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Migration forecasting: Beyond the limits of uncertainty

INTRODUCTION

Migration has become one of the defining features of the early twenty-first century, even though the history of human mobility is in fact as long as the history of humanity. One of the necessary prerequisites for managing migration is to have adequate information about the migration processes, their magnitude and composition. Ideally, management of migration would also require some foresight into the trends and likely future developments, so that any actions that are undertaken are not simply reacting to the events of the past, but understanding trends and current dynamics of flows and anticipating the challenges of the future. This is one of the motivations behind the demand for migration forecasts.

Migration has been recently gaining prominence on the international policy arena, with the European Agenda on Migration initiated by the European Commission in May 2015, the New York Declaration for Refugees and Migrants adopted by the UN on 19 September 2016, and the inclusion of migration-related aspects in the Sustainable Development Goals.[1] The Goals relate to different aspects of human mobility, but at least ten of them are linked to explicit measurable targets – including one, Target 10.7, related to improving migration measurement as such.[2] In that regard, migration estimates and forecasts are needed in order to address the related challenges of sustainable development, ideally in a proactive manner.

Another important justification for attempting to predict migration has to do with the role it plays in overall population dynamics. The estimates and predictions of population size and structure are indispensable for many policy, planning and business decisions. Here, the contribution of migration, next to fertility and mortality, is too important to be ignored – no population forecasts can be considered reliable if they fail to incorporate human mobility. Still, despite their importance, migration predictions are notorious for bearing high errors, migration being the most complex and uncertain of the key demographic processes.[3]

The aim of this briefing is to summarize the current state of knowledge on migration forecasts and, most importantly, on their limits. The subsequent sections are devoted to a critical overview of the existing migration estimates and predictions, and of the potential means for expanding the limits of knowledge on the future of migration processes. The briefing concludes with a discussion of how to use the imperfect information offered by migration forecasts to aid decisions made under uncertainty.

UNCERTAIN MIGRATION ESTIMATES AND FORECASTS

Historically, modern attempts to estimate and predict migration and to use it in population forecasts date back to the turn of the 1960s and 1970s, to the pioneering work of Andrei Rogers at the intersection of human geography and demography.[4] Since then, there have

1 See http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/european-agenda-migration/index_en.htm, http://refugeesmigrants.un.org/declaration and www.un.org/sustainabledevelopment/sustainable-development-goals, respectively.

2 See UN Department of Economic and Social Affairs Population Division (2015), Integrating migration into the 2030 Agenda for Sustainable Development, Population Facts no. 2015/5. Available from www.un.org/en/development/desa/population/migration/publications/populationfacts/docs/MigrationPopFacts20155.pdf

3 See for example, J. Bongaarts and R.A. Bulatao (eds.), *Beyond Six Billion: Forecasting the World's Population* (National Research Council, National Academy Press, Washington, D.C., 2000).

4 A. Rogers, *Matrix Analysis of Interregional Population Growth and Distribution* (University of California Press, Berkeley, California, 1968) and A. Rogers, *Introduction to Multiregional Mathematical Demography* (John Wiley, New York, 1975).

been many attempts at predicting migration flows, with varying degrees of success, many of which have been prepared in anticipation of large-scale political changes, such as the expansion of the European Union in 2004.[5] Still, many events that generated very large migration flows could not be predicted: the recent crisis in the Syrian Arab Republic is just one example, with an estimated 4.8 million refugees and more than 6.5 million internally displaced persons as of November 2016, according to the data of the UN High Commissioner for Refugees (UNHCR) and the UN Office for the Coordination of Humanitarian Affairs.

