Second Annual Conference of EERIA

Predicting Non-life Insurance Segments in the Republic of North Macedonia: A Comparative Multi-Modelling Perspective

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Purpose

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Prediction is a vital but rather complex aspect of insurance, as it plays a significant role in managing risk for insurance companies. Insurance companies use predictive modelling techniques to estimate the likelihood of future events such as accidents, theft, and natural disasters that could result in claims. These models analyze historical data and use statistical algorithms to make predictions.

Premiums and claims have been previously analyzed and forecasted through an ARIMA setting (*2022*). Alternatively, an ergodic Markov model is considered a good approach in forecasting annual insurance premiums (*2018*), while claims prediction has been studied by Berridge (*1998*) and Dal Pozzolo (*2011*).

Our study builds upon these findings and notions, emerging as the first national study of such format dealing with insurance forecasting issues – comparing multiple modelling approach in their predictive performance.

Can we efficiently predict future development of the Macedonian non-life insurance?

Methods

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Statistical methods are compared to draw conclusions based on the series predictability and overall forecasting capabilities of various models, based on a univariate input.

Research hypothesis – The Seasonal ARIMA approach provides better forecasts of GWP, gross liquidated claims, technical premiums and number of contracts than the ETS models.

- Post-financial crisis analysis for the 2012Q1-2023Q2 period for the entire Macedonian non-life insurance sector.

- Training – Test split 90%:10% (2012M01 – 2022M04 : 2022M05 – 2023M06)

- Utilization of R and EViews for result obtaining.

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SARIMA(*p,d,q*)(*P,D,Q,m*)

$$y_t = \mu + \sum_{i=1}^{p} \alpha_i y_{t-i} + \sum_{j=1}^{q} \beta_i \varepsilon_{t-j} + \sum_{i=1}^{P} \mathrm{A}_i y_{t-mi} + \sum_{j=1}^{Q} \mathrm{B}_i \varepsilon_{t-mj} + \varepsilon_t \qquad (1)$$

ETS(*N,Md,M*)

Level equation:

$$l_t = \alpha\left(\frac{y_t}{s_{t-L}}\right) + (1-\alpha)(l_{t-1} + b_{t-1}) \qquad (2)$$

Trend equation:

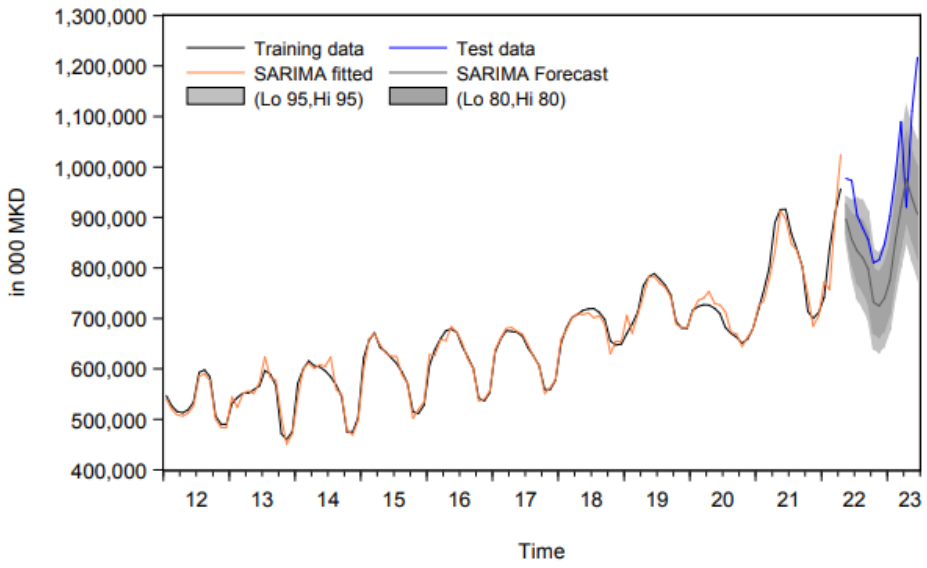
$$b_t = \gamma(l_t - l_{t-1}) + (1-\gamma)b_{t-1} \qquad (3)$$

Seasonal equation:

