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Applying Bayesian Model Averaging to Characterise Urban Residential Stock Turnover Dynamics

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Abstract Building stock is a key determinant in building energy and China is the largest producer of CO_2 emissions and the largest consumer of energy and building energy, so any effective energy and climate policy will need to address this key driver of energy use. However, official statistics on total floor area of urban residential stock in China only exist up to 2006. Previous studies estimating Chinese urban residential stock size and energy use made various questionable methodological assumptions and only produced deterministic results. We present a Bayesian approach to characterise the stock turnover dynamics and estimate stock size uncertainties. Firstly, a probabilistic dynamic building stock turnover model is developed to describe the building aging and demolition process governed by a hazard function specified by a parametric survival model. Secondly, using five candidate parametric survival models, the building stock turnover model is simulated through Markov Chain Monte Carlo (MCMC) to obtain posterior distributions of model-specific parameters, estimate marginal likelihood, and make predictions on stock size. Finally, Bayesian Model Averaging (BMA) is applied to create a model ensemble that combines the model-specific posterior predictive distributions of the stock evolution pathway in proportion to posterior model probabilities. This Bayesian modelling framework and its results in the form of probability distributions of annual total stock and age-specific substocks, can provide a solid basis for further modelling and analysis of policy trade-offs across embodied-versus-operational energy consumption and carbon emissions of buildings in the context of sector-wide transitions aimed at decarbonising buildings.

Keywords building stock; lifetime distribution; Bayesian Model Averaging, Markov Chain Monte Carlo, embodied energy, operational energy; China

JEL Classification **C11, C61, O18, R21**

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