uncertainty) (Bijak, 2010). Uncertainties need to be accounted for. Stochastic process models account for aleatory uncertainty. Uncertainty includes luck and unexpected events.

Migration decision-making is a cognitive and social process consisting of several stages. They may include (i) developing an awareness of the benefits of migration and the losses that are associated with migration, (ii) turning the awareness into a desire or aspiration, (iii) mobilization of resources and social support to make the migration project feasible and justify a decision to migrate. A decision to migrate does not automatically result in a migration. Many factors and actors intervene during the implementation stage. Carling (2002) approaches migration as a two-step process. The first is the development of a belief that migration is beneficial (the outcome is an attitude, desire or aspiration), the second is to turn that aspiration into an action. The factors that affect the first stage may differ considerably from those influencing the second stage. A similar approach is adopted by Kley (2011, 2017), who assesses the facilitators and constraints during the various stages of the migration decision process. Carling (2002) and Kley (2011) report empirical studies in which the two stages of migration are distinguished by means of a longitudinal investigation of intentions to

move followed by actual migration. Kley also cites three-stage models of migration.

Forming an aspiration to migrate introduces a degree of commitment to the action. That commitment gets stronger when the individual decides to migrate. In the early stage of the process, thoughts are dropped again easily without severe consequences. By aspiring to act in a certain way, and particularly by deciding to act, the actor 'crosses the Rubicon'. Abandoning the process becomes costly, because it comes with negative emotions and frustration, and often damages self-respect, as Carling (2002) discovered among youth in Cape Verde¹⁰. The Rubicon model was proposed by Heckhausen (1991; Heckhausen and Heckhausen, 2010) in developmental psychology. The model postulates that individuals pursue development goals to produce the life course they want and mobilize cognitive and other resources to achieve the goals. Developmental goals are anticipated end states, comparable to the goals listed by De Jong and Fawcett. They motivate an individual to act in a particular way. Heckhausen distinguishes several phases between the awakening of a wish to achieve a goal and accomplishment of the goal. He asserts that transitions between the phases are discrete shifts rather than gradual changes (hence the reference to Rubicon). They involve commitments that make it harder not to act in the intended way. Abandonment of the process to which one is committed requires agency too. Abandonment and the associated decision to stay is as much an expression of agency as the decision to move. Kley uses Heckhausen's theory in migration and Coulter (2013) uses Kley's process model to study the abandonment of desires to relocate in the context of residential mobility. Bailey and Mulder (2017) in a study of the emigration of highly skilled Indians to the Netherlands and the UK, embed the phase model of action in the life course and show how individuals and families mobilize different types of resources and access different networks to assure that emigration produces the desired outcome.

3.4 Theory of reasoned action and theory of planned behaviour

A comprehensive theory of action captures all elements that influence human action. A good theory is as simple as possible and as complex as needed (Occam's razor). The theory of reasoned action explains human behaviour in terms of attitudes and intentions (actions and behaviour are used interchangeably). The theory was developed by Fishbein (1963) starting from the instrumentality theory introduced in Section 2.3. At that time there was a growing awareness that attitudes are not good predictors of behaviour. Fishbein pointed out that there are at least two reasons (Mitchell and Biglan, 1971, pp. 438ff). The first is a measurement issue: most attitude surveys measure attitudes toward general stimuli or objects rather than toward a specific stimulus or object. Asking about one's attitude toward migration is too general to be used as a predictor of behaviour. Second, behaviour is only partially related to attitude. Fishbein based his theory partly on existing attitude measurement techniques, such as the Likert Scale¹¹. Fishbein, a social psychologist, also added a normative component. The personal belief about the consequences of an action and the personal belief about social pressure and social approval determine the intention

¹⁰ Frustration about the lack of opportunities may lead to dissent and political violence (Urdal, 2006), with governments reacting by a global securitization of youth (Sukarieh and Tannock, 2018). Securitization of youth and migration, leading to criminalization of entire subgroups is a major obstacle to humane governance, including a humane governance of migration, as demonstrated by detention camps, push-backs and disrespect for international law.

¹¹ The Likert Scale is a symmetrical ordinal scale with substantive labels, such as 'Very likely; Somewhat likely; Little likely; Unlikely'. Carling and Mjelva (2021) discuss the Likert Scale and its use in the collection of information from individuals on the motives and likelihood of migration (aspiration).

to act and subsequently the action. To further improve the predictive power of the theory of reasoned action (TRA), Ajzen (1985) extended the theory by adding perceived and actual behavioural control (see also Fishbein and Ajzen, 2010). He called explicit attention to individual differences in the capability to act successfully on an intention due to differences in agency. The augmented TRA became known as the theory of planned behaviour (TPB). The TPB is widely used in studies across the social sciences, including studies of migration.

What follows is a brief review of the TPB. According to the theory, intention to perform a specific behaviour is the best predictor of the actual behaviour because stronger intentions lead to increased efforts to perform the action. An intention to act (behavioural intention) is determined by three factors: (a) the individual's subjective expectation that the action is beneficial, (b) the individual's perception of social norms and willingness to comply and (c) the personal belief in one's ability to act as intended. The subjective expectation, which in the theory is called *attitude* toward the behaviour, depends on (i) the subjective belief that a given action produces the desired outcome, or at least a favourable outcome, and (ii) the evaluation of that outcome, i.e. the value or utility the individual attaches to that outcome. Beliefs are formed as a result of direct observation, education, word of mouth, media attention, and other factors. Education, socio-economic status, personality and emotions are among the background factors that influence how people go about to form beliefs in the likelihood of particular outcomes and the valuation of outcomes. Ajzen and Fishbein (2005) show that attitude is not a good predictor of behaviour. The reason is that the attitude toward a behaviour is moderated by other personal factors, biased information and situational factors. To improve the predictive performance of attitudes, the authors stress the need to assess specific attitudes toward specific actions, e.g. "Do you believe that a migration to country x in the next 12 months will result in an increase of your income? By how much?"

The attitude concept is similar to the subjective utility concept in the subjective expected utility theory of decision making. Matsumori et al. (2019) considers the TPB as an attempt to improve the expected utility theory's accuracy of predicting behaviour when the action is given (target action) and the task is to choose between performing the target action and not performing the action. This binary choice problem has two alternatives. Most choice problems considered in economics have several alternatives (polytomous choice).

A belief that an action such as migration is beneficial and the benefits outweigh the costs is a necessary condition for developing an intention to migrate, but it is not a sufficient condition. Potential migrants are sensitive to group norms, social pressure and social approval. In general, the opinion of important others (*referent individuals, reference groups*), such as one's partner, family members, friends, and peers matter. For instance, a partner who supports the emigration decision can act as an important stimulus (Van Dalen and Henkens, 2012). Opinion leaders or influencers are important too. *Subjective norms (SN)* do not refer to prevailing social norms, but to the individual's *perception* of the norms, i.e. to the individual belief about social pressure to perform or not perform an action and the social acceptability of the action (social approval). Normative beliefs are acquired by learning from others and the influence through which some individuals exert control over others, by virtue of their power or authority. Ajzen and Klobas (2013) distinguish between normative beliefs based on what others say and those based on what others do. Some societies develop a culture of emigration (see e.g. Kandel and Massey, 2002; Kōu and Baily, 2014). In these societies, individual normative beliefs evolve to shared (collective) normative beliefs and become institutionalized. The Philippines, Mongolia and Ireland developed a culture of emigration. Some agricultural societies developed a culture of migration to prevent farm fragmentation. Subjective norms also take into account an individual's willingness or motivation to comply (compliance), which depends on the desire for autonomy and the ability to make choices according to one's own free will. Note that social norms are not absent from the expected

utility theory, although they are less central than in theories of action that originated in sociology or social psychology. Schoemaker (1982) considers social norms in subjective utility theory (see also Matsumori et al., 2019).

Individuals who consider emigration beneficial and who experience a social pressure or social support to emigrate will not develop intentions to emigrate unless they believe that they have the resources to remove the obstacles to emigration and to make emigration a success. To accommodate this factor in the theory of reasoned action, Ajzen (1991) extended the theory by including behavioural control. Ajzen distinguishes two aspects of behavioural control. The first is the *perceived behavioural control (PBC)*. It is the extent to which people *believe* that they are capable of performing a given action. The second is the actual behavioural control (ABC). The PBC takes into account the personal skills, opportunities, constraints and resources required to perform the action. The concept is closely related to Bandura (1977)'s concept of self-efficacy and the sociological concept of agency. Ajzen (1991) wrote that the role of perceived behavioral control in the theory of planned behaviour is derived from Bandura's concept of self-efficacy. Fishbein and Cappella (2006) state that self-efficacy is equivalent to perceived behavioural control in Ajzen's integrative model. Ajzen (2002) indicates that PBC can be viewed as the combined influence of two components: self-efficacy (a person's judgment about being able to perform a particular action) and controllability (the extent to which the performance of the action is up to the actor) (see also Fishbein and Ajzen, 2010, pp. 165ff). Self-efficacy depends on available resources and the belief that barriers can be removed, while controllability depends on the presence of obstacles. Resources include financial means, but also human capital, social capital and cultural capital. Obstacles include distance (physical and cultural distance), institutional barriers (visa requirements, lack of recognition of professional qualifications, etc.) and cultural barriers (differences in language, religion, etc.).

