

An expert elicitation tool to capture probabilistic estimates of future demographic indicators

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Extended abstract

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Most statistical agencies perform some kind of consultation with experts when designing their demographic projection assumptions. Among UNECE countries, 29 of 31 countries undertook some form of consultations in their recent projections, with 19 of them documenting the results (UNECE 2018). The intensity and the format of these consultations vary considerably, from merely seeking approval from higher levels in the organization to a formal process where a committee of experts has the last word about the final assumptions or methods that will be used.

Expert knowledge elicitation can be defined as the “process of formulating a person’s knowledge and beliefs about one or more uncertain quantities into a (joint) probability distribution for those quantities” (Garthwaite et al. 2005). Expert elicitation has been used to inform decision-makers about numerous critical societal issues such as the likelihood of climate change, of health impacts caused by pollution or the consequences of introducing new technologies (Morgan 2014) and is expected to play a greater role in the future in a context where the range of choices, the availability of data and the demands for accountability are increasing (Dias et al. 2018).

There is a clear role for expert knowledge elicitation in demographic projections given the inherent uncertainty associated with the future. While it has been shown that simple models tend to outperform subjective judgment in prediction performance (e.g., Meehl 1954, Tetlock and Gardner 2015), expert elicitation can be valuable when there is a lack of good data, insufficient knowledge about the underlying causal mechanisms or apparent randomness of the trends. Expert elicitation is also informative about the degree of consensus about the future path of a given component of demographic growth. Finally, compared with conventional statistical techniques, expert elicitation may also offer greater transparency (Knol et al 2010).

In demography, expert elicitation has been used to inform the development of demographic projections assumptions (e.g., Lutz 2009, Billari et al. 2012, Wilson et al. 2011, Bijak and Wisniowski 2010). In their 2013-based demographic projections,

Statistics Canada undertook a pilot survey of Canadian demography experts to support the process of building the various projection scenario assumptions. Following its successful pilot project in 2013, the demographic projections team at Statistics Canada undertook a thorough evaluation of best practices in the field of elicitation. This review reiterated the importance of designing the survey in a manner so as to avoid various cognitive biases and heuristics such as anchoring bias, confirmation bias, hindsight bias and motivation bias (Hora 2007; Kynn 2008; O'Hagan et al 2006; Speirs-Bridge et al 2010; Tversky and Kahneman 1974). This review also revealed the importance of providing visual feedback tools to the respondent in order to allow them to review and revise their responses (Allan et al 2010; Garthwaite et al 2005; Goldstein and Rothschild 2014; Morgan and Henrion 1990; Sperber et al 2013). Since the pilot survey was rolled out, the projections team has also been investigating the possibility of producing probabilistic population projections in the future. As a result, it was also considered necessary to obtain expert estimates in a format that could be utilized in the production of said projections. For instance, it would be necessary to combine the probability distributions from individual experts in some way; several different approaches (behavioural, axiomatic, Bayesian) are possible.

Taking into account these numerous demanding requirements, Statistics Canada recently launched a new tool to elicit the opinions and quantitative probabilistic estimates of demography experts regarding the likely future values of various demographic indicators. In addition to incorporating several best practices in elicitation, this survey meets several practical considerations: it is low cost, user-friendly, self-administered and has relatively low respondent burden. It also offers several innovative features which represent a step forward towards the better characterization of uncertainty in population projections. Using a small number of quantitative estimates provided by the expert, the elicitation tool produces a detailed and flexible probability distribution which can be asymmetric, non-parametric or unbounded in nature. The tool also offers the respondent a graphical validation of their inputs, taking advantage of the recent development of the *metalog* distributions by Keelin (2016). Critically, the tool allows experts to provide feedback on the elicitation exercise to ensure that their knowledge is captured accurately (Gosling 2014). Taken together, the features of this new elicitation tool offer a more scientifically sound approach to combining the views of multiple experts, which can be applied to any question about which there is considerable uncertainty. Figures 1, 2, and 3 below provide snapshots of selected portions of the new Microsoft Excel-based expert elicitation tool.