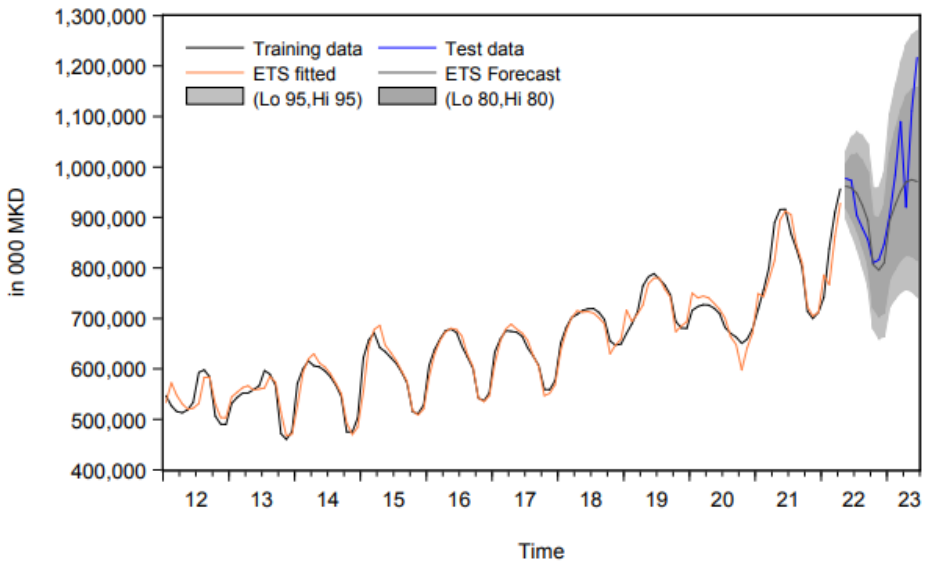
$$s_t = \delta\left(\frac{y_t}{l_t}\right) + (1-\delta)s_{t-L} \qquad (4)$$

Forecast equation:

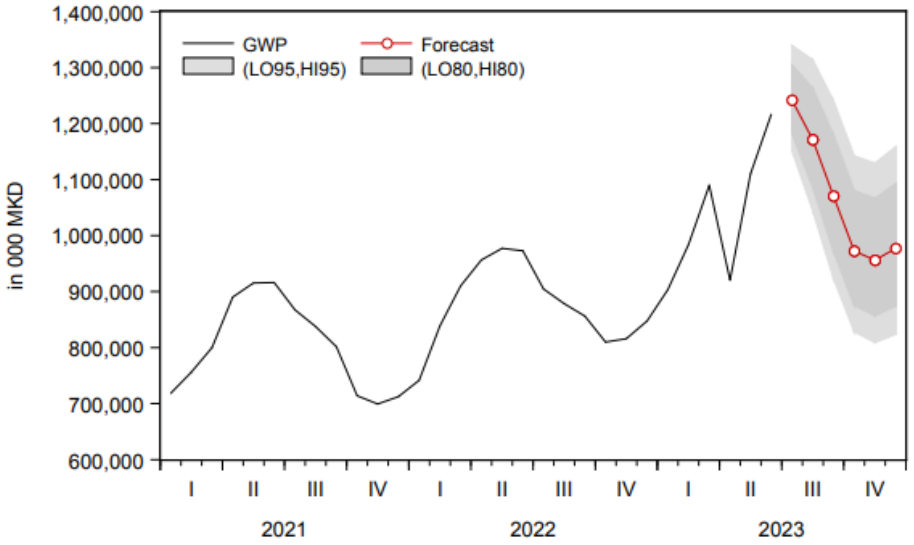
$$\hat{y}_{t+h|t} = (l_t + hb_t)s_{t+h-L(k+1)} \qquad (5)$$



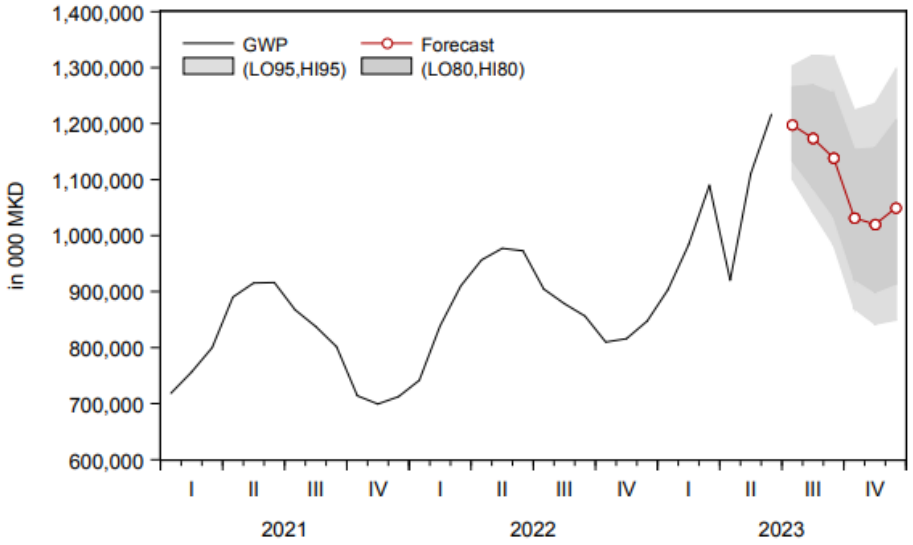
(a) SARIMA(1,0,2)(0,1,1,12) of GWP.



