



Office for
Statistics Regulation

Review of Migration Statistics produced by the Office for National Statistics

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The role of the Office for Statistics Regulation

As an independent UK-wide regulator, we are in a unique position to take a broader look at issues of importance to society and to make the case for improved statistics across organisation and Government boundaries. This is supported by our ability to convene, influence and highlight best practice from other sectors.

This review forms part of our programme of systemic reviews which, underpinned by the [Code of Practice for Statistics](#), are aimed at driving improvements in the public value provided by official statistics.

We want to ensure that statistics provide a robust evidence base for national and local policy development and decision making. We champion the need for statistics to support a much wider range of uses, including, by charities, community groups and individuals. They should allow individuals and organisations to reach informed decisions, answer important questions, make the case for change or hold government to account.

Executive Summary

International migration statistics (referred to as 'migration statistics' in this report) are vital in aiding our understanding of society. They are a key component of population statistics as well as being a key area of public and policy interest. However, it is also extremely challenging to measure migration accurately.

The Office for National Statistics (ONS) has been embarking on an ambitious programme to transform how it measures international migration. ONS has moved away from using the International Passenger Survey (IPS) to estimate migration and is undertaking an innovative programme based on the use of modelled estimates (tactical approach) and administrative data (strategic approach), instead of the survey.

Due to the importance of these statistics and the ambitious transformation programme underway, we conducted this review to ensure that the transformed migration statistics are trusted, high quality and of value in line with the [Code of Practice for Statistics](#).

We have found that ONS is taking a sensible and well thought out approach to its development of data sources and methods for both the tactical and strategic approaches. It is effectively collaborating and engaging with academics and experts and publishing regular updates. However, despite this collaboration and engagement, we think there is a need to **improve and broaden its user engagement**. Despite its flaws, many IPS users were familiar with its approach and its strengths and limitations. User engagement is vital to ensure that all users reach the same level of familiarity with the new approaches, otherwise they may not be confident in the approach. Engaging with both expert and less expert users – their questions, challenge and advice – will help refine and enhance the approach. This engagement will also help to manage expectations around what is possible.

The migration transformation is also taking place in the context of a wider transformation of population statistics and the backdrop of the pandemic. **Clear and coherent communication** of the migration changes in this context is essential to keep users engaged with the transformation programme. Population estimates and migration estimates should be coherent. This is one of the goals that ONS is aiming to reach. ONS is exploring Demographic Accounts as a method to draw together and achieve fully coherent estimates across population and migration through time. Communication around the migration transformation programme should be presented in this wider context to help users understand what data will be available when, how it can be used and any impacts on quality due to the pandemic.

In summary, ONS has been credible and robust in its development of the methods and data sources underpinning its transformation of migration estimates, and has engaged well with experts on these developments. It should build on this in two ways:

- improve and broaden its user engagement; and
- ensure clear and coherent communication of its migration plans in the context of the population and labour market transformation.

We fully support ONS's transformation of its migration statistics and look forward to working with ONS to ensure that the transformed migration statistics serve the public good.

Introduction

Purpose of the review

- 1.1 This review looks at how the Office for National Statistics' (ONS) is transforming its international migration estimates (referred to as 'migration statistics' in this report). It includes ONS's plans to estimate [long-term international migration \(LTIM\)](#), which have been designated as experimental statistics since August 2019.
- 1.2 High quality migration estimates are crucial in helping the public and policy makers understand UK society. Migration statistics directly inform understanding of migration trends and characteristics. They are also a key component of population estimates in the UK. This means they have an impact on many outputs, including as denominators, such as for the unemployment rate and vaccination uptake, as well as to calculate survey weights to ensure surveys represent the full population, for example in the Labour Force Survey.
- 1.3 Our review of migration statistics will consist of a series of compliance checks. This report is the first of these, with the next one planned for later in 2022. As regulators, it is our role to support confidence in statistics by making sure that statistics serve the public good. Our aim through this review is for the transformed migration statistics to be trusted, high quality and of value in line with the [Code of Practice for Statistics](#).

