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Managing Migration: What Can We Learn From Simulation Experiments?

Migration flows can respond to policy changes in unpredictable ways, as a result of complex environments of the underlying drivers, agency of prospective migrants and the way in which they make decisions.

Computer simulation modelling can help decision makers better understand the complexity of migration processes, as well as shed light on intended and unintended consequences of different policy options.

Simulation models of migration route formation highlight the role of information and trust in shaping the ways in which migrants move across unknown terrain, and to identify promising areas for new data collection.

To safeguard against misuse, the simulation models for policy need to be ethical by design: open and transparent about the modelling processes, and honest about the uncertainty of the results and the trade-offs involved.

Why is migration difficult to control?

Migration, particularly asylum-related, is societally important, policy-relevant, yet strongly politically charged. From the policy point of view, there may be a temptation to search for simple and headline-grabbing solutions for the sake of appearing in control of events (Czaika et al. 2022). This, however, can mean sacrificing evidence on the complex and uncertain nature of migration, rendering policy actions ineffective or fraught with unintended consequences. Migration is known for its unpredictability, persistence and self-perpetuating features, which lead to inertia of migration systems. This means that policy makers cannot expect policies to increase or decrease migration flows at will.

There are many reasons for misalignment between policy aims and results. Firstly, migrants are autonomous in their decision making and exercise agency according to their own objectives, rather than the stated aims of government policies (Castles 2004). Hence, government policies can become another obstacle to navigate among many – especially for asylum seekers, who need to follow sometimes risky and dangerous clandestine journeys while trying to avoid other obstacles along the route. Secondly, migration responds to a multitude of drivers and driver environments, so it is all the more difficult to isolate single effective policy instruments (Czaika et al. 2022). Thirdly, the proclaimed and the true objectives of policy makers need not align (Castles 2004).

Simulating migration processes

How can interdisciplinary science shed light on features of migration to help policy makers make better and more robust decisions? An appealing possibility is offered by computer simulations, including individual-level agent-based models. In such models, agents can represent various entities, such as migrants, other actors, or policy makers, all interacting with one another and with their environments. The models can be complex and can shed light on some of the complexity of migration processes, illuminating policy trade-offs and key areas of uncertainty. However, their design needs to be specific to answering well-defined research or policy questions. In this brief, we present several lessons from agent-based models of migrant route formation and persistence (Bijak et al. 2021).

For design and construction of agent-based models for policy aid, we advocate a multi-stage model building process, with multiple, increasingly realistic iterations aimed at

providing more sophisticated explanations, and identifying knowledge gaps (Bijak et al. 2021). Given the complexity of the processes being modelled to aid the replicability of the results, the description of model construction should be also formalised. One approach for achieving this involves provenance graphs showing relationships between different entities in the modelling process (Reinhardt et al. 2023). The different stages of the model construction, including gathering empirical data and incorporating them in the simulations, are described in more detail in Bijak et al. (2021) and Hinsch and Bijak (2023).

How can information shape migrant routes?

Information is one of the key dimensions shaping migration decisions (Czaika et al. 2021), interacting with agency and aspirations of prospective migrants – better information makes the aspirations more realistic – as well as with the decision horizons, with more information available for short-term planning horizons than for long-term. Importantly, information flows are parallel to migration flows, and can provide prospective migrants with feedback on routes and destinations: this is one of the mechanisms through which migration is perpetuated. This information is more likely to come from the networks of other migrants than from official sources. The policy potential of appropriate information delivered through the right channels to shape migration flows remains underutilised.

In our model, information exchange proved to be a crucial element shaping migration route formation, more so than new contacts or own exploration of the environment by the migrating agents (Bijak et al. 2021). Our conjecture is that information is important both on its own, and as a conduit for other migration drivers, making the agents more aware of the factors that may shape their decisions. Still, surprisingly, despite the importance of information, existing data on its role in the migration context are limited (e.g. Dunsch et al. 2019 or Emmer et al. 2016).

Can government messages be trusted?

Scarcity of secondary data on the role information plays in migration implies that one way of informing simulation models is through primary data collection. We have carried out a set of dedicated psychological experiments, exploring the probability of hypothetical risky decisions under uncer-

tainty (Prike et al. 2022). In those experiments, the participants were asked to assess their subjective probability of undertaking a potentially risky trip, based on information on the level of risk conveyed by a range of sources, such as family members, people with previous experience, media, governmental sources, or international organisations.

We examined two contexts: migration, and travel during a pandemic. The results show that the most trusted information comes either from reputable international sources or from people with relevant experience (e.g., migrants who have made the same journey) – none of whom are seen as having incentives to deceive (Prike et al. 2022). This is largely in line with the results of other studies, where personal contacts were found to be more trusted than official or government ones, which may be seen as driven by a specific agenda (Emmer et al. 2016; Dunsch et al. 2019).

Can information campaigns help?

In our simulations, information was a key driver of migrant route formation: in particular, limited information increased the role of direct interactions between actors, driving the overall unpredictability of routes (Hinsch & Bijak 2023). This confirms earlier findings of perpetuation and persistence of routes once they are established, due to the increased information flow along those routes. This finding also links with the increased unpredictability of flows and routes in the absence of accessible – and known – legal pathways to migration (Czaika et al. 2022).