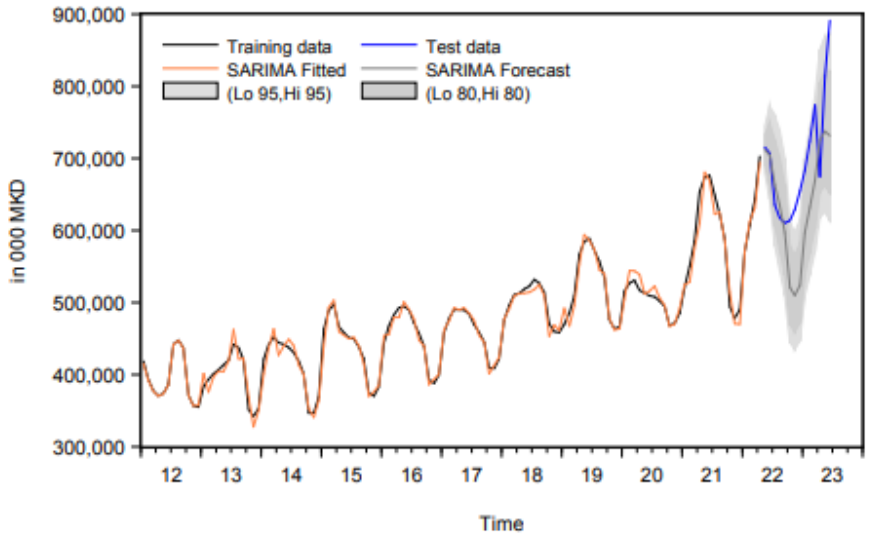
(b) ETS(A,Ad,A) of GWP.



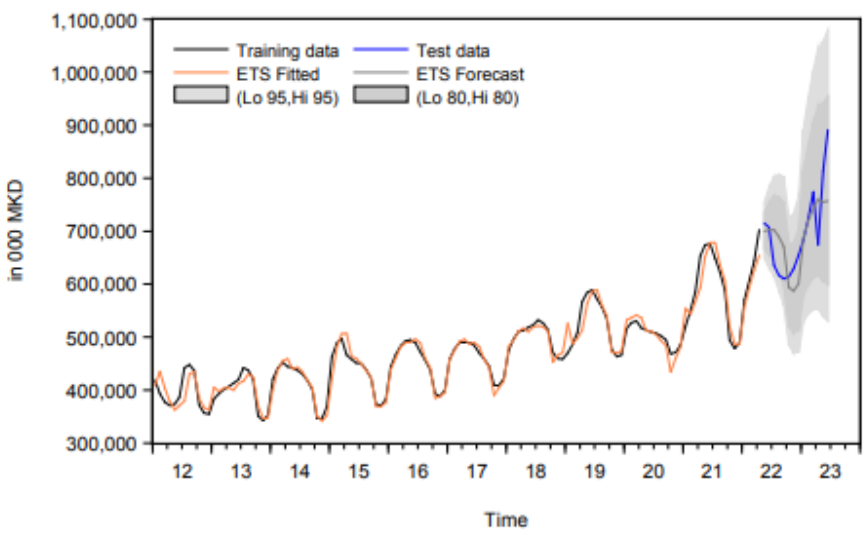
(a) ARIMA(1,1,3)(0,1,0,12) of GWP.