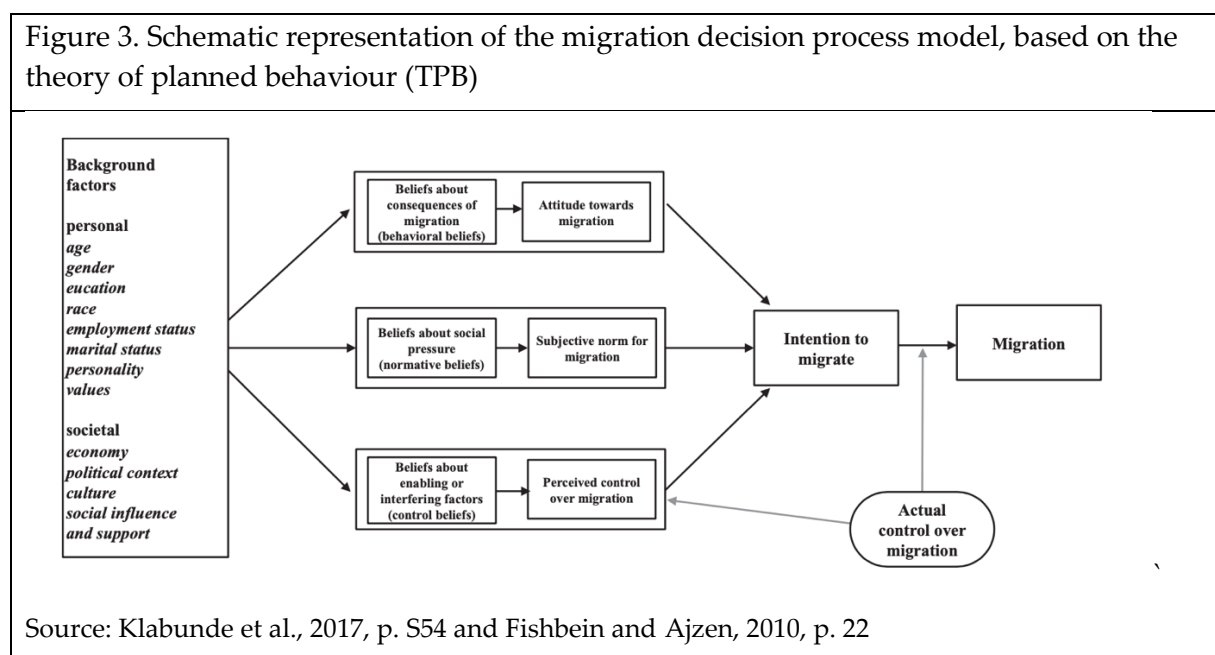
People who overestimate their ability to overcome barriers and to take advantage of opportunities and facilitators of migration are not able to turn an intention into an action when the *actual behavioural control (ABC)* turns out to be less than the PBC. To act as intended, PBC should equal ABC. In other words, an actor's perception or belief should be realistic. Ajzen uses PBC as a proxy measure for actual behavioural control, and notes that it can substitute for control when an individual's perceptions are realistic. The difference between PBC and ABC is one reason for the often limited predictive performance of intentions (Ajzen, 2011). Another is the insufficient detail in measuring intentions in a survey, a reason for inconsistency also stressed by Ajzen and Fishbein (2018) and Ajzen (2011). A third reason is changing intentions. If the interval between measurement of intentions and recording of behaviour is large, intentions may have changed. Intentions and behaviour should therefore be measured in a relatively narrow period of time (see also Ajzen, 2011).

Using longitudinal data on individuals in the Netherlands who expressed an intention to emigrate, Van Dalen and Henkens (2013) found that emigration intention is a predictor of emigration. About one third (34%) of respondents who stated an intention to emigrate actually emigrated within a 5-year follow-up period. De Groot et al. (2011) found, in a study of residential mobility, that people with a strong intention to move are almost four times as likely to move than people with a less strong intention to move. De Jong (1994) reviewed several studies on internal migration in different countries and found that people who intend to migrate are three to four times as likely to migrate in a specified time frame than people who intend to stay and arrives at the conclusion that intentions are often not good predictors of behaviour. De Jong (1994) gives several reasons for the inconsistencies between intentions and behaviour. They are similar to the reasons given above. Time matters too. Sheeran et al. (2003) and Hoppe and Fujishiro (2015), two studies that use the theory of planned behaviour, found that the closer to the emigration, the better informed an

individual is about barriers, resources and social support, and the more accurate an individual's perception of self-efficacy (and PBC) is. The predictive performance of intentions increases closer to the emigration. Esipova et al. (2011) came to a similar conclusion based on the World Gallup Poll. For a discussion, see Aslany et al. (2021, p. 52).

Figure 3 is a schematic presentation of the TPB, applied to migration. The left panel shows the structural factors that influence the personal beliefs about consequences of migration, social pressure, and one's ability to control the interfering factors and act successfully. The middle panel indicates that these beliefs influence the attitude toward migration, the subjective norms and the PBC, and these three factors determine the intention to migrate. Whether an intention to migrate leads to an actual migration depends on the ABC.

Figure 1 of Carling (2017, p. 2) has a number of aspects in common with Figure 3 in this paper.



The theory of planned behaviour and the other theories covered in this section, are static. The development of an intention to migrate and the planning and preparation of migration are assumed not to take time (response is immediate). In reality, these activities and the deliberations associated with them take time. Time is introduced in the next section.

A modelling framework that has much in common with the TPB although the link is often not made is the Belief-Desire-Intention (BDI) framework (Rao and Georgeff, 1998). The model originated in computer science and is relatively popular in agent-based modelling (Balke and Gilbert, 2014). BDI is a model of the human reasoning process, where a person's mental state is characterized by three major components: beliefs, desires, and intentions. Actions are shaped by an actor's state of knowledge about the world (*beliefs*), the states of the world it seeks to bring about (*goals*), and the execution of pre-programmed (partial) *plans* that have been designed to bring about the desired states, in pre-specified circumstances. *Desires* are possible states of the world the actor might want to pursue; they represent options. *Goals* are states an actor actively desires to achieve. A commitment to pursue a particular action to achieve a goal is referred to as *intention*. The model focuses on a representation of reasoning. Beliefs are updated based on perceptions and intentions are updated considering capabilities and resources. Balke and Gilbert (2014) give an extensive review of the model and its extensions, but do not note the commonalities with the TPB.

The formal theory of naïve utility calculus, presented by Jara-Ettinger et al. (2020) also distinguishes beliefs, desires, goals and intentions, stored in a mental models, and actions. The theory embeds the utility calculus in a Bayesian framework

4 Consequences of actions and utilities attached to consequences

This section adopts a more formal approach to decision making and the values attached to actions. The first subsection is about the prediction of the consequences of actions under uncertainty. If an actor may select one of several possible actions, the probability that an action is selected depends on its consequences. That calls for a joint probability of actions and consequences. Since the choice of an action depends on its consequences, new information about consequences of actions may change the action chosen. The *Bayes' formula* is used to assess the impact of new information about consequences on the beliefs about consequences of actions and on probabilities of selecting particular actions. The *Bayes factor* is used to assess the extent to which new information changes in the odds that one action is selected rather than another action. It leads to the concept of *weight of evidence* in favour of a particular action. The concept is particularly useful to study the impact of new experiences and information on an individual's actions. The beliefs mentioned here coincide with the behavioural beliefs in the theory of reasoned action, i.e. personal beliefs that actions have desired consequences. An individual's belief that an action is beneficial is a necessary element in the choice of action, but it is not sufficient. Self-efficacy and social approval provide important input too. The control beliefs and the normative beliefs change the odds of selecting a particular action. The updating of beliefs in light of new information is a learning process that can modelled as a Bayesian updating process.

Individuals attach values to consequences. Some consequences of actions are desired more than other consequences. Values are often referred to as utilities. Utility/value functions describe the values attached to the different consequences that an individual considers relevant. Utility functions are briefly covered in the second subsection. The probabilities and values people attach to consequences of actions vary with the type of consequence and the magnitude of a consequence. Prospect theory identifies several variations. Prospect theory is the subject of the third subsection. The final subsection discusses a utility concept that is particularly relevant to predict migration. It is the utility individuals attach to places of residence.

Possible consequences of actions and probabilities attached to consequences are covered in Subsection 4.1. It includes a discussion of the weight of evidence in favour of a particular action. Utilities attached to consequences are the subject of Subsection 4.2. Actions with multiple consequences lead to utilities with multiple attributes. Different features of the utility of an action are combined in the utility function. The form of the utility function expresses the variation of utility with different levels of consequences. Declining marginal utility, risk aversion, loss aversion and focusing illusion affect the shape of the utility function (Subsection 4.3). Subsection 4.4 considers a particular type of utility: place utility or the utility an actor associates with a place.

