Using expert elicitation for building long-term projection assumptions

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Delivering insight through data for a better Canada

Context

- Most statistical agencies perform some kind of consultation with experts when designing their assumptions about the future
  - Among UNECE countries, 29 of 31 countries undertook some form of consultations in their recent projections, with 19 of them documenting the results[27]
  - The intensity and the format of these consultations vary a lot, from merely getting 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

Context

⇥ Motivation for survey

- Evidence that combining the views of a large group of informed individuals can increase accuracy[e.g., 2,22]
- More credible, more transparent and more consistent assumption-building process[14]
- Take into account information beyond historical trends[14]
- Increase the amount of information considered (outside our walls)
- Better documentation
- Strengthen ties with wider demography community

Context

⇥ What is *expert elicitation*?

- A structured approach to consulting experts on a subject where there is insufficient knowledge or uncertainty is great[12]
- Can be used to translate someone's judgement about uncertain events into something that can be usefully modeled[7]
- Offers greater transparency than other conventional statistical techniques in addressing uncertainties[12]
- Takes into consideration factors other than what has been previously observed[14]
- Most useful in situations where the evidence for mechanically estimating probabilities or distribution is lacking[10]

2013 Survey

- Survey completed in PDF or MSWord
- We requested that experts provide most likely estimates and high/low range representing 80% of possible future developments
- Various demographic indicators:
  - PTFR, CTFR, mean age of childbearing, life expectancy at birth for males and females, and immigration rate and number

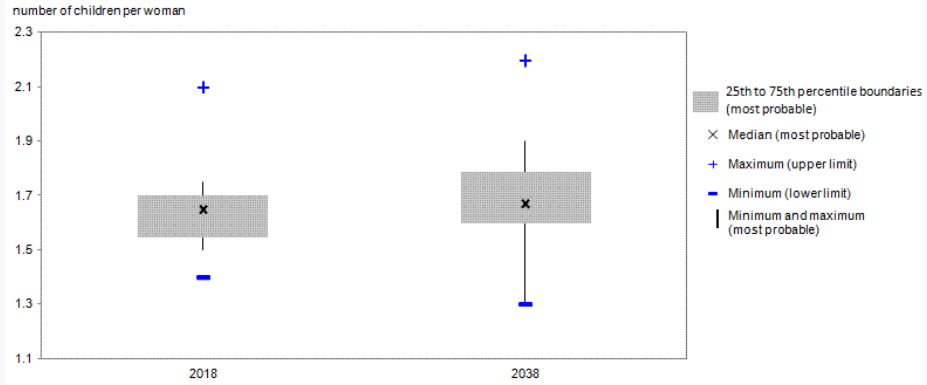
2013 Survey
→ Example of results

Results were documented in technical report, used in formulation of projection assumptions

Survey results

Respondents to the *Opinion Survey on Future Demographic Trends* gave their views regarding future levels of both period (PTFR) and cohort (CTFR) fertility in Canada. In terms of PTFR, respondents generally anticipated a slight increase. Specifically, the median responses of the most probable estimate of the PTFR were 1.65 children per woman for 2018 and 1.67 children per woman for 2038 (Figure 3.8).

Figure 3.8
Summary statistics from the 2013 *Opinion Survey on Future Demographic Trends*, estimates of the period total fertility rate in Canada in 2018 and 2038



Source: Statistics Canada, Demography Division.

Description for figure 3.8

Somewhat in contrast, respondents anticipated a slight decline in cohort fertility rates in the future. Compared to the most recently completed fertility rate of 1.81 children per woman for the 1962 cohort, the median survey responses to the most probable estimate of the completed fertility of the 1980 and 1990 cohorts were 1.75 and 1.78 children per woman, respectively (Figure 3.9).

