IMPERIAL

Dynamic Survival Modelling of Risk Credit Default

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"All models are wrong, but some are useful" (Box, 1976)

Research Question: How can (bio)statistical models be used to study and predict UK housing credit defaults?

Motivation

Survival Modelling

- Techniques typically employed in biostatistics to predict life expectancy

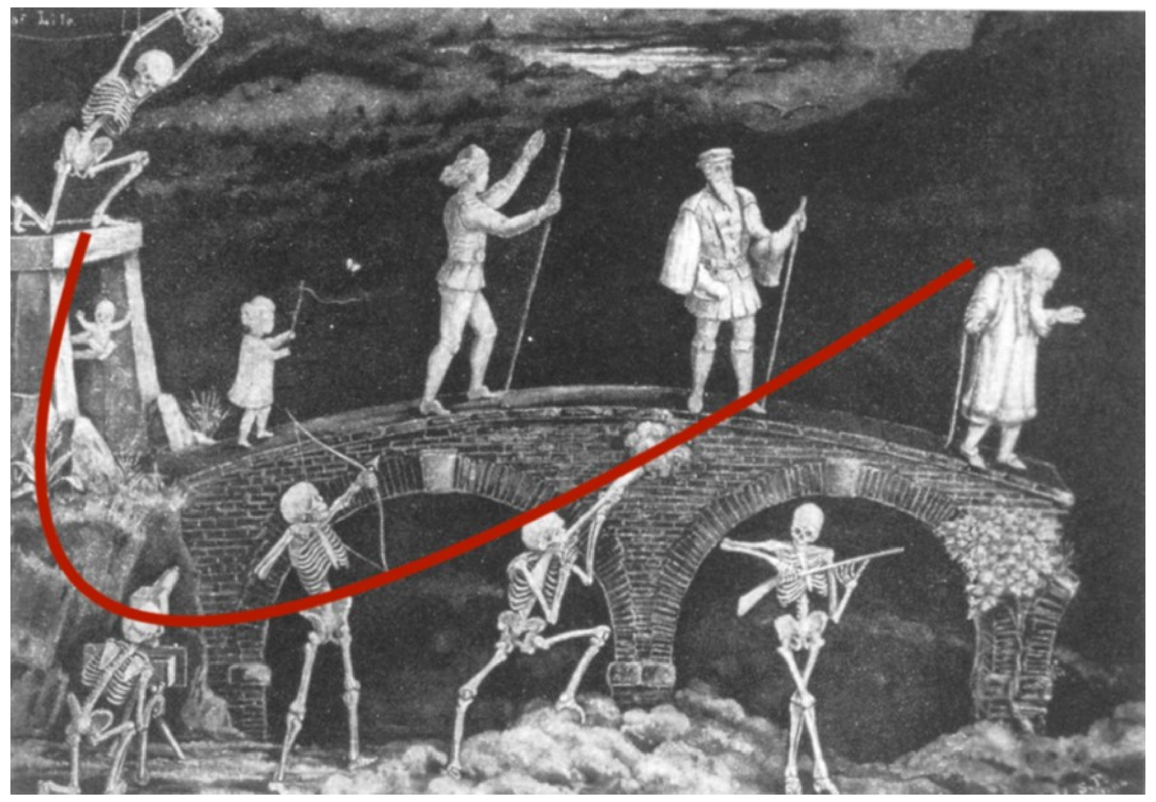


Figure 1: The Bridge of Life, Karl Pearson (1897)

$$h(t) = \lim_{\Delta t \to 0} \frac{P[t \le T < t + \Delta t \mid T \ge t]}{\Delta t} = \frac{f(t)}{S(t)}$$

Redefine the event as mortgage default

Simulated Data

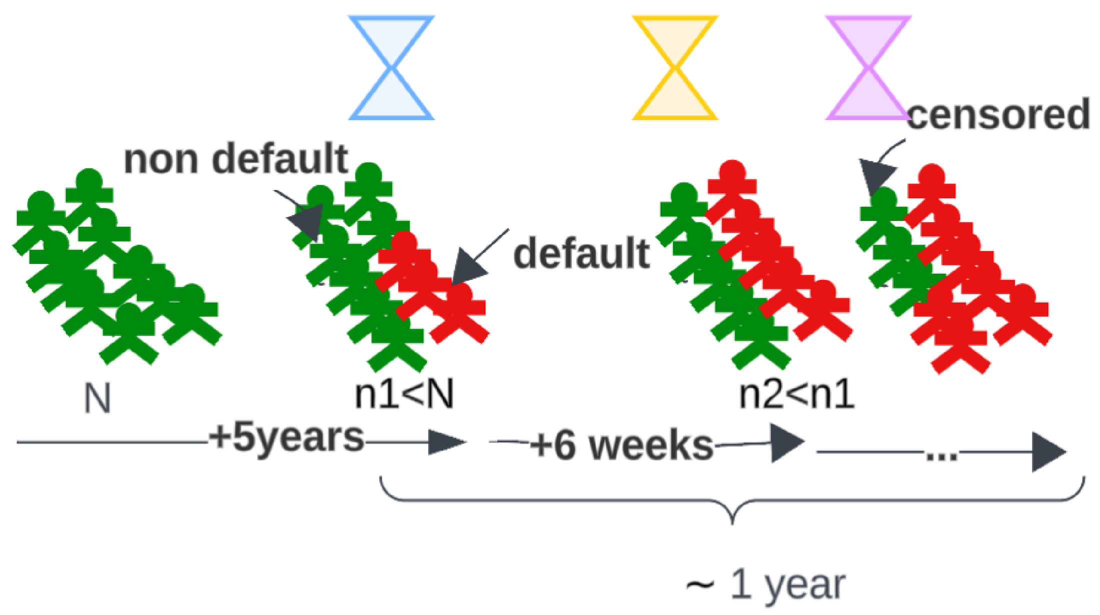
- Lack of available data (UK General Data Protection Regulation the Data Protection Act 2018)

