How Might the Use of AI to Improve Life Expectancy Impact Traditional Actuarial Methods for Projecting Future Mortality?

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INTRODUCTION

Traditional actuarial methods, as well as many of the newer data-driven approaches for projecting future mortality rates, may not work well when there are potential disruptive new drivers like artificial intelligence (AI) that could significantly impact life expectancy in the future.

The key challenge is that most existing mortality projection methods rely primarily on extrapolating historical trends and patterns into the future. However, disruptive technologies like advanced AI have the potential to alter historical trajectories of mortality improvement in ways that past data cannot adequately capture.

Specifically, AI breakthroughs have the potential to enable radically new healthcare capabilities like highly accurate early disease detection and prevention, personalized treatment planning, improving drug discovery, and enhancing human longevity via wearables and robotics or human-AI integration.

These kinds of paradigm shifts could lead to faster declines in future mortality rates compared to what historical data would predict based on previous trends.

The existing mortality models may miss or underestimate the impact of AI because the AI-driven disruptions have no close analogues in the historical data that the models were trained on. The effects could play out in complex, non-linear ways that require fundamentally different modeling approaches. Solely relying on conventional actuarial techniques, which are focused on extrapolating from the past, will become increasingly inadequate for projecting future mortality.

Accounting for difficult-to-predict disruptive drivers remains an open challenge for mortality forecasting. There are also complications in deciding whether to update central best estimate assumptions, or whether the impacts should rather be allowed for economic capital assessments that are more focused on lower probability events. Monitoring technological developments will be crucial. To accurately model the sweeping influences of forces like AI, new prospective frameworks need to be considered.

WHY SHOULD ACTUARIES CONSIDER AI WHEN PROJECTING FUTURE MORTALITY?

Actuaries need to seriously consider the potential impacts of AI when modeling future life expectancy and actively decide how to include potential impacts of this technology. This is important for several reasons, including:

1. Longevity Risk Management - Life insurers and pension plans face major longevity risk if mortality rates decline faster than anticipated. AI-driven healthcare breakthroughs could significantly extend lifespan, causing reserves to be underfunded. Properly accounting for this risk is critical.

2. Medical Transformations - AI systems may achieve human-level or better abilities to understand biology, develop new drugs/treatments, and provide highly personalized precision medicine. This could accelerate improvements to mortality in ways that traditional methods miss.
3. Human Enhancements - Future AI capabilities could make it possible to directly enhance human biology through neural implants, genetic engineering, nanotechnology, and more. This blurs the line between medical treatments and human augmentation, impacting mortality in currently unpredictable ways. This could even lead to changes in the viability of certain insurance coverage, so understanding the potential impacts, even at a very high level, could be of critical importance when considering future strategy and risk management.
4. Change of Risk Factors - The disease burdens and risk factors driving mortality could radically change due to AI introducing new environmental exposures, disrupting socioeconomic systems, altering human behavior/lifestyles, etc.
5. Competitive Advantage - Taking a lead in proactively studying and modeling the cutting-edge intersections of AI and mortality could provide companies with a strategic edge over those who do not engage with this topic.
6. Reputation - The actuarial profession is highly regarded and offers valuable insights. Proactively studying AI's mortality impacts allows the actuarial profession to get ahead of a potentially seismic issue, reinforce its public reputation for foresight and analytical expertise, and position itself as an influential voice in managing technological disruptions.

There are potential limiting factors that constrain the impact of AI on extending human lifespan such as, technological hurdles, biological complexities, and important ethical considerations. However, given the tremendously high potential impact of AI as a potentially "longevity-enhancing" force, actuaries and insurers have strong incentives to put focused effort into understanding the potential impacts of this technology. Monitoring AI milestones may become as critical as tracking medical research. Actuaries need to consider the deficiencies of current modeling techniques for exploring this topic and making appropriate quantifications.

LIMITATIONS OF TRADITIONAL MODELING METHODS: WHY THESE CANNOT ADEQUATELY CAPTURE THE EFFECTS OF AI

Traditional actuarial methods for projecting future mortality rates have limitations when it comes to accounting for the potential impacts of disruptive technological forces like AI. While valuable for many applications, methods like the Lee-Carter model or deterministic alternatives that rely primarily on extrapolating past trends can struggle with the following issues:

- The "Precedent Problem" - Past data reflects mortality patterns driven by the social, economic, technological, and epidemiological conditions of previous eras. Projecting these historical patterns forward assumes an inherent continuity and stability in the underlying drivers of mortality changes. However, truly disruptive forces like radical new AI capabilities can fundamentally alter these drivers in unprecedented ways, invalidating that core assumption. This would render any projections that they make unreliable.
- "Horizon Bias" - Most modeling techniques are optimized for making short-to-medium term projections by capturing recent changes in mortality rates. But longer-term forecasts become increasingly uncertain, especially when anticipating potential disruptions whose timing is unknown. An AI breakthrough could rapidly reshape long-term mortality outlooks in uncertain, non-linear ways that models which are closely fitted to past experience won't capture.
- "Empirical Boundaries" - Historical datasets only reflect mortality within the constraints of existing healthcare quality, disease burdens, biological limits, etc. Potential AI-catalyzed innovations like molecular nanotechnology or brain-computer interfaces could expand human health spans into new empirical regimes. Existing approaches would be unlikely to be able to accommodate such a regime shift.