2013 Survey

⇥ Conclusion

- 2013 survey contributed to improve significantly the transparency and documentation of our assumption-building process
- Overall, we feel this survey was a really great addition and we want to continue with it again for this round
- However, there is room for improvement:
  - Improve participation
  - Best metrics to ask
  - How to capture more information, more accurately
  - Best practices in expert elicitation processes

2018 Survey

Need for an expert elicitation meeting several criteria:

- Not using existing web platforms (e.g., Surveymonkey, googleforms)
- Low cost
- Simple
- Low respondent burden
- Self-administered
- Avoiding cognitive biases and heuristics[e.g., 10,13,19,23,24]
  - E.g.: Anchoring bias, confirmation bias, hindsight bias, representativeness bias, motivation bias

2018 Survey

⇥ Implementing best practices

- ✓ Use visual representations of probability distributions [1,5,6,19,26]
- ✓ Avoid eliciting parameters of a distribution (e.g., variance)[e.g., 5,8,21]
- ✓ Allow experts to give feedback on the elicitation exercise[7]
- ✓ Elicit tail probabilities carefully[25]
- ✓ Limit overconfidence[13,17]
- ✓ Allow for nonparametric fitting[5]
- ✓ Avoid elicitation of multivariate joint distributions[5,10]
- ✓ Pre-test elicitation materials[10,16]
- ✓ Careful selection of experts and self-assessment of expertise[8]

2018 Survey
⇥ Questionnaire

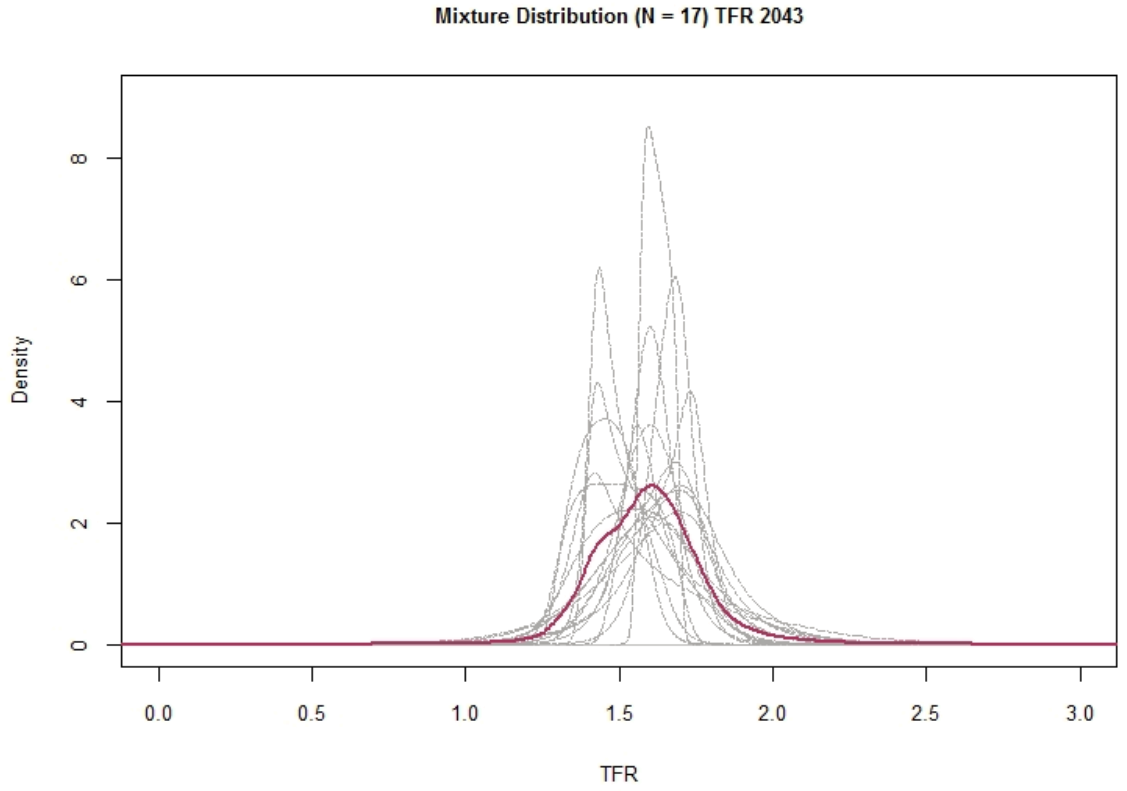
SURVEY DEMONSTRATION

Assumption building

⇥ Aggregation of responses

We adopted a mixture model approach (referred to as a “linear opinion pool” when applied to the context of expert elicitation).