There are many reasons why migration forecasting is such a difficult task. First of all, the underlying concepts are far from being unambiguous: clearly, migration involves relocating across an (international) boundary for a period of time, but in practice, the concepts of migration vary between different countries. Moreover, the diversity of motives behind migration flows, and the emergence of new, fluid types of migration that transcend the dichotomies of the past (such as the short-term versus long-term mobility) make it all the more difficult to conceptualize migration in the contemporary world.[6]

Secondly, the existing statistics do not capture the migration processes well – detailed information is often unavailable, and the quality of the data can be very problematic. The data sources and the methods used for analysing migration data in different countries are very often not comparable, and the resulting statistics are often based on widely different definitions of what constitutes migration. The processes of data collection typically follow either administrative convenience and use tools established for different purposes, rather than being specifically designed for measuring migration and its outcomes. As a result, even in the most developed countries, such as across the European Union, information about migration flows is sketchy at best.[7] As for forced migrations, besides the UNHCR estimates, IOM's Displacement Tracking Matrix tracks and monitors displaced populations in situations of crisis globally.[8] As the data are collected and disseminated as such situations occur, there are inevitable trade-offs between the timeliness of information and its accuracy and detail.

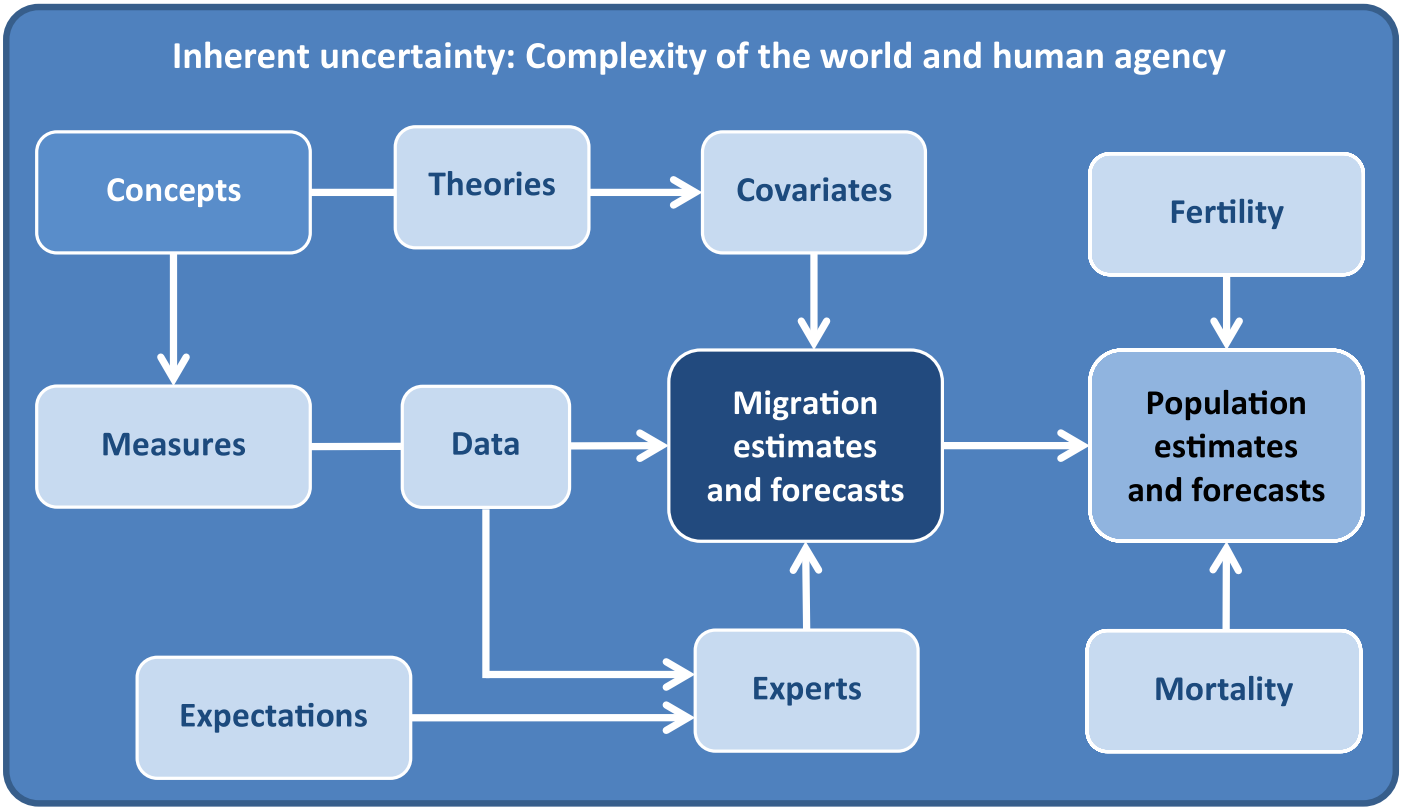
Thirdly, even though many theories have been offered for explaining migration, none of them has proven comprehensive enough to cover the multitude of the forms of migration. The sheer number of push and pull factors (determinants) and drivers of mobility and immobility, all interacting with one another, makes a comprehensive explanation of migration processes anything but possible.[9] The utility of migration theories for making predictions is thus relatively limited, if they are useful at all, especially given that the drivers need to be operationalized as migration covariates, which themselves are uncertain.[10] Worse, expertise on migration is also largely fragmented along disciplinary boundaries – and varies between experts, who may have entirely divergent expectations as to how migration might change in the future.[11]