Dynamical Modelling

- Dynamic behaviour of the Mortgage sector

SIMULATION

Generating times process



Simulated credit default

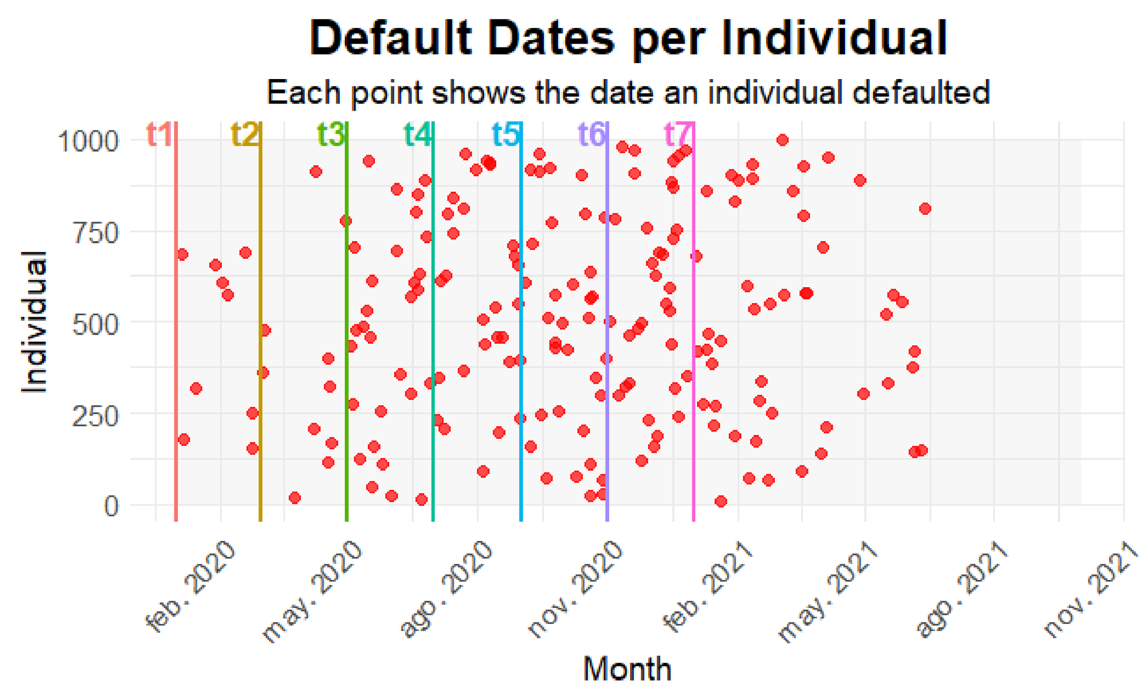


Figure 2: $N = 1000, a = 0.2$

Iteration	1	2	3	4	5	6	7
Events	29	40	23	27	29	13	33

- Times are simulated as in Rubio, F. J. (2019):

$$t_i = F_0^{-1}\left(1 - \exp\left(\frac{\log(u_i)}{\exp(\boldsymbol{x}_i^\top \boldsymbol{\beta})}\right)\right)$$

where $u_i \sim \text{Unif}(0,1)$ at t_1 with rescaling at each iteration and $F_0 \sim weibull(\theta_1, \theta_2)$ s.t $\Pr(t_k \le T < t_{k+1}) = a$

- Monte Carlo simulations, truncated distributions for set of covariates (rate, inflation, LTV, age)

MODELLING

Static (and time-varying covariates)

- **Proportional Hazards (PH) Model:** Assumes the relative effect of covariates is **constant over time**

$$h(t \mid \mathbf{x}_i) = h_0(t)\ \exp(\mathbf{x}_i^\top \boldsymbol{\beta})$$

- **Accelerated Failure Time (AFT) Model:** Covariates **accelerate or delay the event** of default.

$$h(t \mid \mathbf{x}_i) = h_0\Big(t \exp(\mathbf{x}_i^\top \boldsymbol{\beta})\Big)\ \exp(\mathbf{x}_i^\top \boldsymbol{\beta})$$

Pros: Easy to use, interpretable, widely available in standard software (R: *survival*, *fit.survreg*).
Cons: Static (does not update risk over time); cannot handle time-varying covariates; may miscalibrate when individual characteristics change.