The statistics

- 1.4 International migration statistics are published by ONS, the Home Office and the Department for Work and Pensions (DWP). For example, DWP publishes statistics on [National Insurance Number \(NINo\) allocations to overseas nationals entering the UK](#) and the Home Office [publishes quarterly immigration statistics](#).
- 1.5 Long-term international migrants (LTIM) are defined by the UN as those who change their country of residence for a period of 12 months or more. ONS previously published LTIM statistics quarterly in the Migration Statistics Quarterly Report (MSQR). The statistics were published as provisional rolling year statistics for the years ending in March, June, September, and December, with final, revised, figures for the previous calendar year published each November. Statistics on migration stocks are available in [the Population of the UK by country of birth and nationality publication](#).
- 1.6 LTIM statistics were primarily based on data from the International Passenger Survey (IPS). The data were adjusted to allow for flows to and from Northern Ireland (with data provided by the Northern Ireland Statistics and Research Agency), those who change their migration intentions (for example, those who state an intention to migrate who then decide to return to their origin country within 12 months), and asylum seekers (with data provided by the Home Office). The IPS was a face-to-face sample survey of passengers entering or leaving the UK with a boost for migrant contacts. The IPS was carried out by ONS and was initially designed to produce data for National Accounts on tourism, but incorporated additional questions to measure migration using agreed UN definitions of migration.

- 1.7 In August 2019, [Iain Bell Deputy National Statistician ONS, requested](#) support from the Office for Statistics Regulation (OSR) for reclassification of MSQR to experimental statistics in advance of the publication of the August MSQR. [Ed Humpherson, Director General for Regulation, wrote to Iain Bell](#) to agree this reclassification. This request was due to limitations identified with the current estimates and the ongoing research programme ONS had in place to improve these statistics.
- 1.8 Following the pandemic, [ONS announced in August 2020](#) that it would not be returning to producing official migration statistics using the IPS and instead, would be shifting to a new administrative data approach it terms admin-based migration estimates (ABMEs). This meant that the estimates would be based on actual patterns of migration that are evident from administrative data sources rather than on replies to survey questions about respondents' intentions to remain in or out of the UK over the next 12 months.

Strategic and Tactical approaches

- 1.9 Currently ONS is applying two distinct methods in producing migration estimates. The first approach, which ONS is calling the [tactical model-based approach](#), has been developed alongside experts at Southampton and Warwick Universities and can provide more timely, provisional estimates based on applying a statistical modelling technique known as a state space model to data sources, including the historical IPS data, Home Office border crossing data, visa data, and Advanced Passenger Information (API) data.
- 1.10 The second approach, which ONS is calling the [strategic approach](#), uses DWP Registration and Population Interaction Database (RAPID) and Home Office visas and border administrative data sources. ONS looks at whether a migrant appears in the UK through one of these data sources and whether they have been here for 12 months (as the UN definition of a migrant is an individual 'who has resided in a foreign country for more than one year'). This approach is not as timely as the tactical model-based approach, but it is hoped will be more accurate as it is based on observed behaviour.
- 1.11 ONS currently uses the tactical model-based estimates for its headline estimates of international migration, which are published as experimental statistics, and provides updates on progress with developing the strategic approach. In future ONS aims to combine the two approaches to produce timely provisional statistics which are then followed by more accurate final statistics. The statistical model itself is still evolving though and may change. For example, one area ONS is exploring is the feasibility of using Advanced Passenger Information (API) data to better support the provision of monthly migration statistics. The future development of the dynamic population model (discussed in more detail in 2.12) will also be informed by and help to inform the development of migration statistics.

Wider context

- 1.12 The migration transformation programme is part of a wider [population and migration transformation programme](#) which is seeking to understand the potential of administrative data sources and modelling to produce more regular and timely population and migration statistics at both national and local levels. Census 2021

results in England, Wales and Northern Ireland will also feed into the validation of the programme's outputs.