Finally, there is vast inherent uncertainty and complexity in migration processes. This is partly a result of the uncertain nature of the migration drivers, and partly of human nature and the agency of migrants making decisions on whether, where and when to move. When all these ambiguities are combined, the result is that any migration estimates, and even more so forecasts, have to be seen as intrinsically uncertain. Hence, this uncertainty has to be seen as a reflection of the nature of the social reality. Finally, if migration estimates or forecasts are used for making statements about populations, this uncertainty is then propagated into population estimates and forecasts (Figure 1).

Disregarding the uncertainty and complexity of migration leads to an illusion of control on the part of the decision makers, in an area that is rife with vested and often conflicting interests of the various actors. This is why attempts at managing migration often lead to unintended consequences of the proclaimed policy objectives.[12]

5 For an overview, see J. Bijak, *Forecasting International Migration in Europe: A Bayesian View* (Springer, Dordrecht, 2010).
6 R. King, "Towards a new map of European migration", *International Journal of Population Geography*, 8(2): 89–106 (2002).
7 See e.g. M. Poulain, N. Perrin and A. Singleton (eds.), *THESIM: Towards Harmonised European Statistics on International Migration* (Presses universitaires de Louvain, Louvain-la-Neuve, 2006) and J. Raymer and F. Willekens (eds.) *International Migration in Europe: Data, Models and Estimates* (Wiley, Chichester, 2008).
8 See IOM Displacement Tracking Matrix: www.globaldtm.info/
9 J. Arango, "Explaining Migration: A Critical View", *International Social Science Journal*, 52(165):283–296 (2000).
10 M. Kupiszewski (ed.), *International Migration and the Future of Populations and Labour in Europe* (Springer, Dordrecht, 2013).
11 J. Bijak and A. Wiśniowski, "Bayesian forecasting of immigration to selected European countries by using expert knowledge", *Journal of the Royal Statistical Society Series A*, 173(4):775–796 (2010).
12 An excellent account is S. Castles, "Why migration policies fail",

Figure 1: Cumulation of uncertainty in migration and population forecasts



Source: Jakub Bijak (see also Bijak, 2010).

