Robustness of the Cohort-Period Life Expectancy Gap under Model Uncertainty

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INTRODUCTION & AIM

Longevity risk is a key source of uncertainty for pension systems. When survival improves, retirees receive benefits for longer periods.

Life expectancy can be measured in two ways

Period life expectancy uses mortality observed in a given year.

$$e_x^P(t) = \frac{1}{2} + \sum_{k=1}^{\omega-x} {}_kp_x^P(t)$$

Cohort life expectancy follows real cohorts and includes future mortality improvements.

$$e_x^C(t) = \frac{1}{2} + \sum_{k=1}^{\omega-x} {}_kp_x^C(t)$$

This paper studies the **Life Expectancy Gap** at retirement age 67.The gap is defined as:

$$LEG_x(t) = e_x^C(t) - e_x^P(t)$$

We test the robustness of the LEG using GAPC forecasts combined through a stacked regression ensemble.

The contribution is to show whether the cohort–period gap, and the implied pension subsidy, remain stable across alternative forecasting models.

METHOD

We use Italian mortality data from **the Human Mortality Database**.

Mortality is forecast using **six GAPC models**:

Lee–Carter, APC, Renshaw–Haberman, CBD, M7, and PLAT.

Models are estimated on 1960–2007.

Forecasts extend the mortality surface beyond 2007.

$$\hat{\ell}_{x,t+h}^{SRE} = \sum_{m=1}^{M} w_m^{SRE}(h)\,\hat{\ell}_{x,t+h}^{(m)}, \qquad \sum_{m=1}^{M} w_m^{SRE}(h) = 1$$

The weights are **horizon-specific**.

Benchmark: performance-weighted averaging based on **SMAPE** over a validation window.

$$\xi_m = \frac{SMAPE_m}{\max_{q\in\mathcal{M}} SMAPE_q}, \qquad w_m^{BM} = \frac{\exp(-\xi_m)}{\sum_{\ell=1}^{M}\exp(-\xi_\ell)}$$

RESULTS & DISCUSSION

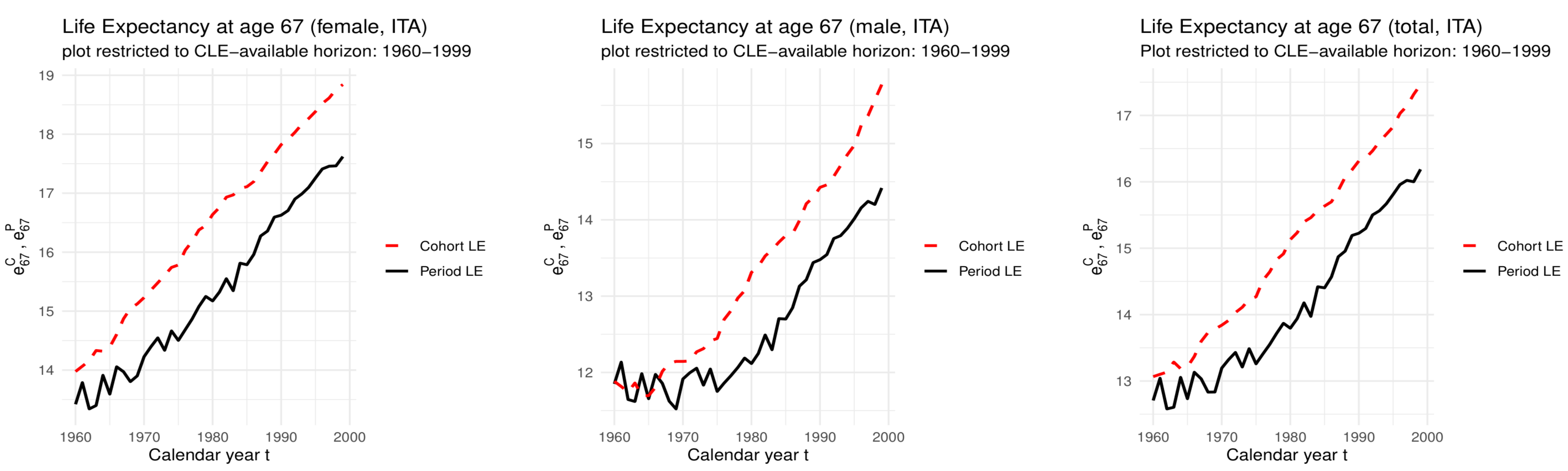

Figure 1. Period and cohort life expectancy at age 67 (SRE mortality surface).