- "Linearity Assumptions" - Many forecasting models assume predominantly linear, incremental processes governing mortality change. However, technological discontinuities like artificial general intelligence could trigger highly non-linear, exponential changes diverging sharply from linear extrapolations of the past.
- "Endogeneity Problem" - Most methods treat past drivers of mortality as exogenous inputs. But technologies like AI are endogenous, self-reinforcing processes whose advancement rates can themselves be altered by the capabilities they enable, creating complex feedback loops. This acts to magnify the effects of the disruptive technology.

In essence, an over-reliance on backwards-looking empirical data alone can lead to failing to adequately anticipate and model the full scope of potential paradigm shifts, such as the introduction of transformative AI. While historical data remains valuable, new frameworks integrating technological insights and expertise are needed to more robustly forecast life expectancy impacts from AI innovations.

ALTERNATIVE METHODS THAT COULD BE USED TO MODEL THE EFFECTS OF AI

To better account for potential technological disruptions like transformative AI, new frameworks may be needed that can:

1. Incorporate expert opinion on the likelihood and timing of key technology changes.
2. Model scenarios explicitly around breakthrough AI capabilities such as highly personalized medicine and human enhancements.
3. Calibrate appropriate adjustments to mortality trajectories to model exponential changes.
4. Integrate diverse data sources beyond just historical mortality experience.

THE CASE FOR A DRIVER-BASED APPROACH

One possible route to consider is a robust driver-based modeling approach. This shows promise as an alternative to the traditional pure backward-looking extrapolation.

Rather than solely relying on fitting to past mortality data, a driver-based framework attempts to disentangle the specific factors influencing mortality rates, quantify their impacts, and then project each driver's future trajectory based on subject matter analysis and simulations. The driver projections are then combined and translated into a projection of future mortality rates. This can be done for specific causes of death, or in aggregate for all-cause mortality. The actuary can then consider whether these projections represent a low probability event that should be allowed for when estimating capital requirements, or an outcome that should be incorporated into the best estimate basis (and if so, to what degree).

While implementing a comprehensive bottom-up driver model is undoubtedly complex, this framework allows actuaries to disentangle transitory effects from more persistent forces redefining longevity trajectories. It facilitates structured sensitivity testing and more transparent assumption-setting compared to opaque adjustments of raw historical data. While this approach relies on more subjective assessments, these could well be more reliable than the output of a more traditional extrapolative approach, in this context.

A driver-based approach to setting mortality rates could better account for the potential impacts of AI. Explicit AI drivers can be included in the projections, aligned with the latest expert opinion on how the technology will develop. AI progress would be treated as an explicit factor influencing mortality rates, similar to how other drivers like smoking, obesity, etc. are currently modeled. Specific AI measures could include adoption rates of AI-enabled medical technologies or the benefits of AI systems deployed in the healthcare value chain to improve efficiencies in healthcare delivery.

Expanding risk factor modeling to include certain AI developments like human enhancement technologies could create entirely new risk factors impacting mortality that need to be accounted for in driver-based models. These new risk factors can be included in a driver-based approach in a relatively straightforward way.

Given the highly uncertain, non-linear impacts of transformative AI, driver-based models used to understand the impacts on future mortality should embed scenario analysis to explore the alternative possibilities. This would involve modeling different trajectories for AI progress—a slow "AI as tool" scenario versus a fast "general AI" disruption scenario for example. This would help demonstrate the plausible range of future outcomes. Given the rapidly evolving developments in the field of AI, frequent updates to the scenarios would be required in order to ensure that they remain relevant and realistic.

Overall, a driver-based framework provides the flexibility to explicitly integrate AI progress as a driver of future mortality outcomes, adjust for transition effects, embed scenario analysis, and expand the risk model as needed to capture AI's potential mortality impacts. This suggests that it could be a particularly effective approach for modeling the impact of AI on mortality.

A transition toward driver-based prospective forecasting should be viewed as an evolutionary journey for the actuarial profession, not something achievable overnight. Even the most advanced driver-based models will necessarily rely on some anchoring to historical data and require careful justification of all subjective judgments. Dynamic updating protocols and advanced data integration methods will be essential to ensuring driver-based models remain credible as new information emerges.

This may require an expansion of the actuarial skill set and knowledge base. Foreseeing AI-driven mortality impacts will require tighter integration between actuaries and experts across disciplines like healthcare, data science, economics, and public policy. Actuaries will need to leverage knowledge and skills from across disciplines when setting assumptions.

CONCLUSION

The actuarial profession needs to proactively account for the potential impacts of advanced AI on future mortality rates and life expectancy trends.

An over-reliance on modeling techniques that primarily extrapolate from historical data could leave significant blind spots. Transformative AI capabilities in areas like healthcare, human enhancement technologies, and accelerated scientific discovery have the potential to fundamentally alter mortality trajectories in ways not well-captured by past experience alone. While promising for the potential to extend lifespans, the effects of such disruptive forces may play out in complex ways that conventional modeling techniques will struggle with.

To address this, actuaries should explore complementing traditional backward-looking methods with alternative, more forward looking techniques such as driver-based modeling frameworks.

Accounting for the potential impact of AI and implementing robust driver-based models will be challenging—requiring expanded data sources, enhanced simulation capabilities, strengthened processes, and interdisciplinary collaboration across multiple fields. However, developing these adaptable frameworks is important for effective longevity risk management as the life insurance and pension fund industries navigate an era of accelerating technological change.

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