BEYOND THE LIMITS OF PREDICTION

The first step towards avoiding the illusion of control is to acknowledge the uncertainty of forecasts and describe it – ideally by using the language of probabilities. A simple example for Germany is presented in Figure 2, where the data on immigration and emigration are used to provide forecasts for 2015–2020 with various probabilities attached to the ranges of possible future values. The ranges are wide – as would be expected given the uncertainty discussed before – yet even the 95 per cent probability still fail to capture the inflow of 2 million people and outflow of 860,000 in 2015, reported by the Federal Statistical Office (Figures 2a and 2b).[13] There are two possible interpretations: firstly, the migration crisis of 2015 was even more extreme than it would be implied by 95 per cent probability (1 in 20 years); and secondly, even an approximate indication of uncertainty is more informative than none at all. In the words of the philosopher Carveth Read, "It is better to be roughly right than precisely wrong."[14]

Recently, a full description of uncertainty has been included in the long-term migration and population projections prepared for the United Nations Population Division.[15] Their end date – 2100 – remains beyond the typical five- to ten-year migration forecasting horizon,[16] but they still offer valuable insights into long-term population trajectories. Besides, for the first decade of the twenty-first century, these forecasts were found to be well-calibrated: the stated levels of uncertainty matched the observed

Ethnic and Racial Studies, 27(2):205–227 (2004).

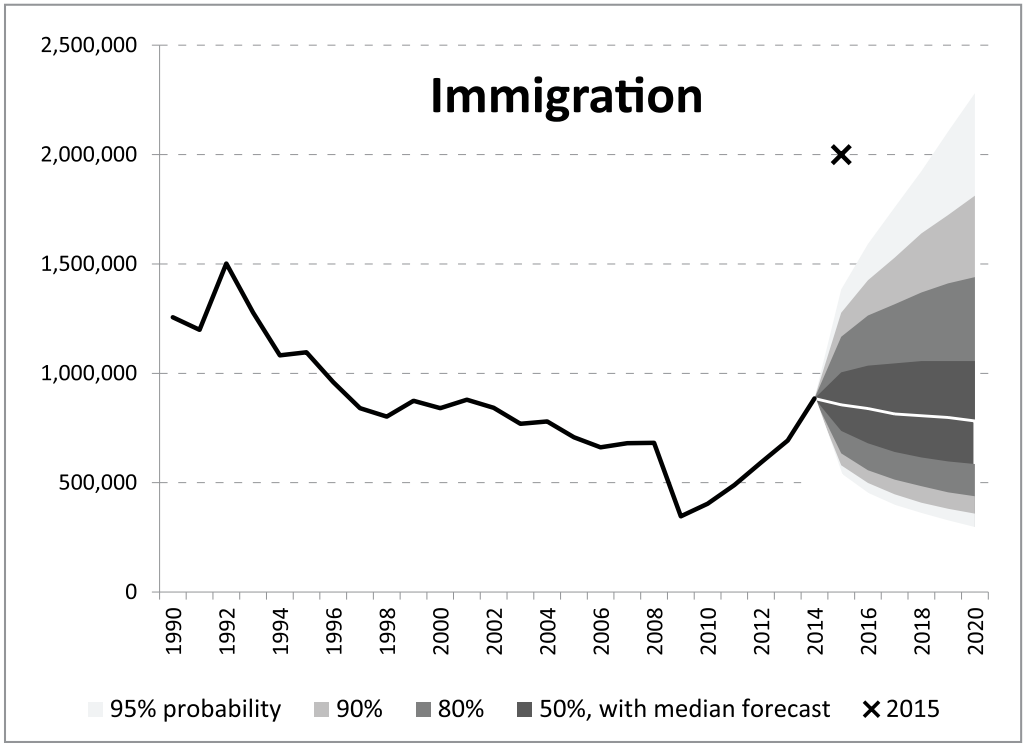
13 www.destatis.de/DE/PresseService/Presse/Pressemitteilungen/2016/03/PD16_105_12421.html

14 C. Read, *Logic: Deductive and Inductive* (Simpkin & Co., London, 1920), page 351. Available from Project Gutenberg at www.gutenberg.org/ebooks/18440

15 See J.J. Azose and A.E. Raftery, "Bayesian Probabilistic Projection of International Migration", *Demography*, 52(5):1627–1650 (2015); and J.J. Azose, H. Ševčíková and A.E. Raftery, "Probabilistic population projections with migration uncertainty", *Proceedings of the National Academy of Sciences, USA*, 113(23), 6460–6465 (2016).