4.1 Consequences

Consider a set of possible actions $R_a = \{a_1, a_2, a_3, \dots, a_s\}$. The consequences of the actions determine which action the actor chooses. Since consequences are uncertain, the action that will be chosen is uncertain too. Let A denote the action that will be chosen. A is a random variable with possible values R_a ($A \ni R_a$). The probability that an actor chooses action a_i is $Pr\{A = a_i\}$. A

probability mass function gives the probabilities of each possible action. Choosing an action does not mean that the actor will be able to act according to the choice. That depends on the actual behavioural control. Let $R_d = \{d_1, d_2, d_3, \dots, d_s\}$ denote the possible outcomes of the decision process. If the distinction between perceived and actual behavioural control is disregarded, as is commonly done in utility theory, the decision to act determines the action. An action has multiple consequences. For instance, an actor considering migration may pursue a higher income, more freedom and security, and proximity to family and friends. Each possible consequence is considered to assess the degree to which actions contribute to the attainment of goals. With each consequence may be associated an evaluation criterion. Criteria do not need to be internally consistent; they may be conflicting. In the presence of multiple criteria, the decision problem is known as a multiple-criteria decision making or multi-attribute utility theory¹². Criteria may be weighted differently. Consequences are represented by continuous or discrete variables. If consequence j is a continuous variable, then let $c_j dc_j$ denotes the infinitesimally small interval of values of the consequence between c_j and $c_j + dc_j$. Let C_j denote the unknown j -th consequence of an action and let $f(c_j)$ denote the probability density function of C_j with $\int_{-\infty}^{\infty} f(c_j) dc_j = 1$. The consequence takes a positive value if it results in a gain or favourable outcome and a negative value if the action generates a loss. A consequence may be measured in absolute or relative terms, relative to a reference value (reference point). The reference point may be the actor's current value of j or the value of j attained by a reference person or reference group. If the consequence is represented by a discrete variable, a consequence is one of possible values in $R_{c_j} = \{c_{j1}, c_{j2}, c_{j3}, \dots, c_{jm_j}\}$ with m_j the number of possible values (or levels) of consequence j . Suppose consequences are represented by discrete variables. The probability that an action generates level k of consequence j is $Pr(C_j = c_{jk})$ with $\sum_{k=1}^{m_j} Pr(C_j = c_{jk}) = 1$. The set of probabilities is the probability mass function of C_j . Different actions may produce a same level k of outcome j , but with different probabilities. For instance a person may reach a same goal by migrating or investing locally, e.g. in an activity or social network, or may switch to a different activity if one activity no longer produces the desired outcome¹³.

The probability an actor assigns to outcome j of action a_i is subjective, although observed frequencies of actions producing outcome j may be taken into account. The actor may not have sufficient knowledge to assign probabilities to possible outcomes or may lack the cognitive capabilities and have severe time constraints to collect the information needed to assign a probability that is accurate. The principles of probability calculus apply irrespective of how probabilities are generated and how realistic they are. Actors also update the degrees of belief about the consequences of actions in light of new evidence or new information. Let $Pr\{A = a_i, C_j = c_{jk}\}$ be the joint probability that an actor selects action a_i and that the action generates outcome c_{jk} (i.e. level k of outcome j). The joint probability may be expressed in terms of conditional probabilities:

¹² It is used in operations research to select optimal sites to deliver products or services, or to determine the attractiveness of locations. The method is suited to take into account several points of view and interests, and to arrive at a compromise. Brunarska (2019) uses the approach to explain and predict migration destination choices. Arandarenko et al. (2020) uses it to determine the attractiveness of regions and to predict their immigraton potential. Baláz et al. (2016) consider eight attributes of destination countries, include wage, cost of living, crime rate, language and health.

¹³ Kingsley (2016, p. 34) reports that the collapse of the tourist industry in Agadez in Niger, since the Middle Ages a tourist town with many travel agencies serving travellers and traders trying to make it through the Sahara, forced many people to change jobs and resulted in a boom in migrant smuggling.

$$\Pr\{A = a_i, C_j = c_{jk}\} = \Pr\{A = a_i | C_j = c_{jk}\} \Pr\{C_j = c_{jk}\} = \Pr\{C_j = c_{jk} | A = a_i\} \Pr\{A = a_i\} \quad (4.1)$$

Suppose the actor has new evidence about the consequences of action a_i and modifies the initial probability or degree of belief that action a_i is a plausible action. The updated probability in light of the new evidence is

$$\Pr\{A = a_i | C_j = c_{jk}\} = \frac{\Pr\{C_j = c_{jk} | A = a_i\} \Pr\{A = a_i\}}{\Pr\{C_j = c_{jk}\}} \quad (4.2)$$

The formula is known as Bayes' formula. It links two probabilities: the probability the actor assigns to action a_i before learning new evidence (prior probability) and the probability after the evidence (posterior probability). Before the evidence becomes available, an actor assigns probabilities based on available knowledge, i.e. knowledge stored in mental models (Johnson-Laird, 2010). The denominator of equation 4.2 is the evidence factor. It is the probability of producing level k of consequence j over all possible actions: $\Pr\{C_j = c_{jk}\} = \sum_i \Pr\{C_j = c_{jk} | A = a_i\} \Pr\{A = a_i\}$. The denominator can be viewed as a scale factor that guarantees that the posterior probabilities add to one. The Bayes' formula describes a strategy for updating choices under conditions of uncertainty in light of new evidence. It is the basis of Bayesian decision theory (Robert, 2007; Smith, 2010; Mongin, 2020). See Gray et al. (2017) for an application in demography.

Mental models are products of individual histories of information gathering and experiences. Jaynes (2003, p. xxii) approaches the Bayes' probability calculus as extended logic (see also Oaksford and Chater, 2007). Tourmen (2016) shows that Bayesian reasoning is coherent with Piaget's theory of cognitive development and constructivism in which mental models (schemata) are used to interpret new experiences or information, and construct personal (and subjective) realities. The learning process involves two basic processes: assimilation (integration of new experiences in existing mental structures) and accommodation (change schemata in order to fit new experiences or information) (for some discussion, see Willekens et al., 2017, p. S9). The process ensures adaptation (change) while maintaining consistency (continuity). The updating of the mental model in light of new evidence is essentially a learning process that reduces uncertainties. If new evidence reduces uncertainty, it is rational to revise the probability distribution of actions. If the evidence informs an actor that action a_i is more beneficial than initially thought, then the actor is more likely to choose action a_i than before that knowledge. Actors may not trust evidence and disregard it or consider it irrelevant or as noise, and resist changing the plausibility of the different possible actions. This selection mechanism explains why two persons, given the same information, may change their opinions differently. It also explains several of the biases in decision making, addressed by Kahneman, Tversky and others.

The theory of planned behaviour is consistent with Bayesian reasoning. Initial beliefs about plausible actions are modified in light of new information on (i) likely consequences of actions (behavioural beliefs), leading to change in attitudes towards the actions, (ii) evidence about social approval of the actions and social pressure to act in a particular way (normative beliefs), and (iii) beliefs about one's capability to control intervening factors (perceived behavioural control). That learning process generates an intention to act and a set of plausible actions. The ultimate probability of a plausible action depends on the actual behavioural control revealed by the evidence once the intention is being turned into an action. The TPB distinguishes different types of beliefs and evidence. The link between revisions of beliefs in the theory of reasoned action and the

Bayesian information processing model was already made explicit by Ajzen and Fishbein (1975), but it was never elaborated. Ajzen and Fishbein also make explicit that beliefs are subjective probabilities. They conclude that “Revisions in beliefs tend to be probabilistically consistent and to correspond quite well to the prescriptions of Bayes's theorem.” (Ajzen and Fishbein, 1975, p. 263).

Bayes' theorem specifies optimal revisions of beliefs in light of new information. The new information may strengthen the belief in the benefits of an action and weaken the belief in another action. The amount of change in a given belief resulting from new information is a function of the diagnostic value of that information. Consider two actions a_1 and a_2 . The initial odds in favour of action a_1 is $\frac{Pr\{A=a_1\}}{Pr\{A=a_2\}}$. The posterior odds in favour of action a_1 is

$$K = \frac{Pr\{A = a_1 | C_j = c_{jk}\}}{Pr\{A = a_2 | C_j = c_{jk}\}} = \frac{Pr\{C_j = c_{jk} | A = a_1\} Pr\{A = a_1\}}{Pr\{C_j = c_{jk} | A = a_2\} Pr\{A = a_2\}} \quad (4.3)$$

The posterior odds in favour of action a_1 is the product of the prior odds in favour of action a_1 and the odds that action a_1 predicts the consequence of the action better than action a_2 . The ratio of the final (posterior) odds to the initial (prior) odds is the support in favour of action a_1 provided by the evidence C_j . The ratio is known as the *Bayes factor* (Kass and Raftery, 1995):

$$\frac{\frac{Pr\{A = a_1 | C_j = c_{jk}\}}{Pr\{A = a_2 | C_j = c_{jk}\}}}{\frac{Pr\{A = a_1\}}{Pr\{A = a_2\}}} = \frac{Pr\{C_j = c_{jk} | A = a_1\}}{Pr\{C_j = c_{jk} | A = a_2\}} \quad (4.4)$$

The Bayes factor transforms the initial odds (prior odds) into final odds (posterior odds). It summarizes the evidence provided by the new information on consequences in favour of a given action. The term ‘Bayes factor’ was introduced by Good (1958). Good worked with the logarithm of the Bayes factor, which he called *weight of evidence* in favour of action a_1 . The Bayes factor lays the foundation for Bayesian reasoning and Bayesian learning (Etz and Wagenmakers, 2017, p. 321). Good (1952) discusses its use in decision making. The Bayes factor measures the relative strength of the evidence. Ajzen and Fishbein (1975, p. 264) use the weight of evidence to measure the amount of change in a given belief or disposition towards an action due to the new information. The effect of the information is not determined solely by the diagnostic value. If the freedom of action is restricted in any way, the effect of new information is tempered. Ajzen and Fishbein also observed that information on undesirable consequences of an action has a larger impact on attitudes towards the action than information on desirable consequences (pp. 269ff). That finding is consistent with prospect theory. Kullback and Leibler (1951) use information theory to quantify the information gain and uncertainty reduction due to the new evidence. Their measure of information gain is derived from the Bayes factor and the unit of information is determined by the base of the logarithm of the Bayes factor.

4.2 Utilities

Actions serve a purpose. The purpose is captured by terms such as preference, utility, aspiration, desire or goal. Purpose is motivating. An actor may pursue several goals or objectives when deciding on an action and attach different weights to each of the consequences of the action. With each consequence is associated a value or utility. Utilities are combined into a utility function, which accounts for the relative weights attached to goals and consequences (trade-off).