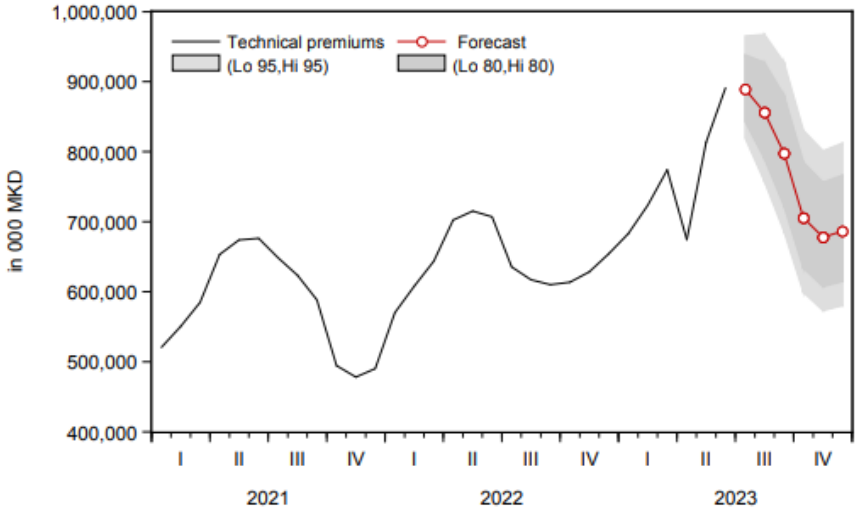
(b) ETS(A,Ad,A) of GWP.



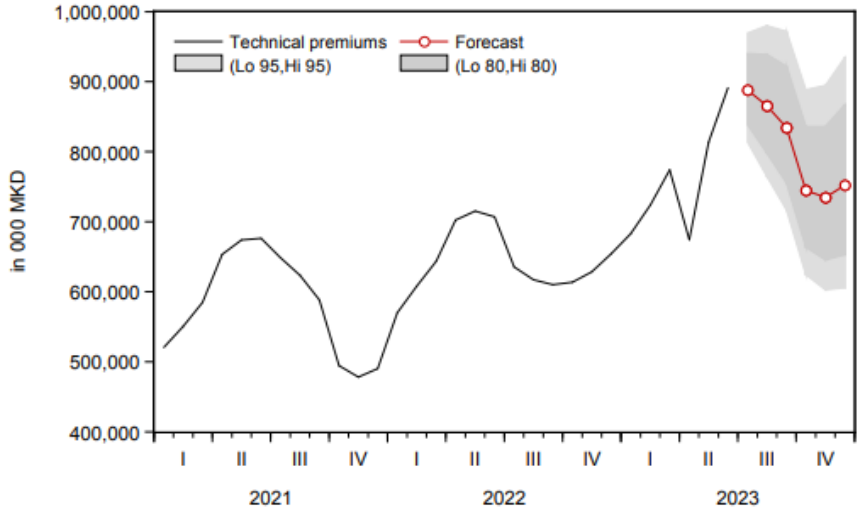
(a) SARIMA(4,1,4)(0,1,1,12) of technical premiums.



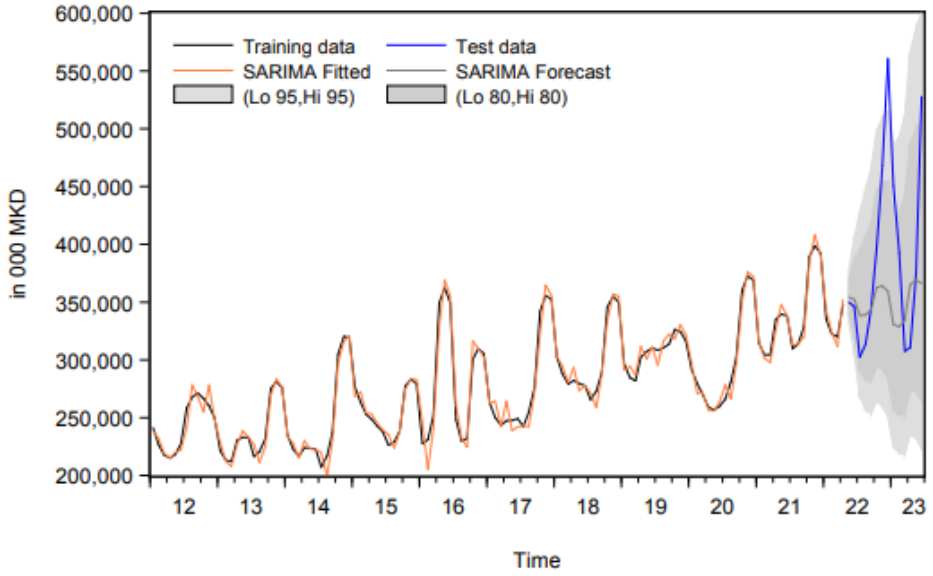
(b) ETS(A,Ad,A) of technical premiums.