- 1.13 In 2023, the National Statistician will report to the government on ONS's recommendation on the future of the Census and population statistics in 2023. This will include an update on progress with its population and migration transformation programme, and will set out what is needed in the future to continue to achieve these ambitions.

How this part of the review was carried out

- 1.14 We have undertaken desk research looking at migration estimates in the UK and methods used to produce migration estimates, both here and abroad. We have held meetings with producers and key stakeholders with an interest in migration to capture their views about ONS's current migration publication and its plans. We have spoken to academics, some of whom are involved in working with ONS, think tanks, devolved administrations, media commentators and other government departments.

What we found

Data sources

- 2.1 ONS has taken an ambitious and open approach to data sources. It is drawing on different sources from across Government and continuing to explore the potential of new sources to improve the accuracy of its estimates. Currently the two major sources in the [strategic approach](#) are the RAPID dataset (Registration and Population Interaction Database) sent to ONS annually and the Home Office Border Data. RAPID aims to identify a migrant through their interactions with earnings and benefit systems. The [tactical approach](#) draws on datasets including Home Office exit checks data, the Civil Aviation Authority (CAA) data and uses trend and seasonality elements from the historic IPS.
- 2.2 Over time, ONS plans to integrate data across more input datasets to ensure a wider population coverage and enable more granular reporting. For example, as part of the ABME approach ONS plans to include further Home Office administrative data, HM Revenue and Customs Pay As You Earn Real-time Indicators (PAYE- RTI) (and Self-Assessment), NHS Hospital Episode Statistics, Further Education data (AEDE), Council Tax and others such as Electoral Register and DVLA registrations. Currently, RAPID data is available once a year, it is hoped that in the future it will be available more frequently.
- 2.3 ONS is aware of, and has set out, the limitations of the data used in its current approaches. For example, the strategic approach will not provide complete coverage of the UK population and some population groups will be hard to estimate. Non-working students is one such group and ONS is investigating ways to best estimate migration in this group. There are also other concerns about the use of administrative data to measure migration, such as the issue that many people can still interact with these administrative systems while living abroad. Also, these administrative data sources all have a different primary purpose which is not directly related to migration and therefore consideration needs to be taken when using and linking these data sources.
- 2.4 As ONS progresses with its plans, it should make clear which data sources will be feeding in to both the ABME (strategic) and provisional state space model (tactical) approaches, what their strengths and limitations are, and how these additional sources will contribute to improving the migration estimates. For example, some data sources may only be updated annually, and certain sub-groups will therefore only be updated annually. Also, it may be that the provisional estimates are only appropriate to be used for national level estimates, with the final estimates providing the more granular data.
- 2.5 In general, the user responses to ONS's approach to using administrative data sources were positive. However, it was noted that these sources are likely to be good at measuring population inflows but less good at capturing those who are leaving the country. Some users did comment that they are waiting until more outputs are available which use the ABMEs before making a judgement.

A. ONS should publish details of which data sources it intends to use for the ABME (strategic) and provisional state space model (tactical) approaches. It should also set out how each additional source impacts the migration estimates and the implications for how users should interpret the different provisional and final estimates.

B. ONS should ensure data sources used in the estimates remain up to date. It should be clear with users how it will achieve this, for example by identifying points when it will review the data sources, such as use of historical IPS data and Home Office visa data.

Methods

2.6 ONS has taken an innovative approach to estimating migration in the absence of the IPS and has been collaborative in its decision making around methods. As mentioned above, ONS currently has two primary ways of measuring international migration, the [strategic approach](#), which produces behaviour-based estimates from administrative sources, and the [tactical solution](#), which uses state space modelling to produce more timely estimates of migration flows.