Actors assign utilities to consequences or outcomes. Utility judgements are essentially value judgements because utilities include all human values that are considered relevant in a given context. The utility of a consequence does not depend on the action producing the consequence. The actor is indifferent to the action producing a given outcome. In decision theory, the set of possible actions is often referred to as alternative or options, and a consequence is called an attribute of an option (and an attribute of the utility function). The utility associated with an alternative is a *multi-attribute utility* (Smith, 2010, Chapter 6). For instance, if an actor desires a higher income, then the utility attached to the income is not influenced by the action. If the action has other relevant side effects, a utility may be attached to each side effect. Let $u(c_{jk})$ denote the utility associated with level k of consequence j . A utility function assigns a utility to each level of consequence c_j and the multi-attribute utility function assigns utilities to all possible consequences. In case an action is costly and produces losses only, the utility function is referred to as loss function. The expected value of the utility associated with consequence j of action a_i is

$$E[u(C_j|A = a_i)] = \sum_k u(c_{jk}) Pr(C_j = c_{jk}|A = a_i) \quad (4.5)$$

The expected utility of action a_i is

$$E[u(C|A = a_i)] = \sum_j w_j E[u(C_j|A = a_i)] \quad (4.6)$$

where w_j is the weight attached to the expected utility derived from consequence j . The weight attached to consequence j may also be included in the utility of j . In that case, $w_j = 1$ for all j .

If an actor considers one consequence or outcome only, then the expression simplifies to

$$E[u(C_1|A = a_i)] = \sum_k u(c_{1k}) Pr(C_1 = c_{1k}|A = a_i) \quad (4.7)$$

with $Pr(C_1 = c_{1k}|A = a_i)$ the probability that action a_i produces level k of the single consequence of the action.

The form of the utility function $u(\cdot)$ received much attention. At the beginning of the 18th century, Nicolas Bernoulli (1713) drew attention to the psychology of individual decision-making and found that the utility of additional wealth decreases with the amount of wealth. It is the principle of diminishing marginal utility. He proposed a logarithmic transformation of the utility function and to maximize the logarithm of the utility function instead of the utility function. The logarithmic utility function is a special case of constant relative risk aversion utility function. Roughly speaking, this family of utility functions views risks in percentages of wealth as constant for all levels of wealth. That is, a 10 percent gain or loss of wealth has the same utility for rich and poor, and a €10 increase in salary has a much larger utility for the poor than for the rich.

4.3 Biases in risk assessment and utility: Prospect theory

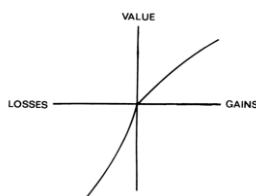
Humans tend to compare. They are less interested in absolute levels of utility than in relative levels, that is relative to a reference point, e.g. the current utility level (status quo), an aspired future level, or the utility level of a reference person or a reference group (Schoemaker, 1982, p. 550). Utility is the subjective value an actor attaches to a consequence or outcome of an action, but consequences are framed as gains and losses (Kahneman and Tversky, 1979). Relative utility matters more than absolute utility. An individual has a different attitude toward risk above the reference point than below the point. "Losses loom larger than gains." (Kahneman and Tversky, 1979, p. 279). People dislike losses, i.e. giving up something or failing to meet a target level, more

than they like gains¹⁴. People are *loss-averse*. They are also willing to accept higher risk to prevent a loss or being worse off than they do get a gain or to improve their situation. When all their options are bad, people become risk seeking (Kahneman, 2011, Chapter 3). Kahneman and Tversky (1979) and Tversky and Kahneman (1992) extended the subjective utility theory to accommodate loss aversion. The outcome is *prospect theory*. Gains and losses are weighted differently. It explains the relative importance of relative deprivation. Relative deprivation (RD) is the judgment that one is worse off compared to some standard. The theory of relative deprivation suggests that people do not experience satisfaction or dissatisfaction based on whether the material conditions of their life are good versus bad, but rather based on whether these conditions are 'better' or 'worse' than those experienced by relevant others with whom they compare (Smith et al., 2012; Kafle et al., 2020). This is formalized in the value function, the name Kahneman and Tversky give to the utility function. Kahneman and Tversky give one specification of the *value function* that incorporates the reference level and loss aversion, but many other specifications have been proposed since. Stott (2006) reviews the literature.

Another feature of human nature is to attach different weights to low probabilities of outcomes of actions than to high probabilities. High probabilities are underweighted and low probabilities overweighted (people overreact to small probability events). Edwards (1954) proposed to replace probabilities by weighted probabilities. That proposal is incorporated in prospect theory, which replaces probabilities of consequences of actions by *decision weights*. Notice that in prospect theory, the consequence or outcome is multiplied by a decision weight. The result is called *prospect* (Kahneman and Tversky, 1979, p. 275). A value (utility) is attached to each prospect, but positive prospects (consequences) are treated separately from negative prospects (Tversky and Kahneman, 1992, p. 300). The prospect with the highest value is chosen.

Another bias in decision making, introduced by Kahneman is the focusing illusion (Schkade and Kahneman, 1998). People have a tendency to focus on one consequence of behaviour or one aspect of their lives while ignoring other aspects. Kahneman describes it in a single sentence: "Nothing in life is as important as you think it is, while you are thinking about it" (Kahneman, 2011, p. 402). Kahneman (1999, p. 17) gives the example that some people may be so persuaded that moving to California would increase their well-being that they will actually move there, although it is far from certain that their prediction of the ultimate outcome will prove correct. Morrison and Clark (2016) use that element of prospect theory in the study of migration. People have the tendency to give more weight in decision-making to distinctive aspects of the new location and to easily observed and distinctive differences between locations than they will have in reality. People considering migration or any other change exaggerate the importance of the change because they focus on those things they expect to change and pay less attention to the things that are going to stay the same. A fixation on a belief that migration has important desired consequences turns that belief into a motivating factor.

¹⁴ The utility function (value function) is S-shaped: concave in the domain of gains and convex in the domain of losses. A utility function is shown in the figure below (Source: Kahneman and Tversky, 1979, p. 279):



Clark and Lisowki (2017) use the concept of focusing illusion to test the hypothesis that loss aversion suppresses mobility and extends the length of stay. The idea is that people are attached to what they have accumulated, often with considerable effort (endowment). It includes a level of income and wealth, but also locational capital (e.g. a home, familiarity with the neighbourhood and proximity to social support). The risk of losing that locational capital has a larger effect on the propensity to migrate than the prospect of a gain. Using individual-level data, the authors demonstrate the empirical power of prospect theory in predicting migration. In doing so they provide a theoretical basis for the empirically observed dependence of mobility on duration of residence: duration is a proxy for accumulated capital, which is endowment and the duration-of-stay effect is an endowment effect.

Czaika (2015) outlines a migration prospect theory. He uses aggregate (country-level) data for Germany (e.g. unemployment rate) and measures relative utility by the change in the economic and unemployment prospects in origin and destination between two periods. Prospects in the base period serve as the reference point. The study shows that migration between country *i* and country *j* increases when the prospects of *j* relative to *i* increases in time. The author finds that the migration from *i* to *j* responds more strongly to negative prospects in *i* than to positive prospects in *j* (Czaika, 2015, p. 74). Return flows, however, respond more strongly to positive prospects in the home country (relative to host country) than to negative prospects in the host country (relative to home country), indicating a utility associated with home country residence (geographical reference-dependence). Potential migrants are risk-averse when expecting an improvement in economic prospects and risk-seeking when expecting relatively negative prospects for the future.

Prospect theory seems to indicate that the high risks migrants from Africa take to reach Europe is related more to the expected worsening of the situation in Africa than to the attractiveness of Europe, meaning that push factors dominate relative to pull factors. When migration is the only viable option to escape hunger or violence, risk taking is not the issue. If that hypothesis would be confirmed by empirical analysis, it has major implications for development policies and programmes.

4.4 Feeling at home matters: place utility

A particularly interesting utility concept is that of *place utility*. Wolpert (1965) introduced the concept to denote the utility an individual derives from being integrated in a place. Place may refer to neighbourhood, city, town, village, region, country, or any other geographic area. Place utility depends on the attributes of the place, including the attractiveness, the population composition, infrastructure, public service, governance of the place, etc.. Better governance and public service increase the satisfaction and reduce individuals' migration aspirations (Aslany et al., 2021, p. 40). People who are satisfied are less likely to aspire to migrate: "The more positively people assess their current environment, the less likely they are to have migration aspirations." (Aslany et al., 2021, p. 38, see also Hooijen et al., 2020, p. 12). Place utility is an umbrella concept. It includes place attachment (emotional bond with place), community attachment, location-specific capital and endowment effect, the concept used by Morrison and Clark.

Wolpert uses the concept of place utility to distinguish two steps in the migration decision process: the development of a place utility and a response in terms of an action (leave or stay). He reasons that, depending on the place utility, an action becomes part of the "calculus of conscious choice" and a response is to be expected. It is a discrete shift, comparable to the Rubicon in the Heckhausen's theory of decision-making. Conceptually, the approach is analogous to the two-step process proposed by Carling (2002): development of an aspiration and turning the aspiration into an action (leave or stay).

Wolpert uses the concept to distinguish between movers and stayers in a mover-stayer model (see further). Utility is measured in relative terms, relative to the utility significant others attach to their place and it functions as a threshold that separates satisfaction from dissatisfaction. Place utility is a reference utility that measures an individual's satisfaction or dissatisfaction with a place¹⁵. The threshold concept is also introduced by Aslany et al. (2021, p. 7) as the level of aspiration individuals must cross to become aspiring migrants.