The aggregate distribution for each component can be thought of as a weighted average of the individual expert distributions.



Assumption building

⇥ Short and long term integration

A short-term forecast is produced based on recent historical data.

Scenarios are built by interpolating the short-term forecast with a long-term trajectory based on experts' responses.

Logarithmic curves are used to to obtain wider opening in the short term from low and high trajectories
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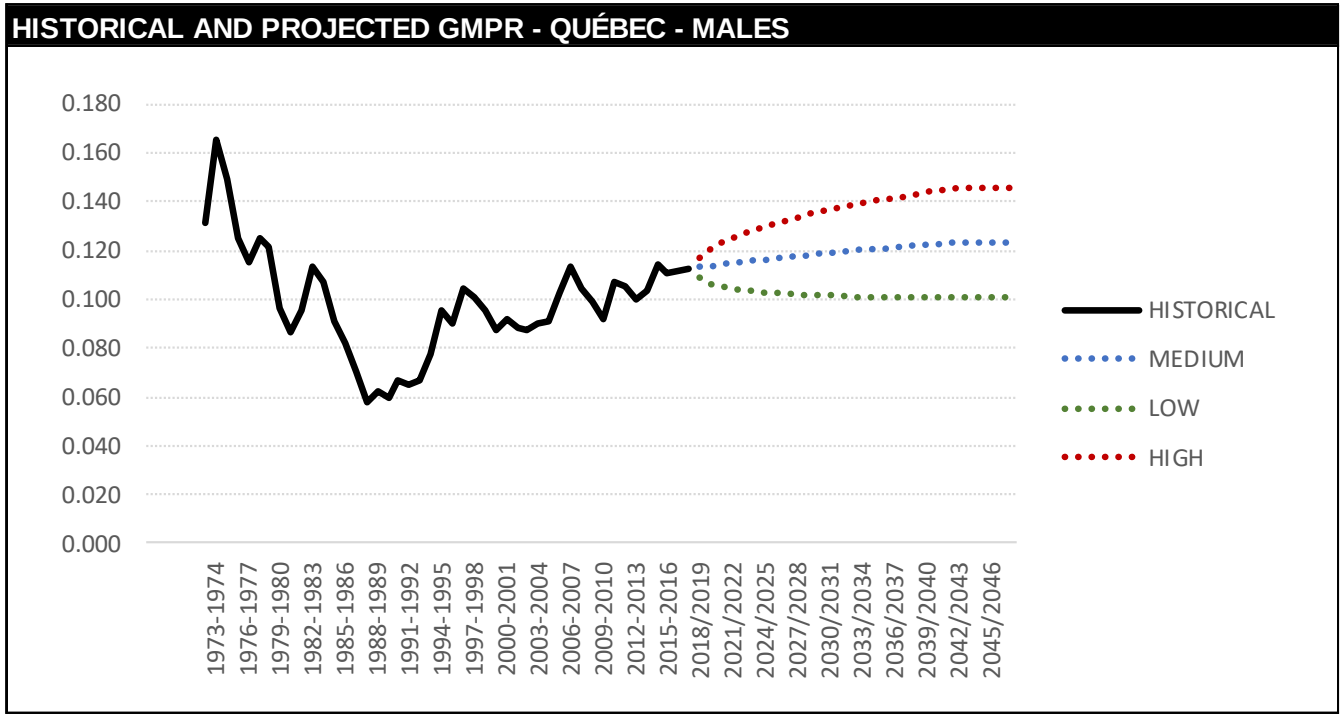