2.7 The development of the tactical approach was done in collaboration with academics from the University of Southampton and Warwick and came about following the suspension of the IPS in February 2020. A state space model was developed that took the trend and seasonality elements from the historic IPS and additionally applied the continuing time series from other sources. Currently, ONS publishes on a 6-monthly basis with quarterly breakdowns. It is looking to set up data feeds that would allow monthly publication of estimates. State space models are generally considered to deal well with shock events such as the impacts of COVID-19 and EU Exit. However, underpinning assumptions should be reviewed, e.g.: the assumption that EU and non-EU leaving rates are the same - although ONS plans to introduce RAPID data into the model which should address this issue. More information on state space models is included in Annex A.

2.8 However, some aspects of state space models can be challenging to explain to users without touching on quite complex areas. If users feel the model explanation is inaccessible it may undermine confidence in the estimates and users may resist using the estimates produced by the model.

C. ONS should make the modelling approach more transparent and easier to understand for less expert users. It should support users to understand when and how to use the estimates calculated in this model, for example by writing an explainer piece on the state space modelling, including its strengths and limitations, and the impacts of different assumptions.

D. ONS should keep under review the underpinning assumptions of the state space model and the impact of these assumptions on the use of these statistics.

2.9 ONS is continuing to develop its strategic approach to estimating migration, using data from across Government. It has produced [two admin-based migration series](#). The first ABME measure is based on the RAPID dataset developed by DWP to

provide a view of an individual's interactions across DWP, HM Revenue and Customs (HMRC) and local authorities (via Housing Benefit) datasets. These interactions include benefits, employment, self-employment, pensions and in-work benefit. RAPID contains a record of everyone who has a National Insurance number (NINo) and for each, the number of weeks of activity (or interactions) within these systems is summarised for each year from tax year. The second ABME measure is based on Home Office Exit Checks data. The method looks at first arrival and last departure within a visa period as an approximation for length of stay in the UK. Work on refining these methods continues including the extension of the use of the RAPID data to include UK nationals and working more closely with the Home Office to include data on EU nationals as it becomes available through their new migration system. ONS is also working on resolving some of the challenges in using RAPID and Home Office Exit Checks data in a complimentary way. For example, understanding the overlap between the two datasets.

- 2.10 ONS has not yet provided details of its approach to calculating uncertainty associated with its ABME estimates. In order for estimates to be used appropriately, it is important that users understand how the estimate may differ from the “true value” and the degree of confidence that can be placed in the outputs.

E. Users need a clear understanding of uncertainty associated with the estimates and how the estimates can be used appropriately. ONS should share detailed plans for how uncertainty will be measured and communicated.

- 2.11 ONS plans to combine the strategic (ABMEs) and tactical (state space model) approaches to provide more timely, higher quality estimates. Greater use of administrative information should reduce the need for some of the assumptions currently present in the modelling and help to improve the accuracy of the estimates. The challenge with the ABME approach is the timeliness of the data, as ONS is waiting to observe whether a person remains in the country for 12 months. To overcome this challenge, ONS is proposing to provide provisional estimates based mainly on the modelled state space method. The final estimate would then be based mainly on the administrative data method. This approach – having provisional and then final estimates – has been used successfully by ONS for other statistics. The highest profile of which is GDP. ONS is intending to discuss with users how to define a migrant, and it could be that in the future, the 12 month definition may become more flexible with shorter durations also included in the publication.
- 2.12 Additionally, as part of the overall population transformation programme [ONS is exploring Demographic Accounts](#) as a method to draw together and achieve fully coherent estimates across population and migration through time. ONS will publish more on this work later in 2022. Under this approach, Bayesian methods are being used to estimate population counts and rates by constructing models for observed data sources and demographic systems. The resulting demographic account is a framework that is built up with layers. This begins with a simple population framework including population stocks, and components of population change due to births, deaths, internal migration and international migration, but

can be extended to include more demographic components such as country of birth or household structure.