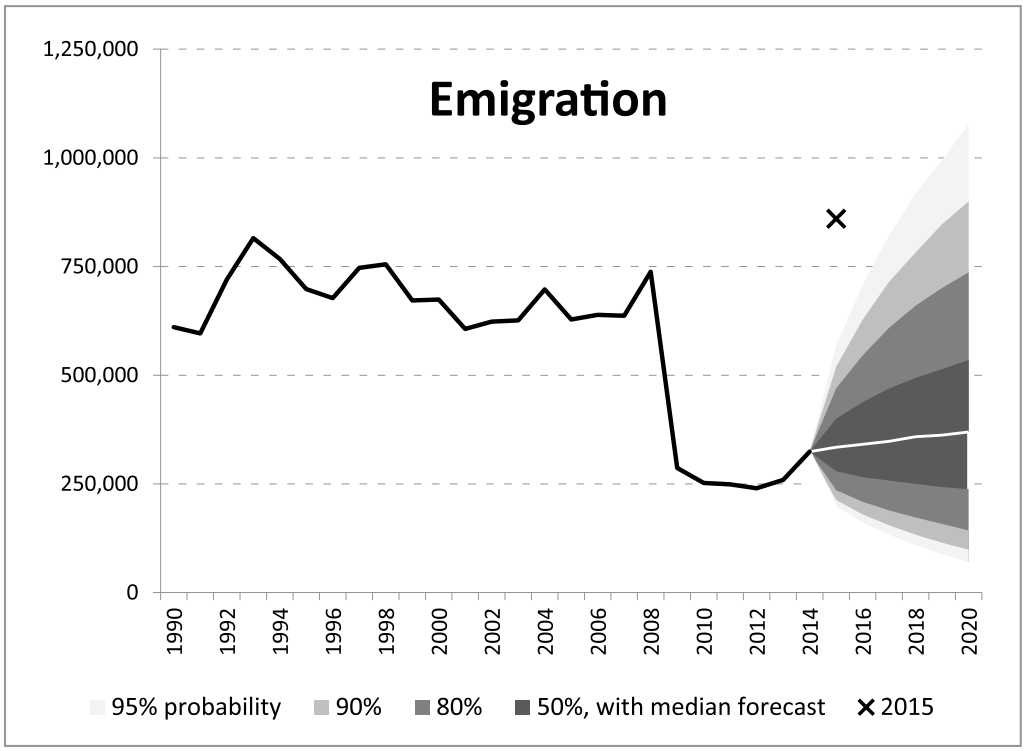
16 Bijak and Wiśniowski (2010), op. cit.

Figure 2a: Forecast example – Immigration to Germany, 1990–2020



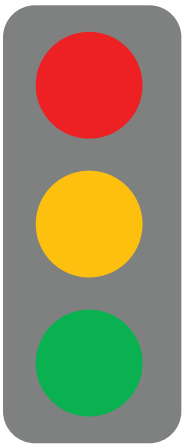
Source: Eurostat and Federal Statistical Office.

Figure 2b: Forecast example – Emigration from Germany, 1990–2020



Source: Eurostat and Federal Statistical Office.

Figure 3: Framework for quality assessment of forecasts



Data	Models	Assumptions	Uncertainty
Missing or inadequate	Inappropriate for the process	Overly simplistic or misleading	Too high or miscalibrated
Imperfect, but consistent	Reasonable given the data	At least coherent and defensible	High, yet still informative
Good quality and comprehensive	Describing the process well	Realistic and well justified	Manageable and well-calibrated

Source: Jakub Bijak (see also Bijak, 2010).

volatility in the data well. From a practical point of view, such long-term scenarios with an assessment of uncertainty are indispensable for long-term policy questions related for example to impacts of climate change.