At the same time, in our experiments, simulated top-down information campaigns about increased migration risk were found to be ineffective (see Dunsch et al. 2019). The reason is that such information is mediated by other factors and subject to limited trust amongst people making migration decisions (Bijak et al. 2021). Information needs to be trusted to be followed, and information campaigns need to be honest to be trustworthy, carried out by actors with no hidden agendas, who are perceived as such.

What are the limits of knowledge?

There are important limits to what can be inferred about migration from computer simulation models. One reason is the limited availability of secondary empirical data which is typically collected for other purposes, and is very fragmented. Our study of Syrian migration to Europe in

the 2010s showed large data availability gaps, with only a handful of potentially useful sources for calibrating the models and simulation experiments (Nurse & Bijak 2021).

At the same time, there seems to be an important trade-off between more data availability, potentially increasing the predictive capacity of models, and the richness of theoretical description, increasing the explanatory capacity of simulations. The potential of different data sources varies by prediction horizons, with new, digital data mostly useful in the very short term, as opposed to traditional survey or administrative sources. At the same time, greater model sophistication, despite offering richer explanations, is unlikely to reduce the overall uncertainty of the simulation results. Conversely, the unpredictable nature of migration means that new explanations bring additional sources of uncertainty that need to be factored in (Bijak et al. 2021).

Ethical considerations

Simulation models, especially informed by digital data, come with ethical risks and dangers. One key problem is the possible abuse of the results. This can lead to oversimplified policy reactions that have unintended consequences, worsening the problems the policies were meant to address (Castles 2004). Importantly, policy actions, even those intended as physical or legal deterrents, do not directly translate into migration decisions. They do, however, provide migrants and other actors, such as smugglers, with information about obstacles to be bypassed, and as a result can increase the unpredictability of migration routes, risk and cost of the journeys (Castles 2004; Hinsch & Bijak 2023). False information can also act in a similar way, before true one spreads through the migration networks.

One way of managing these challenges is to make the models ethical by design, being open about the purpose, complexity, uncertainty, limitations and trade-offs to the fullest extent. The data inputs and the way they are used need to conform to legal and ethical norms with regard to informed consent, privacy protection and safeguarding from harm. The modelling process itself needs to adhere to the principles of transparency and open science, ideally in a formalised and replicable way (Reinhardt et al. 2023), so that the designers and creators can be accountable for how the models work. There is a need to be open about, and fully acknowledge the limits of models, especially in terms of prediction. Models created in this way have the potential of making the migration policy decisions more sophisticated and robust, and in any case, better informed.

Policy recommendations

- Complex migration models can serve as important policy aids, but need to be tailored to answering specific policy questions.
- Policies relevant for managing migration need to consider different actors, their decisions, as well as information flows and channels.
- Ensuring that sources of information are trusted and free of biases is crucial for such information to have an impact on migration decisions.
- Any modelling results must be treated cautiously, and uncertainty must be factored into any decisions and policy solutions.
- Simulation models used for aiding policy need to be ethical and legal by design: this includes ensuring transparency and replicability.

References

Bijak, J., Higham, P. A., Hilton, J., Hinsch, M., Nurse, S., Prike, T., Reinhardt, O., Smith, P. W. F., Uhrmacher, A. M., and Warnke, T. (2021) *Towards Bayesian Model-Based Demography. Agency, Complexity and Uncertainty in Migration Studies*. Methodos Series, vol. 17. Cham: Springer. [Open Access](#).

Castles, S. (2004) Why migration policies fail. *Ethnic and Racial Studies*, 27(2), 205–227.

Czaika, M., Bijak, J., and Prike, T. (2021) Migration Decision-Making and Its Key Dimensions. *The Annals of the American Academy of Political and Social Science*, 697(1), 15–31. [Open Access](#).

Czaika, M., Bohnet, H., Zardo F., and Bijak J. (2022) European migration governance in the context of uncertainty. QuantMig Project Deliverable 1.5. Krems: University of Continuing Education. Available on www.quantmig.eu.

Dunsch, F., Tjaden, J. D., and Quiviger, W. (2019) Migrants as Messengers: The Impact of Peer-to-Peer Communication on Potential Migrants in Senegal. Impact Evaluation Report, available [online here](#). Geneva: IOM.

Emmer, M., Richter, C., and Kunst, M. (2016) *Flucht 2.0: Mediennutzung durch Flüchtlinge vor, während und nach der Flucht*. Project Report, available [online here](#). Berlin: Freie Universität.

Hinsch, M. and Bijak, J. (2023) The effects of information on the formation of migration routes and the dynamics of migration. *Artificial Life*. 29(1), 3–20. [Open Access](#).

Nurse, S. and Bijak, J. (2021) Syrian Migration to Europe, 2011 – 21: Data Inventory. [Online resource](#).

Prike, T., Bijak, J., Higham, P. A., and Hilton, J. (2022) How Safe is this Trip? Judging Personal Safety in a Pandemic Based on Information from Different Sources. *Journal of Experimental Psychology: Applied*, 28(3), 509–524. [Open Access](#).

Reinhardt, O., Prike, T., Hinsch, M., Bijak, J., Wilsdorf, P., and Uhrmacher, A. M. (2023) Simulation Studies of Social Systems – Telling the Story Based on Provenance Patterns. *TechRxiv*. Preprint, v2.0 (28 April 2023). DOI: [10.36227/techrxiv.20209844.v2](https://doi.org/10.36227/techrxiv.20209844.v2)

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