F. ONS should provide clearer information about its longer-term plan for measuring migration estimates. For example, what the longer-term model will look like and how the state space model method (tactical approach) and the admin-based method (strategic approach) will be integrated with this longer-term model and how this fits with ONS plans for a Dynamic Population Model.

2.13 Changes to methods will impact on a consistent time series. It is not yet clear how ONS will handle this. For example, in April 2021, ONS published data comparing migrant flows using RAPID and Home Office border data over the period year ending March 2012 to year ending March 2020. The estimates from RAPID showed higher net migration for EU nationals and lower net migration for non-EU nationals compared with Long Term International Migration (LTIM) estimates based on the IPS. Additionally, the 2021 Census results may provide additional information which impacts historical migration estimates.

G. To help users understand the implications for their use of data, ONS should provide more detail on its plans to maintain a consistent time series, including the rationale for its plans.

Quality assurance

2.14 In terms of validating migration stocks and flows, there is no 'gold standard'. The results from Census 2021 in England, Wales and Northern Ireland will start to become available throughout 2022 and will be crucial to validate the migration stocks for both the tactical and modelled approaches. However, the Scottish Census does not take place until Spring 2022 so data covering the whole of the UK is unlikely to be available until late 2023 at the earliest and we do not know the impacts of the pandemic on this data. ONS also plans to use the Census results to validate migration flows but this will be of more limited use as it is based around a question about where the respondent was one year ago.

2.15 ONS has currently used student accommodation data, estimates from the Labour Force Survey (LFS), Advanced Passenger Information (API) data on arrivals and departures for validation to see if there are regular patterns evident across the sources.

2.16 The Annual Population Survey (APS) is also likely to become a quality assurance source although there are current concerns around the bias and previous reweighting as discussed above. ONS is working on the new Labour Market Survey (LMS) to replace the LFS/ APS which will hopefully be more robust.

H. To give users greater confidence in ONS's quality assurance, ONS should set out its approach to validating migration estimates, particularly migration flows.

User engagement and communication

- 2.17 ONS engages well with expert users about migration statistics through a variety of forums and groups including the Migration Expert Users Forum, the GSS Migration Steering Group, the Migration Statistics Users Forum and the UK population theme advisory group (UKPTAB). It also engages with users through bilateral meetings on specific issues and topics. The users we spoke with were positive about the level of engagement with ONS and felt that generally their views were taken on board.
- 2.18 We did receive comments that ONS does not always clearly acknowledge problems with data in its publications, or it takes a while for these limitations to be acknowledged externally. However, this seems to have been improving. These comments were made specifically with reference to the interim migration estimates from the Annual Population Survey. Following these comments further work was undertaken by ONS to improve notes on limitations in the 17 September 2021 and 25 November 2021 releases. Another area of concern highlighted by users was the reweighting exercise. ONS is undertaking another reweighting exercise to try and address these concerns. It is important that ONS continues to respond to user input to support the quality of estimates, and user confidence in the estimates.
- 2.19 ONS regularly publishes updates on progress with the Migration Transformation programme. For example, its most recent update was published on [26 November 2021](#). These updates are also communicated to registered users through email alerts and the Migration and population statistics newsletter. Generally, users felt that they were well informed on plans.
- 2.20 However, for users who engaged less frequently with the migration transformation programme, these updates can be difficult to navigate, and it is not always clear what the most up-to-date information is. For example, how would a user navigate ONS's website to find the most up-to-date information on the admin-based migration estimates, modelled estimates or most-up-to-date long-term migration estimate? As a result, some users commented that they are relying on previous year data, while they wait for ONS to develop a new measure.

I. ONS should improve the accessibility of migration data and information:

- relating to the migration transformation programme so it is clear to all users what is the most up-to-date data and information and what should be used in what context.
- available across Government so it is clear to users what related information is produced by other Government Department.