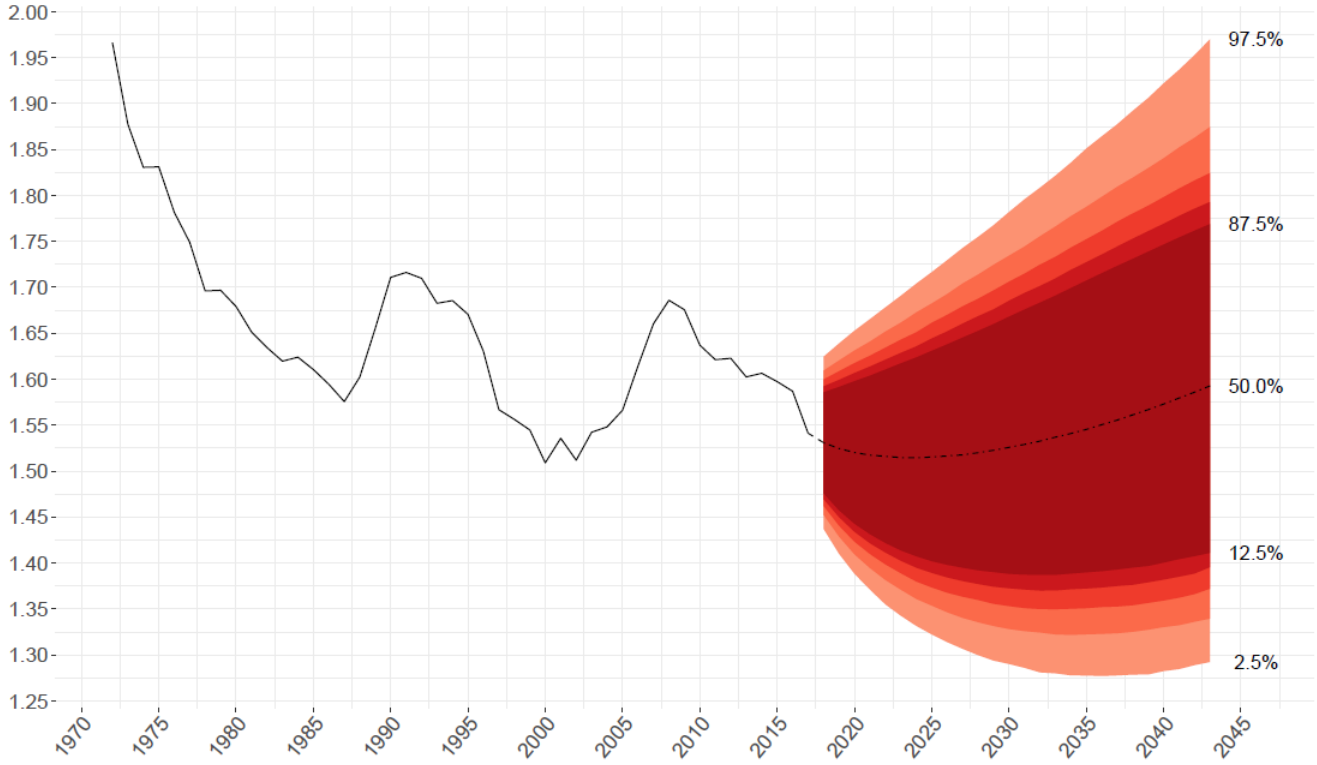
Application: Probabilistic projections

- Based on the modification of an existing method proposed by Lutz et al. (2001)
- Uses ARIMA models in combination with results from the survey to help inform time series parameters
- An overly-simplified model for a single demographic indicator (the PTFR) meant only to demonstrate the utility of the survey in the context of probabilistic projections

Application: Probabilistic projections

→ Forecast distribution of PTFR (2018-2043)