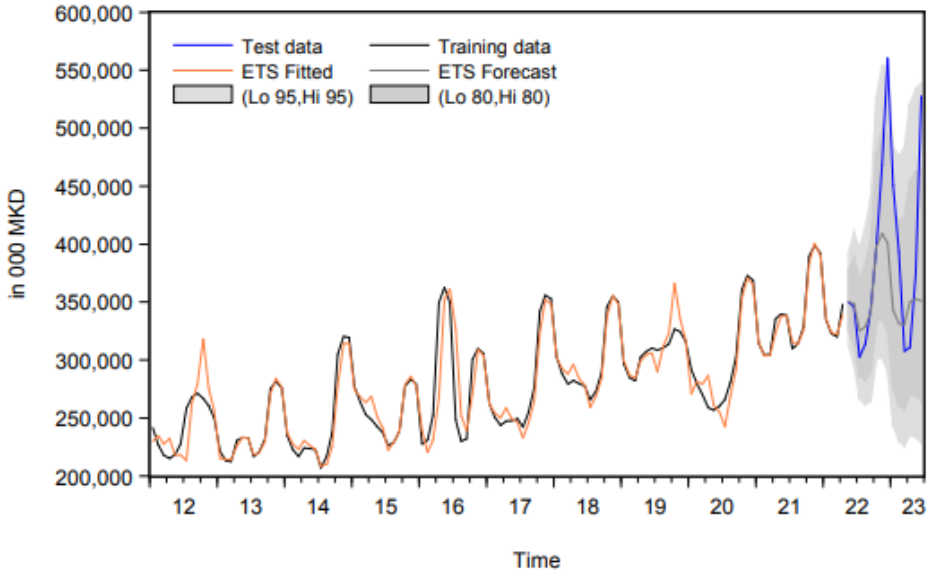
(a) ARIMA(3,1,1)(0,1,1,12) of technical premiums.



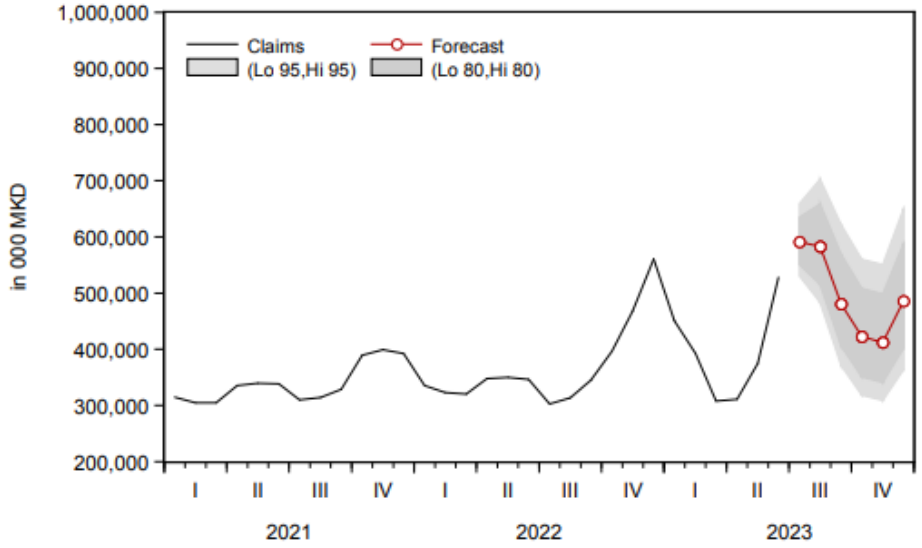
(b) ETS(A,Ad,A) of technical premiums.



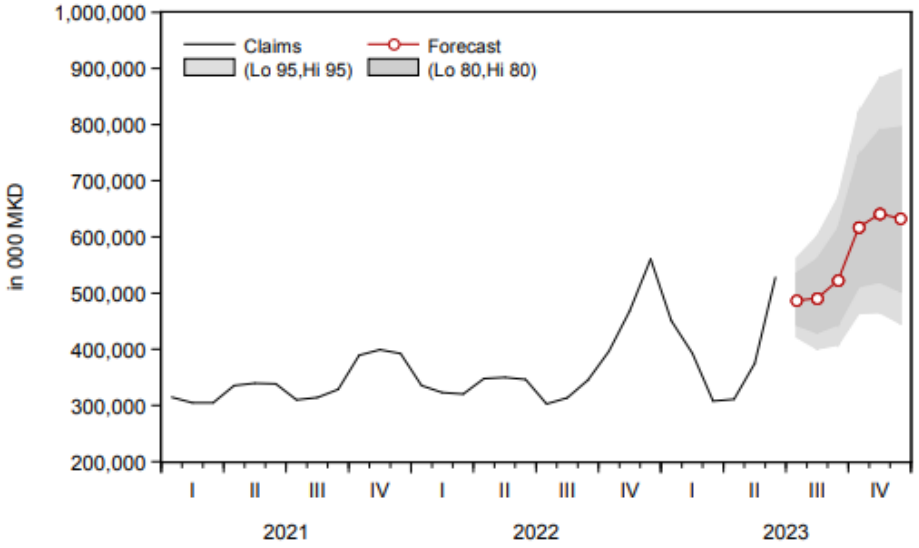
(a) SARIMA(3,1,2)(0,0,3,12) of claims.