5 Process theory of planned behaviour

Choices and actions are outcomes of processes. Because of the uncertainties, these processes are stochastic processes. Few process theories of action exist. Process theories of decision-making and action emphasize that choice and action are outcomes of developmental processes. A developmental process is a goal-oriented or teleological process of change. A characteristic feature of any developmental process is that it consists of phases or stages, with each stage building on previous stages. Developmental processes are subjects of study in biology (developmental biology), health (disease processes), psychology (developmental psychology), economics (e.g. stages of economic growth, product life cycle), social transformation and migration (e.g. demographic transition, Zelinsky (1971)'s model of migration transition). The life course is a developmental process too. The characteristic stages are: infancy, childhood, adolescence, adulthood, old age (old, oldest old). Each stage results in an outcome. If the outcome implies a transition to the next stage (*progression*), the outcome is intermediate. The final outcome is the endpoint. A progression to the next stage is not certain; it depends on several factors. Instead of continuing to the next stage, a process may be discontinued. The concept of *progression ratio* is often used to denote the proportion continuing to the next stage in a given period. An alternative is the more general concept of *transition rate*. It is the ratio of the probability of a transition from the current stage to the next stage and the duration of stay in the current stage (see Annex). The adjective *developmental* emphasizes the function of the process rather than its structure, and the stages represent the functional architecture of the process.

Process theories of action originated in different disciplines and therefore seem to differ considerably. They have important elements in common, however. First, all distinguish stages. Second, stages are similar. Successive stages imply an increased commitment to the intended action. Third, the benefit or utility of the action is uncertain. The uncertainty is higher in early stages than in later stages. The closer to the endpoint, the lower the uncertainty. Fourth, valuations of alternatives are subjective. They depend on inborn characteristics and one's values, preferences and goals. They also depend on the incomplete information available to the individual at a point in time. Process theories seem to be converging to a transdisciplinary theory of action; they increasingly incorporate elements of other theories and disciplines.

Process theories of action include the staging theory of Janis and Mann (1977), the Rubicon model of Heckhausen (1991), the transtheoretical model of action (Prochaska et al. 1992), search theory, e.g. the dynamic model of job search (McCall 1970), and the 'horse race' model, an offspring of random utility theory. Klabunde et al. (2017) and Willekens (2017) propose a process model for the theory of planned behaviour and apply the model to migration between a region in Africa and Europe. The Janis and Mann model, the Rubicon model, the 'horse race' model and the TPB

¹⁵ Wolpert measures the utility people associate with a place by comparing the observed level of in- and outmigration with the in- and outmigration expected when origin and destination are independent.

process model are covered in this section.

One of the first decision-making processes that distinguishes stages was proposed by Janis and Mann (1977). Haberkorn (1981) applied it to migration. Janis and Mann distinguished five stages:

1. Appraising the challenge. A decision-making process starts when a person is confronted with an event or information that signals a prospective loss or gain. In the context of migration, the event could be (i) a job offer or job loss, (ii) a partnership, marriage, separation or divorce, (iii) a natural disaster, (iv) a conflict, etc. Migration involves a risk but staying may involve a higher risk. That risk triggers a decision process.
2. Surveying alternatives. The individual collects information and advice from relatives, friends, peers (significant others), and professionals. The outcome is a set of alternatives or options.
3. Weighing alternatives. The advantages and disadvantages of each alternative are assessed and the best alternative is identified.
4. Deliberating about commitment. The individual develops a commitment to the alternative selected by an intention to implement the action implied by the best alternative. An expression of that commitment is the announcement of the choice to significant others. The commitment makes it more difficult to abandon the process and not to proceed to the action.
5. Adhering despite negative feedback. The individual implements the intention despite doubts and regrets due to new information. The commitment to the decision extends beyond the action. After migration, the individual may face a period of doubts and regrets because (a) the migrant may find out that the new reality is quite different from what was expected and (b) the loss of freedom of choice due to the previous decision (feeling of being locked in). A common reaction to doubts is to accentuate and exaggerate positive consequences and minimize negative consequences.

Figure 4 shows the social-psychological variables as they relate to the stages of the migration decision-making process. An accumulated dissatisfaction, a risk or a signal pointing to an opportunity triggers the onset of the process. The individual's response depends on the achievement motivation, which is the disposition to improve one's situation. Stages 2 and 3 are similar to the value-expectancy theory and the subjective utility theory. Janis and Mann include significant others in the identification and weighing of alternatives. Whether an individual communicates the intention to others depends on the anticipated reactions from significant others, the personal need for social approval, and the willingness to comply with existing norms.

Heckhausen (1991) presents a phase model of action, known as the Rubicon model. It originated in developmental psychology. Heckhausen postulates that individuals pursue development goals to produce the life course they want and mobilize cognitive and other resources to achieve the goals. Developmental goals are anticipated end states. They motivate an individual to act in a particular way. The process of action consists of several stages. It begins with the awakening of a wish to achieve a goal and ends after the goal has been accomplished. The initial Rubicon model distinguishes four phases: the predecisional phase, the postdecisional but pro-actional phase, the actional phase and the postactional phase. Heckhausen asserts that transitions between the phases are discrete shifts rather than gradual changes (hence the reference to Rubicon). Later the Rubicon model was extended to a theory of motivation that covers the entire life span (Heckhausen et al. 2010; Heckhausen and Heckhausen 2010).

Figure 4. Socio-psychological variables as they relate to the stages of migration decision-making processes	
Stage 1	<p><i>Appraising the challenge</i></p> <ul style="list-style-type: none"> • Individual characteristics (e.g. willingness to take risks, feeling of uncertainty, mobicentric/pioneer personality) • Psychological and social community integration • Locus of control • Achievement motivation
Stage 2	<p><i>Surveying alternatives</i></p> <ul style="list-style-type: none"> • Migration expectations • Perception of available alternatives • Cultural and social norms
Stage 3	<p><i>Weighing of alternatives</i></p> <ul style="list-style-type: none"> • Individual decision-making experience • Cognitive and functional fixedness • Individual and social conflict
Stage 4	<p><i>Deliberating about commitment</i></p> <ul style="list-style-type: none"> • Social and cultural norms • Need for social approval
Stage 5	<p><i>Adhering despite negative feedback</i></p> <ul style="list-style-type: none"> • Psychological reactance • Cognitive dissonance (individual coping strategies)
Source: Haberkorn, 1981, p. 260	

The process models of Janis and Mann and Heckhausen identify the stages of the developmental process and transitions between the stages. They consider activities in each stage but they remain silent about the duration of a stage. The formation of beliefs, attitudes and intentions, and the actual implementation of intentions take time. They may also involve activities, such as the collection of information, the mobilization of social support and other resources, deliberation, the handling of administrative requirements, etc. Realistic theories of action should account for the time these activities take and the way individuals deal with time constraints.

The 'horse race' model is an offspring of random utility theory. Random utility models account for the stochastic variability underlying choices due to differences between individuals, between the object of choice, and changes in choice situation. The random utility discrete choice model predicts the probability of a choice between a limited number of alternatives (Hess and Daly, 2014). It does not consider the time it takes to reach a decision and it gives no insight into the cognitive process that underlies decision making. Marley and Colonius (1992) extended the random utility model by including the time individuals take to accumulate and process evidence in favour of an alternative (see also Colonius and Marley, 2015). The time, known as response time, deliberation time and decision time, is random and follows a response time distribution, which is a waiting time distribution. The factors that influence the choice affect the choice probability as well as the time it takes to make a decision. The evidence accumulation model is a simple description of the cognitive process that underlies decision-making. In psychology, there is considerable support for the thesis

that evidence accumulation drives decision making (see e.g. Rodriguez et al. 2014; Usher et al. 2013). A particularly useful observation, made by Marley and Colonius (1992) is the relation between the evidence accumulation model and the theory of competing risks. The challenge is to determine the joint probability of a decision (deliberation choice) and the time it takes to make a decision (deliberation time) (see also Hawkins et al. 2014). Some decisions are taken quickly, while other decisions take a lot of deliberation, which requires time (Kahneman 2011). For a brief and general overview of models that account for effects of deliberation times on choice probabilities, see Busemeyer and Rieskamp (2014). Early attempts to extend the discrete choice model to integrate choice probabilities and waiting times to the decision/action include Pudney (1989) in economics. The model Pudney proposed is a competing risk model too. The competing risk model and the theory of competing risks have untapped potential in choice modelling.

Hybrid choice models (Ben-Akiva et al. 2002, 2012; Marley and Swait, 2017) are extensions of discrete choice models. They introduce into economic choice models relevant psychological factors such as values, beliefs, and attitudes. If the factors cannot be measured but the effects are real, they are included as latent variables. That development is to be applauded because it makes the economic models considerably more realistic and the psychological models more formal.