Dynamic

- **Landmarking.** For $t \ge t_L$

$$h(t \mid T > t_L, \mathbf{x}_i(t_L)) = h_0(t \mid t_L)\ \exp\left(\mathbf{x}_i(t_L)^\top \boldsymbol{\beta}\right).$$

Pros: Captures changes in individuals' characteristics (dynamic).
Cons: Limited available software (R: *landmark**); no unique way of updating information; more difficult interpretation.

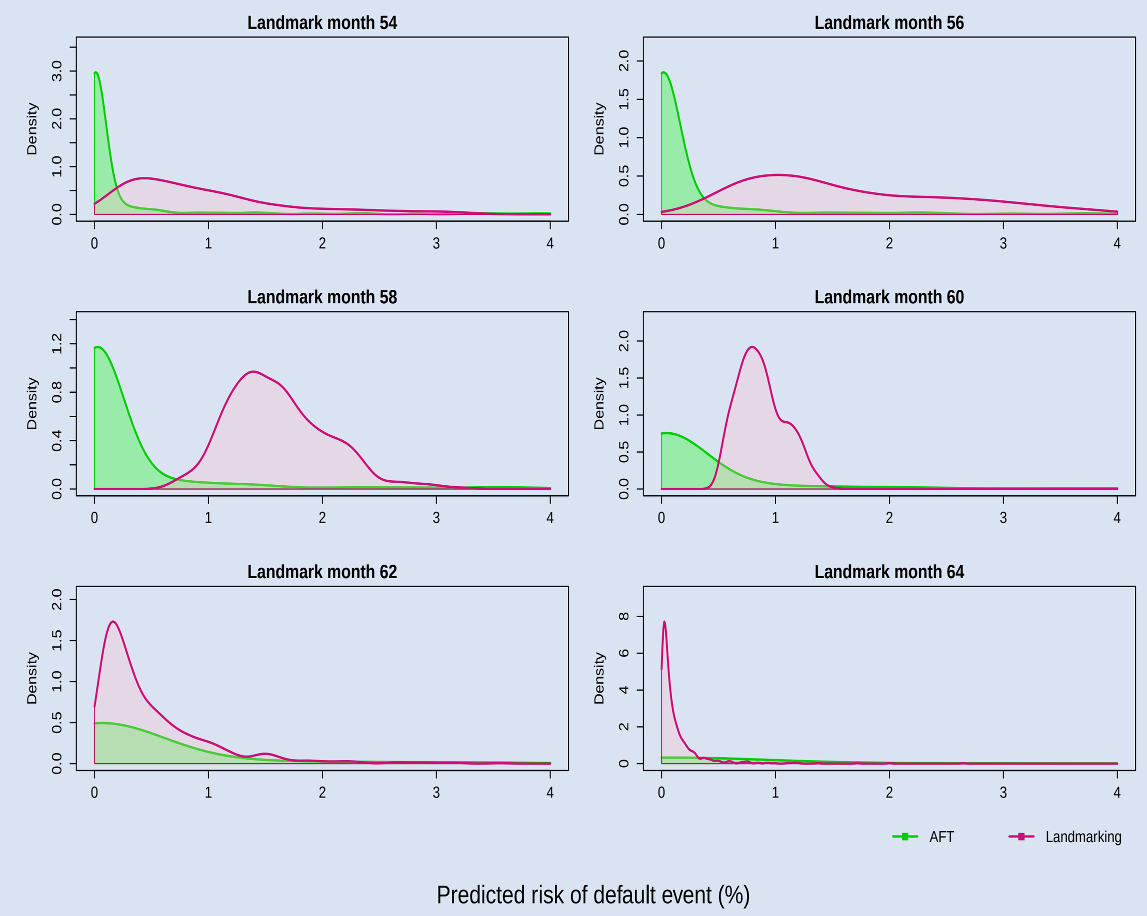
References

- Rubio, F. J. (2019). Simulating survival times from a General Hazard structure with a flexible baseline hazard.
- Campbell, J. Y., & Cocco, J. F. (2015). A Model of Mortgage Default. The Journal of Finance, 70(4), 1495–1554.
- Barrott, I. (2022). How to use the R package 'Landmarking'.

PREDICTION

Probability of Event Risk

Dynamic model adaptates in comparison to static model



CONCLUSIONS

- **Dynamic survival modelling for finance is a pioneering approach**, with limited literature currently available.
- **Limitations:** emulating real-world behavior remains challenging.
- **Future avenues:** improve data simulation and explore additional dynamic models for more realistic analyses.

Affiliations

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Collaborative Computational Modelling at the Interface