One key advantage of predictions explicitly equipped with uncertainty assessment is that they offer their users additional information, which can be used in contingency planning and hedging against risk. Here, appropriate communication of the uncertainty is crucial, and complex or difficult concepts that are the cornerstone of probabilistic modelling need to be simplified. One idea is to use *traffic-lights approach*, which intuitively summarizes the uncertainty and other aspects of the data, models and assumptions used in preparing the forecasts (Figure 3). An important note is that different migration types and movements of different groups of people – such as labour migrants, asylum seekers or migrants of different nationalities – vary with respect to their uncertainty levels and thus require different methods and assumptions in the forecasts.[17]

There are many ways in which the existing forecasts can be still improved. First, more use can be made of the various stylized facts and the more stable features of migration, such as the relatively stable age and spatial patterns or global shares of migrants. Second, the gaps in theory and data need filling to the greater possible extent. There will always be sizeable residual uncertainty left, but much more work can be done on improving the existing data and integrating the various theories that are currently too fragmented.[18] Some recent encouraging examples include the following: (a) work on model-based harmonization of migration flow estimates for Europe;[19] (b) reconstruction of global flows from the migrant stock estimates;[20] (c) new creative uses of "big data";[21] and (d) use of agent-based computer simulations.[22] Finally, a wider range statistical methods need to be looked at; after all, these are the very tools that are designed to describe and deal with uncertainty.

17 G. Disney et al., *Evaluation of existing migration forecasting methods and models. Report for the Migration Advisory Committee* (ESRC Centre for Population Change, Southampton, 2015).

18 F. Willekens, et al., "International migration under the microscope", *Science*, 352(6288):897–899 (2016).

19 J. Raymer et al., "Integrated Modeling of European Migration", *Journal of the American Statistical Association*, 108(503):801–819 (2013). The estimates are available at www.imem.cpc.ac.uk

20 G.J. Abel and N. Sander, "Quantifying Global International Migration Flows", *Science*, 343(6178):1520–1522 (2014). The dataset is available at www.global-migration.info

21 An example of such a pilot study is E. Zagheni and I. Weber, "You are where you E-mail: Using E-mail Data to Estimate International Migration Rates", Proceedings of the 4th Annual ACM Web Science Conference, Evanston, Illinois, 22–24 June 2012.

22 See a review by A. Klabunde and F. Willekens, "Decision-Making in Agent-Based Models of Migration: State of the Art and Challenges", *European Journal of Population*, 32(1):73–97 (2016).

FROM FORECASTS TO DECISIONS

The future opportunities in migration forecasting require not only new and more creative uses of data or new models, but above all, a new philosophy in what the forecasts can actually offer. This will require a paradigm shift, from forecasts and forecasting methods to supporting actual policy and business decisions. Here, different needs and time horizons require different approaches: strategic planning can involve some form of risk management, where uncertainty of different migration processes is analysed together with their impact.[23] On the other hand, operational decisions with short timescales necessitate having adequate tools for timely detection of warning signals. An example related to the Syrian refugee crisis is presented in Figure 4, where the data on average daily changes above or below control bounds (dashed lines) indicate deviations from the trend that may require taking action, for example by committing additional resources in very short timeframes.[24]