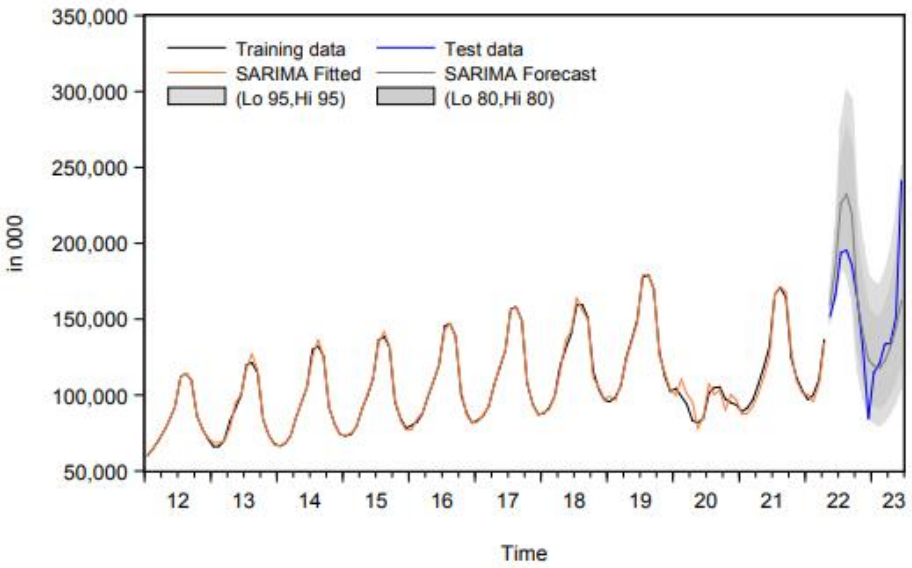
(b) ETS(A,Ad,A) model of claims.



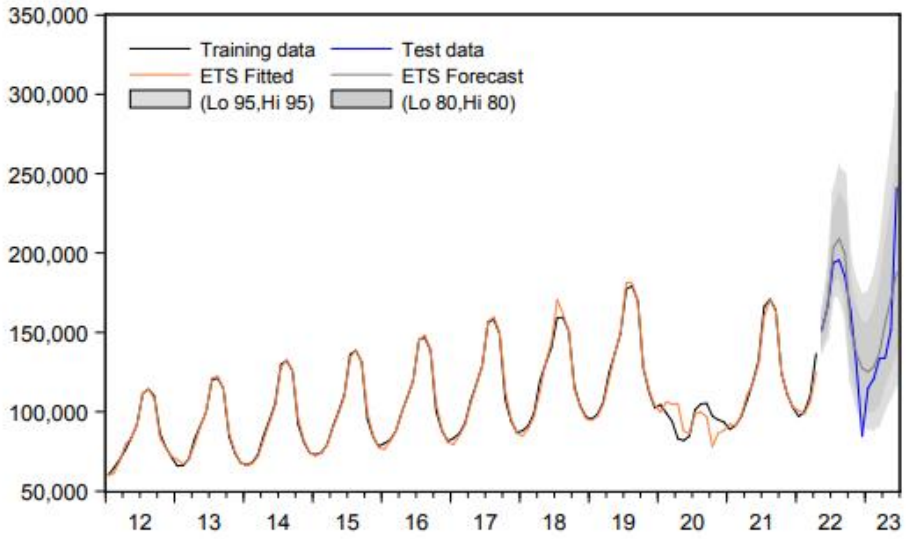
(a) SARIMA(3,1,0)(2,0,0,12) of claims.