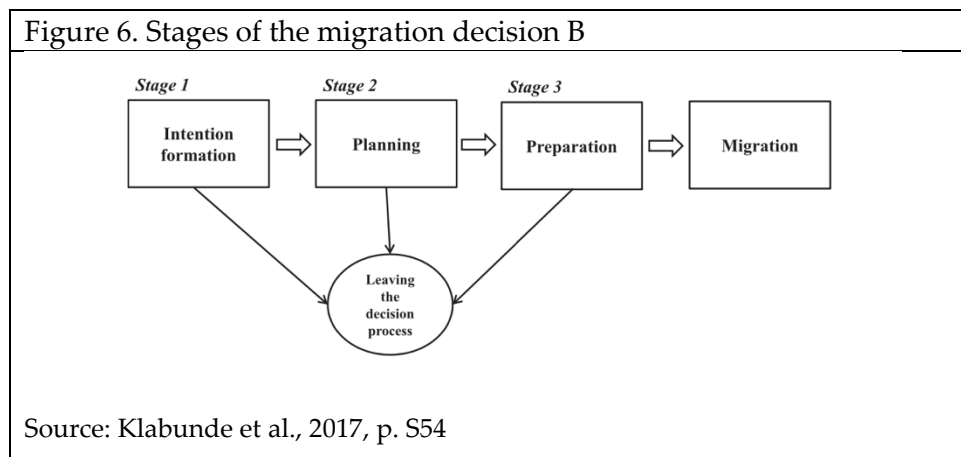
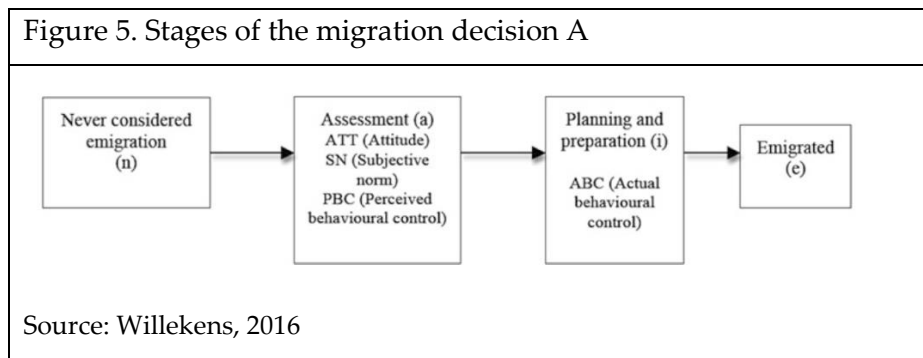
The process model of planned behaviour, which extends the static theory of planned behaviour to a dynamic version, has features in common with process models reviewed or mentioned above, in particular the 'horse race' random utility model, the rubicon model and the transtheoretical model of action. To be consistent with the theory of planned behaviour, the process model should distinguish at least four stages (Willekens, 2017, pp. 267ff):

1. A person in the first stage never considered emigration. The person leaves the state when he/she develops an interest in emigration as a viable option or decides that emigration is not a viable option.
2. The person develops efficacy, normative beliefs and control beliefs. These beliefs determine the attitude (ATT), the subjective norm (SN) and the perceived behavioural control (PBC). ATT, SN and PBC determine the intention to emigrate. Attitude (ATT) is a latent disposition or tendency to favour or disfavour an action (Fishbein and Ajzen 2010, p. 76). Fishbein and Ajzen use the term attitude to refer to the evaluation of a behaviour along a dimension of favour or disfavour, good or bad, like or dislike, approval or disapproval, advantageous or disadvantageous. The outcome of this stage is an intention to migrate or a decision to stay.
3. A person who has developed an intention to emigrate starts planning and preparation. During that stage, the person needs to mobilize resources, to overcome barriers and to take advantage of opportunities that may arise. Planning and preparation will be successful if the person is capable of dealing adequately with control factors. In case the actual behavioural control is deficient, the person is likely to stay.
4. A person who leaves the country enters the fourth and final stage of the decision process.

Figure 5 shows the stages. The first stage is denoted by 'n'; the second stage by 'a', the third stage by 'i' and the fourth stage by 'e'. In any stage, a person may leave the decision process.

Klabunde et al. (2017) consider slightly different stages. The first stage is the formation of an intention to migrate from the attitude, social norms and perceived behavioural control. Between the formation of an intention and the actual event (migration), a planning phase and a preparation phase occur. Individuals can leave the decision process at any stage and at any point in time. The outcome of the model is a decision to either stay or migrate. The individual faces a binary choice: to stay or to leave. In the model, the competition between the two alternatives is operationalized

by applying the theory of competing risks. Figure 6 shows the stages.



In the theory of planned behaviour, ATT, SN and PBC act independently on intention. Ajzen recognizes the possibility that PBC moderates the effect of ATT and SN on intention, but that interaction effect is not a formal part of the TPB (Ajzen 2002; Fishbein and Ajzen 2010, p. 181). The reason Ajzen has given is that being capable of performing an action does not imply an intention to perform that action. In the literature, PBC interactions did not receive much attention because, in statistical models, the interaction is often not significant. Yser (2012) argues that the limited attention to PBC interactions is a missed opportunity for advancing our understanding of intention formation. Fife-Schaw et al. (2007) study the moderating effect of SN on the effect of ATT on intention. In the process model proposed in this project, SN and PBC are intervening factors in the transition from attitude to intention. They moderate the effects of attitude on intention, i.e. a positive attitude leads to an intention only if the SN and the PBC are supportive (positive). An individual who considers emigration beneficial may or may not develop an intention to emigrate depending on (1) the perceptions of what significant others want and willingness to comply and (2) the perceived available resources.

Individuals in a given stage may be thought of as collecting information and accumulating evidence to make a decision to migrate or stay (at least for the foreseeable future). The time it takes to reach a decision depends on (a) the stage in the decision process, and (b) individual attributes including level of education (skill level), cognitive capabilities, personality traits, and (c) contextual (societal) factors. Continuation and discontinuation (dropout, attrition) are competing risks. They compete to be the reason for exit from the current stage. In the proposed model, simple rules govern the choice. Exceeding a threshold is one such rule.

6 Conclusion

The decision to migrate is a developmental process embedded in a multi-layered system that includes the life course, community processes and social, economic, cultural and political processes in the countries of origin, destination and transit, and at the international level. All these parallel processes are intertwined and are subject to uncertainties due to ignorance and randomness. The processes shape the lives of people and influence their values and opinions, the resources they have, the decisions they make and the actions they engage in. Individual abilities to pursue aspirations in this complex of processes differ greatly due to differences in cognitive capabilities and resources, and differences in access to education, jobs and financial and social support. The unequal geographic distribution of resources and the rules that govern access to resources trigger migration and ensure perpetuation of migration flows. A remarkable fact is, however, that the great majority of people do not migrate because they are satisfied, attached to their place or lack the resources needed to migrate. International migration is a very small fraction of international mobility. To understand why some individuals and families decide to leave their country while others decide to stay requires an emic perspective, i.e. a view from within. Root causes of migration and drivers of migration have an impact, but the impact is mediated by processes internal to the individual, in particular processes of decision processes.

A plethora of decision theories and theories of action exist. Most theories capture the essence of decision making and turning decisions into actions. Some disregard some key factors or processes, such as social mechanisms and different types of some constraints that affect the outcome of decision processes and an individual's capability to successfully execute an intended action.

In this paper, the theory of planned behaviour (TPB) is selected as a reference. The TPB incorporates essential features, is simple, and is able to accommodate other important theories of action, such as the subjective expected utility theory. Behavioural beliefs in the TPB are not essentially different from the subjective expected utility. Normative beliefs express the impact of others on individual decision making. Control beliefs are indicative of the significance of human agency and self-efficacy. The theory's emphasis on subjective beliefs and degrees of beliefs, and adjustments of beliefs in light of new experiences, information or influences, paves the way to approach the TPB as a Bayesian learning process. That approach is briefly touched upon but is not fully developed in this paper.

In a recent assessment of migration theory, de Haas (2021) asserted that considerable theoretical progress can be achieved by further embedding migration studies within broader theories of social change. That includes theories of action. Migration scholars have many theories of action to choose from. No single theory has all the elements required to explain and predict directional migration. The decision to migrate is embedded in a hierarchy of processes, the most basic being the life course. All other processes, including processes of social transformation, influence the propensity to migrate through their impact on the life course. In other words the effects of these processes on migration are indirect because the life course mediates all the effects of factors and processes outside the individual (commonly referred to as structure). Individuals pursue developmental goals to produce the life course they want and mobilize cognitive and other resources to achieve the goals (Heckhausen, 1991). Or as Bandura (2006, p. 164) states: evolution gave people the capacity to transcend the dictates of their immediate environment and the power to influence their life circumstances and the courses their lives take. Social systems are both the medium and the outcome of individual actions. Social systems respond to individual actions to preserve their identity and stability. Agency and structure co-evolve as a hierarchy of interacting processes. The relative position of human agency in that interdependent system of processes is changing,

however. The primacy of human agency is increasing in virtually every sphere of life (Bandura, 2006, 2018). As a consequence, people acquire more capabilities to control their own lives, something David Hume, Adam Smith, Amartya Sen and many others would welcome. Science should respond by an increased attention to theories of action that are simple, comprehensive and realistic, and account for individual differences in capability and access to resources.

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Annex A. The model: general characteristics

This paper is the basis for a model of migration decision making. The model will be documented in a subsequent paper. The proposed model is an actor-based microsimulation model or agent-based model. Agent-based models describe plausible developmental processes (mechanisms) that generate macro-level phenomena. The world is approached as a system and network, with actors as elements (units of analysis) and countries as subsystems or nodes in the global network. In practice, not all countries are used, but a selection of countries. Countries may be grouped into regions and countries beyond the scope of the study may be combined in a “rest of the world” category. Actors are situated in space and time. They have a location and an age. Location and age vary in time. Space is discrete and divided in geographical areas (countries or regions). Time may be discrete or continuous. Two time scales are used: calendar time and age. Other time scales may be added. A number of additional considerations lead to the proposed model. They are briefly reviewed in this Annex. The structure of the Annex is as follows. Section A.1 is about the relation between micro-level models and macro-level models of migration. Section A.2 is a brief discussion of the two major types of parameters underlying micro-level models: transition rates and transition rules. The proposed model emphasizes transition rules. Section A.3 is a brief and general account of agent-based modelling of migration. It situates the proposed model in the family of agent-based models. Section A.4 highlight two dimensions of the model that increase complexity but also realism. Migration is embedded in the life course and migrants are part of social networks. Section A.5 lists the five pillars on which the proposed model is founded. A note on data (Section A.6) concludes this Annex.