Linked to the wider population transformation programme

- 2.21 ONS is transforming the way it produces population, migration and labour market statistics. This programme is complex and we heard how some of the terminology connected to the transformation programme is new and evolving and can be challenging for less expert users – for example, whether at the centre of

the system there will be a 'Bayesian demographic account' or 'dynamic population model' and what these terms mean.

J. To ensure all users, including non-expert users, understand its developing thinking ONS should publish and keep up to date a glossary of terms for the population, migration and labour market transformation programme (which is easy to navigate to) and ensure consistency in how it refers to emerging parts of the programme in its communications.

2.22 ONS has recently provided users with a high-level [update on its work to transform population estimates](#), including how the transformation of migration statistics fits within this. We welcome this update, although note that migration outputs were not listed in the planned outputs table.

2.23 ONS has also undertaken work internally to bring together the different transformation streams in population, migration and labour market statistics in a coherent way and shared with us an overview of this and a high-level roadmap for the transformation streams work.

K. ONS should publish a high-level roadmap for the population, migration and labour market transformation programme, including how migration fits with the rest of the transformation plans, when migration outputs are due to be published and how users can get involved.

Users and uses

2.24 ONS is developing its thinking on how to define a migrant and as part of this is considering its continued use of the UN definition of a long-term migrant (i.e. someone resident in the country for 12 months). It is crucial that feedback from a broad range of users feeds into this development as different users have different uses. For example, some of the users we spoke with were interested in whether a person is here for the short-term (i.e. less than 1 year) or the long-term (i.e. 12 months or more) as most policies apply to those who are here for 12 months or more, therefore supported the continued use of the UN definition. A couple of users did note that if the amount of time a migrant had been here was published as one characteristic of that individual then external analysts could calculate whatever categories were relevant for their research or policy evaluation. Alternatively for some users understanding the legal status of a migrant was helpful rather than how long they have been here. Many users were also interested in the availability of more granular data, however the type of granular data specified varied between users, from lower geographical areas to the type of migrant.

2.25 Some users noted the potential benefits of deriving migration estimates from Home Office visa data, which are more timely and based on likely intentions about length of stay, although it was also noted that this will only be partially complete. ONS is investigating this potential and has recently published some [research on the visa data](#) and how it could potentially support the development administrative based migration estimates.

L. ONS should engage with a wide range of users to ensure the estimates available will meet the needs of a variety of users. It should also be clear on what the statistics can and cannot be used for and any decisions it has had to make based on the availability, strengths and limitations of the underpinning data which impact on use.

2.26 ONS is proposing to provide provisional estimates based mainly on the tactical approach. The final estimate would then be based mainly on the strategic approach. ONS has used this approach for other statistics, for example GDP. The users we spoke with were generally supportive of this approach and of using administrative data to measure observed migrant behaviour. However, some did note that the modelled provisional estimates and final estimates based on administrative data could potentially result in quite different numbers. Also, it was noted by one user that GDP is more abstract than the number of migrants in the country, which can often be a more emotive issue so the risks may be higher. ONS recognises these risks and that managing expectations through clear communication will be crucial in mitigating them.

M. ONS is planning further work to develop its thinking on how frequently migration estimates are updated. As part of this work ONS should engage with a wide range of users to ensure it:

- Understands how frequently different sets of users need updated migration estimates and why
- Understands user views on having provisional and final estimates
- Clearly communicates the difference between the provisional and final estimates, e.g. different data sources and/or methods used, and how this will impact different uses?

Trustworthiness

2.27 ONS is seen as a credible and reliable statistics producer, with highly skilled professional staff. It is effectively prioritising the development and transformation of these high profile and vital migration estimates. It is transparently updating users on plans. However, as noted in recommendations above, more could be done to improve the accessibility of these updates and to explain them in the context of the wider population and migration transformation programme.

Summary of recommendations

A. ONS should publish details of which data sources it intends to use for the ABME (strategic) and provisional state space model (tactical) approaches. It should also set out how each additional source impacts the migration estimates and the implications for how users should interpret the different provisional and final estimates.