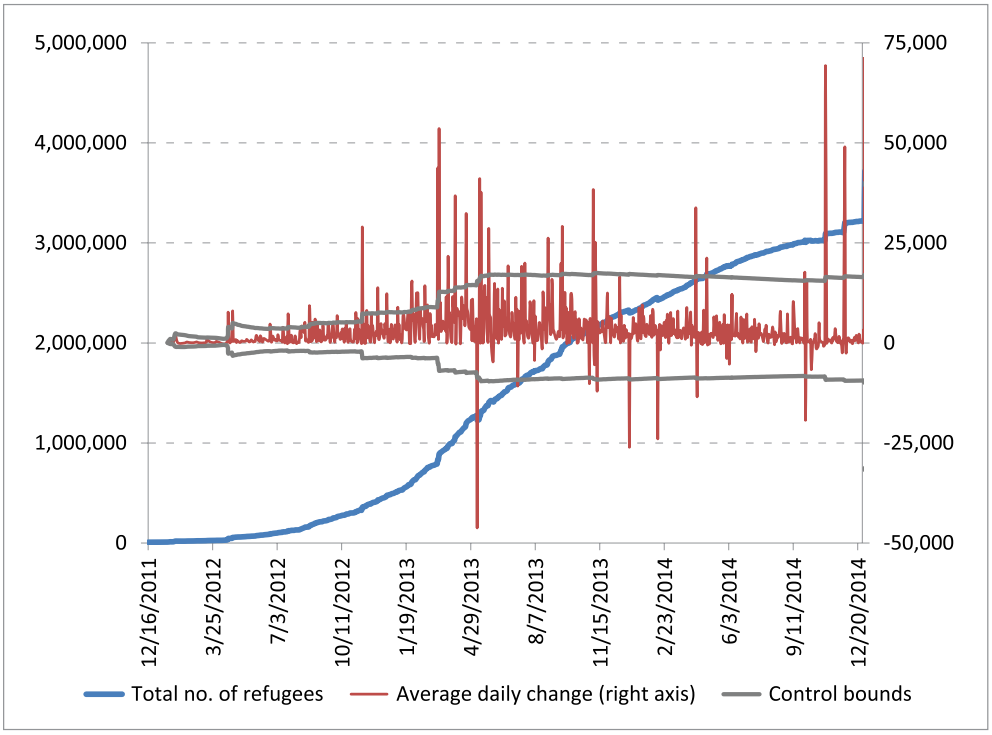
A belief in the possibility of producing precise migration forecasts is not only naïve, but also can backfire if reality does not conform to the expectations. This is very similar to the notion that migration is fully controllable, when the lessons from history are full of examples of unintended consequences of actions purporting to exercise such control.[25] Acknowledging the multidimensional and inherent uncertainty of migration, and showing some humility in the face of the unknown is not the sign of weakness, but of maturity. It is also a required first step in moving beyond the limits of prediction towards achieving greater preparedness and resilience through setting up contingency plans for various possibilities. Instead of pretending that uncertainty does not exist, or does not matter, it should be embraced and made a central element of any discussion about predicting and managing migration.

23 See Bijak (2010) and Disney et al. (2015), op. cit.

24 For details and specific recommendations, see the forthcoming report: J. Bijak, J.J. Forster and J. Hilton, *Quantitative assessment of asylum-related migration: A survey of methodology*. Report for the European Asylum Support Office (ESRC Centre for Population Change, Southampton, forthcoming).

25 For a US example, see e.g. W. Cornelius, "Controlling 'Unwanted' Immigration: Lessons from the United States, 1993–2004", *Journal of Ethnic and Migration Studies*, 31(4):775–794 (2005).

Figure 4: Warning signal detection: Example of the Syrian asylum crisis, 2012–2014



Source: UNHCR, 2016.

About

GMDAC
In response to growing calls for better data on migration, and better use and presentation of migration data, IOM has created a Global Migration Data Analysis Centre (GMDAC). Located in the heart of Berlin, Germany, the Centre aims to provide authoritative and timely analysis of data on global migration issues as a global hub for data and statistics on migration.

Data Briefing Series
The GMDAC Data Briefing Series aims to explain what lies behind the numbers and the data used in migration policy and public debates. The Briefings explain what "the numbers" indicate about movements of migrants, refugees and asylum seekers, on a range of topics for policy across the globe.

The way the data are presented has an important influence on public perceptions of migration in Europe and the development of policy. The Series will serve to clarify, explain and exchange specialist knowledge in an accessible format for wider public and policy audiences, for capacity-building and evidence for policy. Briefings will be of interest to expert, as well as lay audiences, including journalists, students, local authority and city planners and lawyers.

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