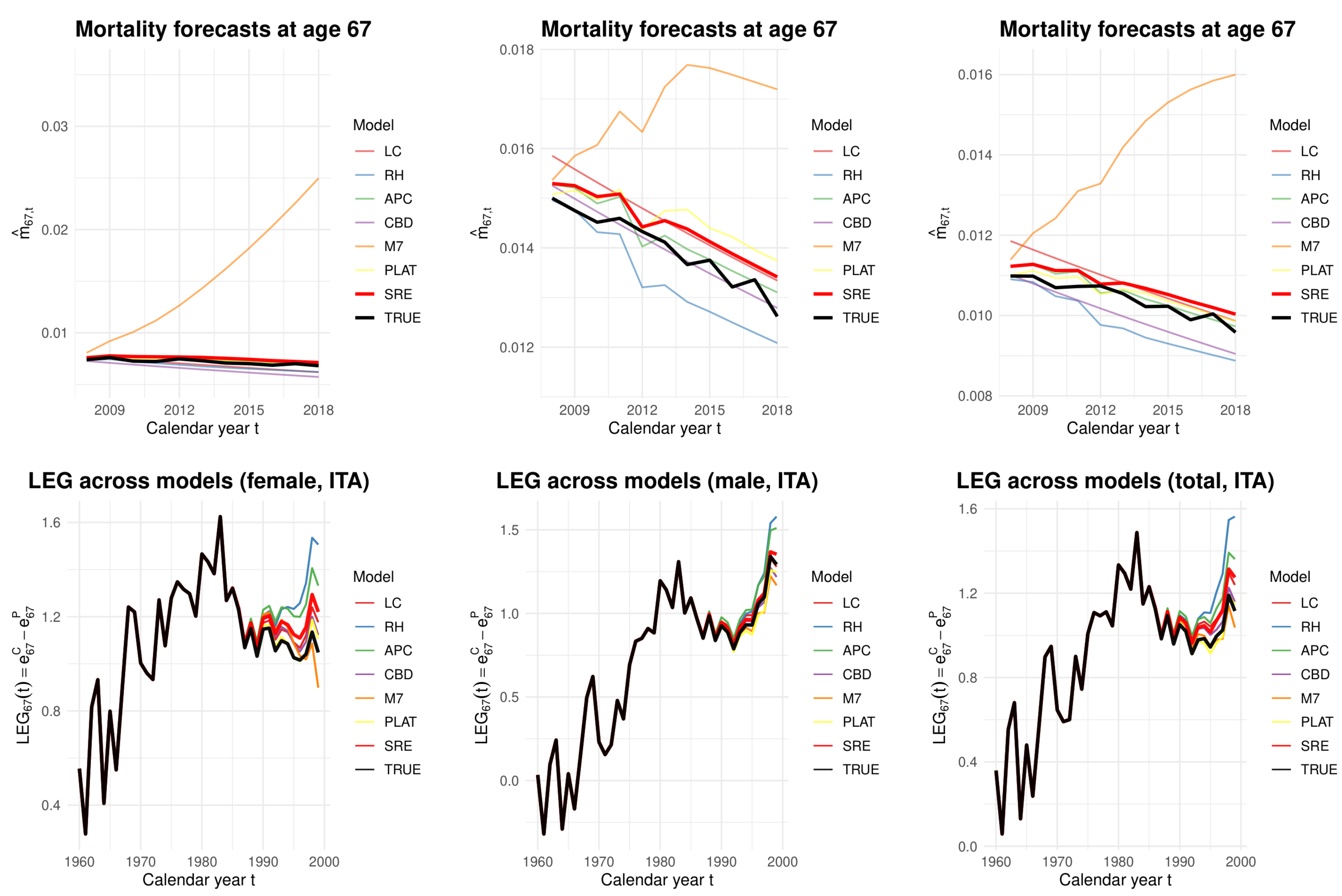

Figure 2. Model dispersion in mortality forecasts (top row) and in the resulting life expectancy gap (bottom row).

Main empirical signal

Cohort life expectancy exceeds period life expectancy for females, males, and the total population.

The resulting LEG is positive over the evaluation horizon and remains sizeable at retirement age 67.

Although mortality forecasts differ across GAPC models, the derived LEG is much more stable.

SRE and benchmark estimates are almost identical: absolute LEG differences are below 0.01 years.

Selected quantitative evidence (SRE)

Group	LEG 1980	LEG 1999	S 1999
Female	1.466	1.222	6.93%
Male	1.196	1.355	9.40%
Total	1.335	1.276	7.88%

Years of additional life implied by cohort rather than period life tables; implicit subsidy ratio:

$$S_{67}(t) = LEG_{67}(t) / e^P_{67}(t)$$

Interpretation for pension design

Positive $S_{67}(t)$ means that period tables understate expected pension duration, creating an implicit transfer toward current retirees.

The sign and magnitude of this transfer do not depend materially on the chosen forecast-combination method.

The policy-relevant object is therefore robust even when individual mortality forecasts are model-sensitive.

CONCLUSIONS

The cohort-period wedge is a persistent and economically meaningful feature of Italian longevity at age 67.

Model uncertainty affects mortality paths, but has limited impact on cohort life expectancy, LEG, and subsidy estimates.

Cohort-based longevity measures should be preferred in pension evaluation when mortality is expected to improve.

FUTURE WORK/ REFERENCES

Future work: extend the limiting age beyond 90; compare countries; include stochastic interest rates and annuity factors; report interval estimates for model and parameter uncertainty.

References: Ayuso, Bravo & Holzmann (2021); Bravo et al. (2021); Kessy et al. (2022); Human Mortality Database; Villegas, Kaishev & Millossovich (2018).