B. ONS should ensure data sources used in the estimates remain up to date. It should be clear with users how it will achieve this, for example by identifying points when it will review the data sources, such as use of historical IPS data and Home Office visa data.

C. ONS should make the modelling approach more transparent and easier to understand for less expert users. It should support users to understand when and how to use the estimates calculated in this model, for example by writing an explainer piece on the state space modelling, including its strengths and limitations, and the impacts of different assumptions.

D. ONS should keep under review the underpinning assumptions of the state space model and the impact of these assumptions on the use of these statistics.

E. Users need a clear understanding of uncertainty associated with the estimates and how the estimates can be used appropriately. ONS should share detailed plans for how uncertainty will be measured and communicated.

F. ONS should provide clearer information about its longer-term plan for measuring migration estimates. For example, what the longer-term model will look like and how the state space model method (tactical approach) and the admin-based method (strategic approach) will be integrated with this longer-term model and how this fits with ONS plans for a Dynamic Population Model.

G. To help users understand the implications for their use of data, ONS should provide more detail on its plans to maintain a consistent time series, including the rationale for its plans.

H. To give users greater confidence in ONS's quality assurance, ONS should set out its approach to validating migration estimates, particularly migration flows.

I. ONS should improve the accessibility of migration data and information:

- relating to the migration transformation programme so it is clear to all users what is the most up-to-date data and information and what should be used in what context.
- available across Government so it is clear to users what related information is produced by other Government Department.

J. To ensure all users, including non-expert users, understand its developing thinking ONS should publish and keep up to date a glossary of terms for the population, migration and labour market transformation programme (which is easy to navigate to) and ensure consistency in how it refers to emerging parts of the programme in its communications.

K. ONS should publish a high-level roadmap for the population, migration and labour market transformation programme, including how migration fits with the rest of the transformation plans, when migration outputs are due to be published and how users can get involved.

L. ONS should engage with a wide range of users to ensure the estimates available will meet the needs of a variety of users. It should also be clear on what the statistics can and cannot be used for and any decisions it has had to make based on the availability, strengths and limitations of the underpinning data which impact on use.

M. ONS is planning further work to develop its thinking on how frequently migration estimates are updated. As part of this work ONS should engage with a wide range of users to ensure it:

- Understands how frequently different sets of users need updated migration estimates and why
- Understands user views on having provisional and final estimates
- Clearly communicates the difference between the provisional and final estimates, e.g. different data sources and/or methods used, and how this will impact different uses?

Next steps

- 3.1 This review will consist of a series of compliance checks during the transformation process. This report is the first of these compliance checks, with the next one planned for later in 2022. As part of the next compliance check in this review we will also follow-up on progress with the thirteen recommendations made in this report and set out our plans for future work.

Annex A: State Space Models (SSMs)

SSMs have been used for time series modelling across many disciplines including population. SSMs are a type of hierarchical model and their hierarchical structure effectively incorporates the modelling of two time series:

- a state (often known as a process) time series that is unobserved and attempts to reflect the true, but hidden, state of migration (e.g. the underlying trend in migration); and
- an observation time series that consists of observations of, or measurements (e.g. the actual migration counts based on either survey (such as the IPS) or admin-based sources (such as Home Office data)).

For example, the actual population of migrants over time would be the state time series, while the incomplete and imprecise counts of migrants sampled in a survey would be the observation time series.

Process variation represents the processes that change the population size through time, while observation error reflects differences between the hidden state (i.e. the trend) and the observed data due to randomness or imprecision in the sampling or survey methodology. These two components act at different levels of the model hierarchy, and the SSM framework allows them to be modelled separately.

When an SSM model is fitted to a time series, the process and observation parameters can be estimated as well as the hidden states (e.g. the trend). These estimates of the hidden states generally reflect the true state of nature better than the original observations.