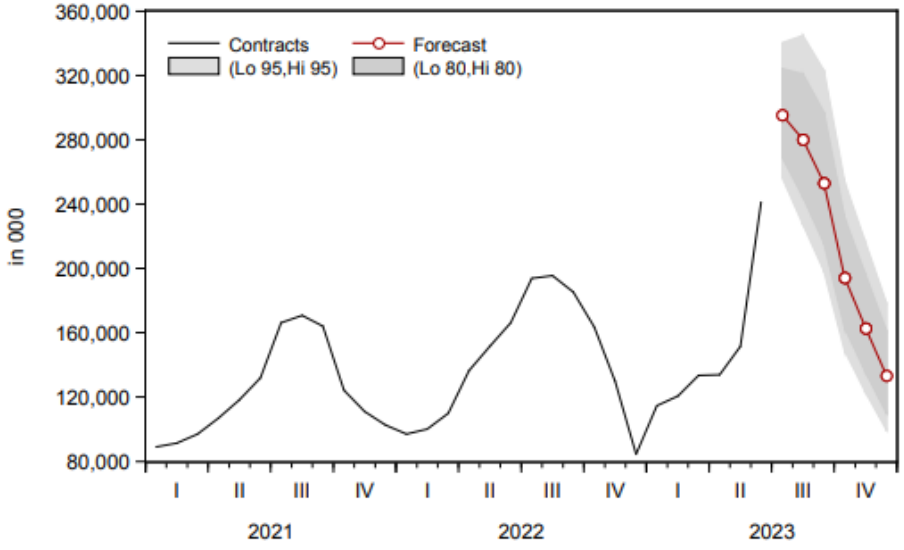
(b) ETS(A,N,A) of claims.



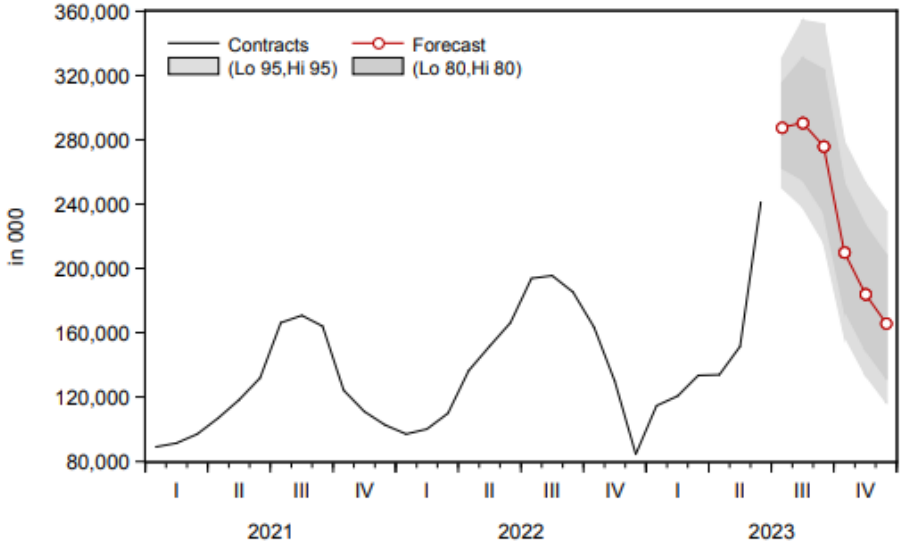
(a) SARIMA(6,1,1)(2,1,0,12) of contracts.