In the fall of 2018, a survey of Canadian demography experts will be completed using this new and improved tool, eliciting their views about the future levels of fertility, mortality, immigration and non-permanent residents in Canada. Results of this elicitation exercise and lessons learned will be available by March 2019.

Figure 1: Excerpt (1) from the 2018 Survey of Experts on Future Demographic Trends

NON-PERMANENT RESIDENTS

Note: If you don't feel you have adequate expertise in this domain to respond to this question, please click the "SKIP" button to move to the next question.

SKIP

STEP 1 - ARGUMENTS

Please indicate briefly some of the main factors (trends, theories, plausible new developments) that will likely influence the evolution of the number of non-permanent residents in Canada over the next 25 years. If possible, try to take into consideration a variety of possible future scenarios (an increase, decrease or status quo). Feel free to consider and analyze some historical data by clicking the adjacent "DATA" button.

DATA

Figure 2: Excerpt (2) from the 2018 Survey of Experts on Future Demographic Trends

STEP 2 - ELICITATION

Please answer questions a) to d) below using the highlighted cells to input your estimated values.

a) Please provide the lower and higher bounds of a range covering nearly all plausible values (in your opinion) of the number of non-permanent residents in Canada in 2043. There should be an equal probability in your mind that the true value lies below or above the range you provide.

Lower bound (L) Higher bound (U)

b) How confident are you that the range you created above will capture the true value? (note: typically confidence levels are over 90%)

Confidence

c) Within the plausible range you have provided, please estimate the median value, so that you expect there is an equal (50-50) chance that the true value lies above or below the median.

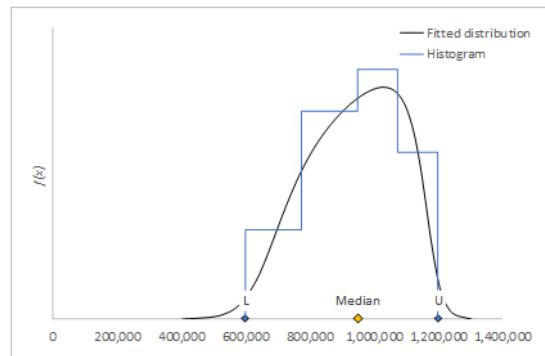
Median (M)

d) If the true value was to fall between the lower and upper bounds (with 100% certainty), what are the probabilities that it would lie within the following intervals of equal length?

Below the median			
Between 600,000 and 775,000 :	<input type="text" value="15.0%"/>	50%	100%
Between 775,000 and 950,000 :	<input type="text" value="35.0%"/>		
Above the median			
Between 950,000 and 1,075,000 :	<input type="text" value="30.0%"/>	50%	100%
Between 1,075,000 and 1,200,000 :	<input type="text" value="20.0%"/>		

STEP 3 - REVIEW INPUTS

Does the resulting visual representation below capture your views well? If not, you may want to try and revise your estimates provided in step 2.



NOTE: You should see two things in the graph above: a histogram providing a rudimentary representation of the values you provided, and a probability density function (pdf) fitted from the same values (note that the area under the curve and the histogram may not match and this is fine). Please review and adjust your inputs until you obtain a pdf that you feel represents your beliefs fairly accurately.

In some cases (e.g., bimodal or some extreme distributions), a pdf cannot be fitted by the algorithm in this worksheet. If a pdf is not shown, try to revise your estimates using the histogram as a reference. However, if you feel confident about your responses provided in step 2, or if you simply cannot obtain a pdf that accurately represents your beliefs (e.g., you intend to describe a bimodal distribution), please move to step 4.

Figure 3 : Excerpt (3) from the 2018 Survey of Experts on Future Demographic Trends

STEP 4 - OVERALL ASSESSMENT

Using the drop-down menu, please assess how well the graphical representation (pdf) represents your beliefs about the elicited value. If the pdf graph does not represent your beliefs well, please explain in what way in the comment box.

How accurate is the pdf as a representation of your beliefs?

Comments

NEXT

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