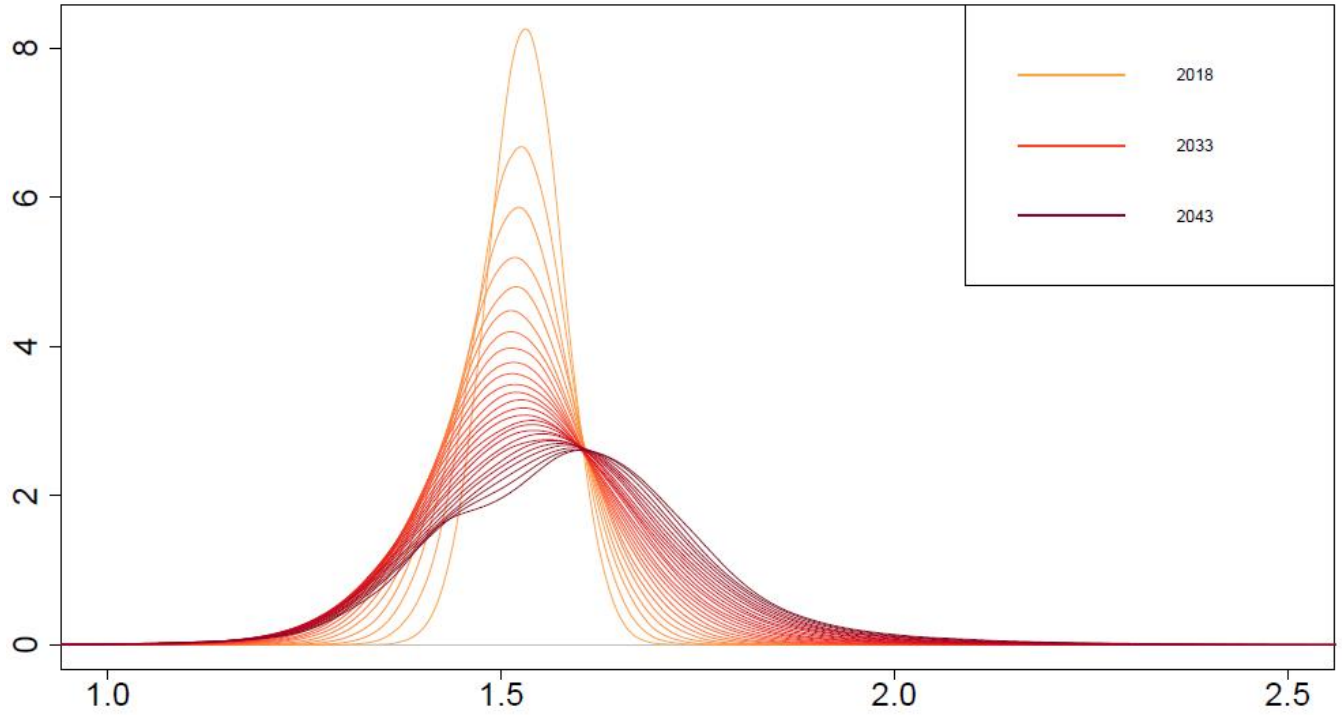
Based on an MA(26) model with parameters selected so that the distribution in the last year of the forecast (2043) is equal to the aggregate expert survey distribution.



Application: Probabilistic projections

⇥ Forecast distribution of PTFR (2018-2043)

The forecasted density in other years of the projection gradually transitions from (approximately) Normal to a density more similar to the expert survey density.



Conclusion

+ Our protocol provides probabilistic information about a parameter without forcing strong assumptions about its distribution (e.g., normality, bounded distributions).
+ Design helps to avoid cognitive biases. [e.g., 26]
+ The results improve the characterization of uncertainty in our (deterministic) projections, and could be used in the production of probabilistic projections.
+ Strengthen ties with community of experts.
- Use with caution: Simple models often outperform subjective judgement in terms of predictive performance.[18]
- Difficult to use without knowing the underlying autocorrelation structure.[15]

THANK YOU!
MERCI!

#StatCan100

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