A.1 Models of migration flows: macro and macro

A particular feature of the proposed actor-based model of migration is that it is a logical extension of traditional models of migration flows between subsystems of the global system. The gravity model has been the main model of migration flows for decades and continues to be popular today. Over the years, the gravity model, which originated in physics, has gradually been replaced by more elaborate spatial interaction models that include a range of determinants or drivers of migration. Spatial interaction models are population-level models, which emphasize the interaction between population subsystems (regions or countries). Initially spatial interaction models took the form of a gravity model or the equivalent log-linear model. The gravity model has some desirable properties: it is easy to incorporate (a) structural constraints, such as immigration restrictions and other barriers to entry, (b) spatial deterrence or spatial friction, such as distance and costs of relocation, and (c) historical migration patterns. A further development was viewing migration as an outcome of stochastic processes, predominantly the Poisson process and the Markov process, and extensions that removed unrealistic assumptions (Willekens, 2008 for a review). The estimation of gravity/spatial interaction models evolved too, from maximizing the likelihood function (e.g. Sen and Smith, 1995), to a Bayesian approach (Brierley et al., 2008; Bijak, 2010; Raymer et al., 2013; Azose and Raftery, 2019; Bijak, 2021) and entropy maximization, which is part of information theory (Wilson, 2010; Dennett and Wilson, 2016; Abel et al., 2021). Entropy maximization is used to estimate the proposed actor-based model. Note that entropy maximization and the Bayesian approach have much in common. Information theory also relies on prior knowledge to approximate unknowns, updates parameters of a model in light of new evidence, and probabilities may be subjective degrees of belief.

The extension of population-level models to actor-based models involves adopting individuals, institutions and organizations as units of analysis, while ensuring logical consistency between the

traditional spatial interaction models and the actor-based models. The logical consistency requirement is needed to prevent that population-level and individual-level models produce widely different results that cannot be explained. The integration of population-level and individual-level models into a multilevel model that bridges the gap between macro and micro received some attention. Three approaches may be distinguished. The first is a statistical approach, without any reference to behavioural mechanisms. The second is to identify a behavioural mechanism or decision rule that is consistent with the statistical approach. It aims at a behavioural underpinning of population-level spatial interaction models. The third approach is to specify empirical or theory-based behavioural rules (behavioural mechanism) without reference to a population-level model. The three approaches are briefly presented:

The first approach assumes that individual differences are random. The approach is widely used across the sciences and is known as random effects models controlling for unobserved heterogeneity. The approach has been used successfully to explain the duration-of-residence effects on the propensity to migrate. People who reside in a place for a short time are more likely to move than people with long durations of residence. The hypothesis is that individuals with long durations of stay differ from individuals with short durations of stay and the observed duration-of-residence effect is essentially a selection effect rather than a real duration-of-stay effect. Some individuals have a mindset that includes mobility, while other individuals have a mindset that rules out migration under normal circumstances. Those with a mobility-oriented mindset move more frequent than members of the other group. The proportion of individuals with a mobile mindset underlies the empirically observed effect of duration of residence on the propensity to migrate. Selection effects can be identified statistically. Blumen et al. (1955) proposed the mover-stayer model, which divides the population into these two groups. The proportion stayers is not known but can be estimated from empirical data on migration using statistical methods that account for unobserved population heterogeneity. Spilerman (1972) extended the mover-stayer model to a model in which individual orientations toward migration ranges from a minimum value, zero say, to a maximum value, one say. The orientation toward migration expresses a hidden or unobserved population heterogeneity. The mover-stayer model and its extensions may be viewed as a statistical method to differentiate persons who consider migration from those who do not.

The second approach to bridging the divide between macro and micro models of human mobility was initiated by MacFadden (1974, 1978) who derived spatial interaction models from utility maximization, and more specifically random utility theory. The utility being maximized varies randomly between individuals. The result was a decision model, known as discrete choice model. Anas (1983) showed that population-level entropy maximization and individual-level utility maximization lead to identical spatial interaction models. Haghani et al. (2021) offer a good review of discrete choice modelling in the last fifty years. The authors emphasized the behavioural underpinning of spatial interaction models.

The third approach, used in agent-based modelling, drops the requirement of logical consistency between the structures of the micro-level and the macro-level models. Behavioural rules are specified without reference to a macro-level model. The validity of the model is assessed by comparing the results of the micro-level model with observations or results of macro-level models, e.g. projections. Most agent-based models adopt this approach. In recent years, interest increased in actor-based or agent-based models of migration (for reviews, see Klabunde and Willekens, 2016; MacAlpine et al., 2021; and Thober et al., 2018).

The three approaches are incorporated in the proposed model. The relocation of actors in the global system is viewed as a *random walk*. A random walk is a stochastic process that describes a

succession of random steps in some space. Extensions of a random walk include biased random walks and constrained random walks. Migration is a biased random walk because individuals are not indifferent to destinations. They generally prefer attractive destinations. Destination preferences may differ by place of origin, personal attributes and reasons for migration. The random walk is also constrained due to immigration thresholds imposed by actors (e.g. governments) in places of destination. Because of the restrictions, some actors cannot enter their preferred destinations and move to an alternative destination instead. Actor-based models reproduce the migration flows predicted by population-level spatial interaction models, if two conditions are satisfied: (a) individual preferences are revealed preferences, derived from actual or historical migration patterns and (b) immigration thresholds are determined empirically. The actor-based model that is fully consistent with macro-level models of migration is the point of departure of more complex and realistic actor-based models that account for heterogeneity of actors, country-specific migration policies and border controls, and migration decision-making under uncertainty based on a given decision theory or theory of action. In the proposed model, the theory of planned behaviour is the main theory of action used. In the theory, an actor develops a belief about the benefits of migration (behavioural beliefs), interprets social norms and is willing or not willing to comply (normative beliefs) and develops a belief in one's ability to mobilize resources and overcome barriers (control beliefs). Behavioural beliefs, normative beliefs and control beliefs result in an intention to migrate. An intention to migrate predicts migration if the perceived control is realistic, i.e. the actual control coincides with the perceived control.

A.2 Transition rates and transition rules

A random walk is a Markov chain if time is discrete and a Markov process if time is continuous. The parameters of a Markov process are *transition rates*, i.e. rates (or propensities) at which individuals at risk experience transitions from one position in a system to another. Migration rates are transition rates. For a given transition, only individuals at risk of that transition can experience the transition. Individuals not at risk cannot experience the transition. This requires that individuals are categorized in "at risk" and "not at risk", or "exposed" and "not exposed". Individuals move between categories. Individuals not at risk may become at risk. A change in risk status is often a consequence of a transition in the process being studied or in concurrent or parallel processes. Transition rates relate transition counts to exposure (population at risk at a given point in time OR total duration of exposure during a period of time). Transition rates may vary by age and in calendar time, and may depend on personal attributes (covariates), prior experiences, e.g. migration experience, and contextual factors. Notice that this extended model is no longer a Markov model and is not constrained by the restrictive assumptions of the Markov model, such as lack of memory.¹⁶ A transition rate may depend of personal and contextual factors. The association is usually represented by a regression model.

The occurrences of some or all transitions in the life course may be governed by *transition rules* rather than transition rates. In that case, transition rates are replaced by transition rules. Rules describe the conditions that must be satisfied for a transition to occur, while accounting for uncertainties. If transitions are governed by transition rules, they are essentially governed by algorithms because in the simulation rules are translated into algorithms. Rules can be empirical or theory-based. *Empirical rules* are derived directly from observations on how actors behave. In case

¹⁶ A similar issue of grouping people in these two categories is manifest in the Covid19 problem. Determining who is at risk of infection and what is the risk level is a dominant issue.

of migration, the empirical migration rate is used to determine whether an actor migrates or stays.. *Theory-based rules* are rooted in theories of action and social theories and mimic the cognitive and social processes that underlie an actor's behaviour (e.g. norms, social influence, sanctions; or agency and structure). Theory-based rules operationalize a decision theory or a theory of action, and account for empirical evidence (quantitative and qualitative data). Models that incorporate transition rules are usually referred to as agent-based models (ABM)¹⁷.

The distinction between rate-based models that use regression models to predict transition rates and rule-based models is not always clear-cut, especially if a regression model is seen as a concise representation of a data-generating process.

A.3 Agent-based models of migration

Klabunde and Willekens (2016) review ABMs of migration. Most authors use simple decision rules, often not based on any behavioural theory or based on neo-classical rational choice theory. Random utility discrete choice models belong to this class of models. Several models consider deviations from rational choice, such as imperfect knowledge and the influence of social norms. Few are based on psychological or cognitive and social theories of action. The theory of planned behaviour (TPB) is used by Kniveton et al. (2012) in a model of climate-driven migration in Burkina Faso and by Smith (2014) in a model of rainfall-induced migration in Tanzania. In a review of agent-based models in migration research, in particular in relation to modern slavery associated with low-wage labour migration, McAlpine et al. (2021) find that ABMs are used primarily to test theories and less frequently draw on primary empirical input. The main theories used were utility maximization theory, social network theory and the TPB. Klabunde and Willekens, and McAlpine et al. conclude that capturing the core elements of decision-making and the integration of network analysis in ABMs remain major challenges. Thober et al. (2018) review ABMs aimed at understanding of the environment-migration-nexus. Al-Khulaidy and Swartz (2020) present an ABM of migrants who must decide where to cross the United States-Mexico border (48 border crossings, and 330 active ports of entry). Recently, Bijak (2021) published the *Routes and Rumours Model*, an agent-based model of the diffusion of information between migrants *en route* to the destination country, and the effects on the route choice.

A.4 Life courses and social networks

Since migration is intertwined with other events in the life course, migration should be embedded in the life-course. The life course of an individual may be approached as a set of parallel and interdependent processes (careers). That perspective has become relatively common in the social sciences (Willekens, 1991; Blossfeld, 2009; Mayer, 2009; Coulter et al., 2016; Bernardi et al., 2019). It is also the approach adopted in the proposed actor-based model. At any point in time, an individual may experience a transition in any domain of life (survival, education, work, partnership, family formation, health, residence). Migration is one of these transitions. If a transition occurs in a domain of life other than residence, the propensity to migrate changes, and if an individual migrates, the entire future life course is affected. Migration and other transitions in the life course are intertwined. They are usually viewed as competing risks. Marriage, divorce, job change, transition to parenthood and migration are competing transitions. Process models are

¹⁷ A particular class of agent-based models consists of models that describe groups of actors. They are referred to as multi-agent models because they study actions and interactions in multi-agent systems. Families, communities and social systems in general are multi-agent systems.

usually in continuous time for three reasons: (a) transitions may occur at any time, (b) durations (e.g. duration of current residence) can be measured more accurately in continuous time, and (c) the impact of competing transitions that may occur can be assessed accurately with the theory of competing risks. The duration between two transitions is described by a waiting time distribution. The modelling of life histories as continuous-time stochastic processes is relatively well established (Willekens, 2014; Cook and Lawless, 2018). Multistate models are used across the sciences to provide useful and meaningful predictions of transitions in the life course and to predict employment careers, partnerships, fertility histories and migration histories. The simulation of life histories makes extensive use of waiting time distributions and the theory of competing risks. Microsimulation models in continuous time are also known as discrete event simulation (DEVS). The term is common in the modelling of complex physical systems and queuing problems.

Some transitions in the life course may be governed by transition rates, while other are governed by transition rule. Klabunde et al. (2017) combine rate-based and rule-based transitions in a single model. In the Klabunde et al. model, all transitions in the life course (changes in marital status, changes in employment status, and death) are rate-based, while migration is rule-based (based on the process theory of planned behaviour).

Actors interact with other actors and form social networks. As a result, social structures emergence (structuration) and these structures impact on future actions (feedback). Social networks are particularly important for migration. The initiation, maintenance and termination of social ties (bonding) is a cognitive (and emotional) process involving agency and decision-making under uncertainty. Network dynamics is therefore a stochastic process. Models of social networks that approach networks as outcomes of stochastic processes are stochastic actor-oriented models of network dynamics (Snijders, 2017). They operationalize the emergence, growth and decline of social networks under conditions of uncertainty. Recently, life course dynamics and network dynamics are combined in models of network formation and dissolution in the life course (Niezink et al., 2019). Agent-based models adopt various approaches to incorporate social network (see Hinsch and Bijak, 2021, p. 54).

A.5 Five pillars supporting the proposed agent-based model.

The envisaged actor-based model is founded on five pillars:

1. Actors
 - a. Actors are individuals, groups of individuals, institutions or organizations.
 - b. Actors have attributes. Attributes of individuals include sex, occupation, employment status, marital status, health status, place of residence, etc. Attributes pertain to one or several domains of life. Personal attributes include also values, beliefs, opinions, attitudes, preferences, intentions and character traits. For modelling purposes, it is useful to rank attribute by their relevance for the research question. For instance, in studies of migration, place of residence is an attribute of prime importance. In life history models, a distinction is made between personal attributes that are of prime interest in the study and attributes that have a strong effect on state transitions. The first type of attribute is represented by a *state variable* and the second by *covariates*. Note that in life history models, age is not treated as a personal attribute because it is a time variable or duration variable: time elapsed since birth.
 - c. Actors have a life course. The human life course is a set of parallel (concurrent) and interdependent developmental processes (careers): biological, cognitive, social.

- d. Actors have resources (cognitive, social, social, cultural, political, financial).
- e. Actors have resources, although the resources may be limited (eg budget constraint, bounded rationality)
- f. Actors have agency, which is the capacity to act independently. They have the cognitive capabilities to learn from their own observations (past experiences, observation of others) and from the information they receive. The learning process is central to actor-based modelling. Learning is the accumulation of knowledge. Actors are able to use that knowledge to interpret events and processes in their environment and to anticipate the consequences of their actions (e.g. utility) for themselves and for others. Agency is generally limited and varies during the life course and depends on social support.
- g. Actors are faced with risks and uncertainty. As a consequence, events and outcomes of actions cannot be predicted with certainty and decisions are made under uncertainty. Risks and uncertainties are described by probability distributions. Models are probability models or stochastic models. Migration is essentially a random walk.

2. Actors occupy a place

- a. A place is a location in geographical space, e.g. place of residence. The place of residence may refer to a dwelling unit, a neighbourhood, a municipality, a subnational area, a country or a region of the world. The location changes in time. Geographical space may be replaced by social space, and the location by the position in the social space (social structure).
- b. Places have attributes. Place characteristics include urban/rural and population count or density.
- c. Actors assign a utility to a place and have some degree of attachment to a place.

3. Actors interact, connect and create social networks

- a. Actors interact and communicate. They meet other randomly or as a result of an active search in a subpopulation.
- b. Interaction usually results in exchanging or sharing something: resources, information, meaning, commitment, interests, opinions, beliefs, worldview, affection, etc. Shared values lead to social norms intended to streamline the behaviour of individuals.
- c. Social interactions underlie the emergence of social structures (structuration), including social networks. Structuration is a stochastic process, modelled by a stochastic actor-oriented models of network dynamics.
- d. Sharing may result in *influencing*, which in turn may lead to *diffusion* when more actors participate in sharing. It may produce (a) cognitive and emotional connectedness (bonding), mutual understanding and consensus, trust, solidarity, norms, and (b) relations (social ties) (eg friendship, partnership) and (c) communities, groups and other social structures with different degrees of permanence, group identity, social cohesion, social support and collective action. Communities may protect their identity by a system of boundaries and social processes intended to preserve the stability of the group and its resilience (ability to recover from disturbances and to adapt to new conditions). Examples of processes include social control, the regular expression of loyalty to the group, and the allocation of shared resources to loyal and committed members.
- e. As a result of the interactions, the collective behaviour or the behaviour of the system

transcends the behaviours of the individual actors.

4. Actors enter a population, go through stages of life, and leave

- a. Actors enter a population by birth or entry (e.g. immigration) and leave a population by death or exit (e.g. emigration).
- b. Actors inherit characteristics from their predecessors. Traits, resources, values and other features may be passed from one generation to another (intergenerational transfers).
- c. Actors whose life course is embedded in the same historical context form a (birth) *cohort*. They share experiences, e.g. historical events, with lifetime consequences. The replacement mechanism, augmented by shared experiences during the formative years, “makes social change possible” (Ryder, 1965).

5. Life histories of different individuals may be linked, a phenomenon known in the sociological and demographic literature as *linked lives*. A consequence is that individuals experience certain actions at the same time. The concept of linked lives identifies a particular type of social network: a network of two or more individuals with lives that evolve together. The life courses exhibit a much greater interdependence than may be expected if the two individuals are selected at random. Partnership formation and marriage are transitions that initiate linked lives. The event must be experienced by two persons at the same calendar time. The lives of co-resident individuals, e.g. same household, are linked too, as are the lives of members of transnational families. A transition experienced by one member affects the life course of other members. For instance, becoming a grandparent in a transnational family may trigger a migration or regular visits to provide childcare. Individuals with linked lives and ties that bind share resources, provide support, and share risks. The microsimulation of individual life courses offers a unique instrument to study transnational linked lives.

A.6 A note on data

The model accounts for selected differences in migration concepts and measurements. A variety of data on migration exist (see Mooyaart et al., 2020, for a recent inventory). Migration is a relocation, a transition from one geographical area to another. The definition of migration varies between countries and in time. Differences in definition can be attributed to (a) differences in residence concepts (e.g. usual residence versus actual residence) and (b) differences in measurements, e.g. in duration-of-stay criteria adopted. Recently, the United Nations Expert Group on International Migration Statistics proposed a new overarching conceptual framework and accompanying definitions on international migration and mobility (United Nations, 2021). A distinction is usually made between migration, which is an event, and migrant, which is a person. The events are changes in residence or relocations. Except in countries with population registers, relocations are not recorded, and event data are not available. Migration is usually measured by comparing places of residence of individuals at two points in time: current residence and residence at a reference point in time. The data are referred to as status data. The reference is usually birth (*lifetime migration*), a given calendar date or the starting time of a given duration interval (e.g. 5 years prior to a census or survey) (*recent migration*). Lifetime migration data are migrant stock data: it gives counts of persons by place of current residence and place of birth. The harmonization of migration statistics after data are collected is a subject of intense research (Willekens, 2019). Internationally comparable migration data is the ultimate goal of that research. The strategy is to model migration flows using data from different sources (censuses, registrations, surveys, digital tracing) and to produce a *synthetic database*. The proposed model generates migration data. The experimental nature of the model leads to migration data that are illustrative.

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