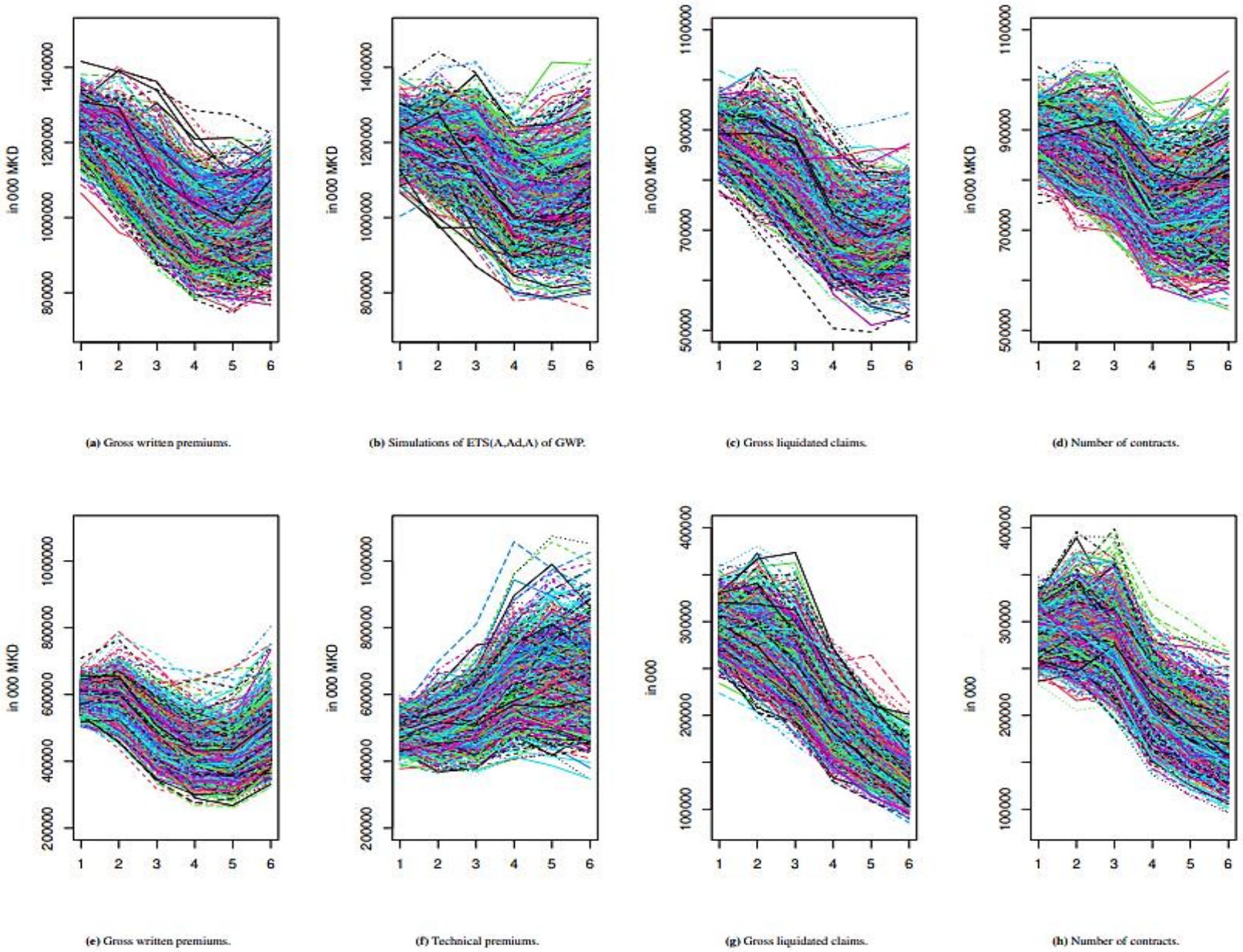
(b) ETS(A,Ad,A) of contracts.



(a) SARIMA(1,0,1)(0,1,1,12) of contracts.



(b) ETS(A,Ad,A) of contracts.



(a) Gross written premiums.

(b) Simulations of ETS(A,Ad,A) of GWP.

(c) Gross liquidated claims.

(d) Number of contracts.

(e) Gross written premiums.

(f) Technical premiums.

(g) Gross liquidated claims.

(h) Number of contracts.

FIGURE B2 Thousand six step ahead simulations of GWP, technical premiums, claims and contracts based on estimated models.

Conclusion

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Variable	Model	AICc		RMSE		MAPE		MASE	
		Train	*Test*	*Train*	*Test*	*Train*	*Test*	*Train*	*Test*
GWP	SARIMA(0,1,2)(0,1,1,12) with drift	-503.17	Inf.	16318.2	27790.2	1.565%	1.864%	0.232	0.101
	ETS(A,Ad,A)	-207.98	n.a.	21333	n.a.	2.269%	n.a.	0.329	n.a.
Technical prem.	SARIMA(4,1,4)(0,1,1,12) with drift	-501.78	Inf.	10118.8	16289.8	1.5%	0.915%	0.217	0.053
	ETS(A,Ad,A)	-188.17	n.a.	17096.7	n.a.	2.394%	n.a.	0.347	n.a.
Claims	SARIMA(3,1,2)(0,0,3,12)	-458.8	2.02	8093.3	45835	2.288%	8.075%	0.208	0.315
	ETS(A,Ad,A)	-62.66	n.a.	15278.5	n.a.	3.118%	n.a.	0.285	n.a.
Contracts	SARIMA(6,1,1)(2,1,0,12)	-428.07	-1.12	2976.7	11728.5	1.899%	1.761%	0.151	0.102
	ETS(A,Ad,A)	-152.1	n.a.	4007.28	n.a.	2.293%	n.a.	0.175	n.a.

Conclusion

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Out of sample forecasting

Variable	Model	AICc	RMSE	MAPE	MASE
GWP	SARIMA(1,1,3)(0,1,0,12)	-453.03	32361	2.071%	0.309
	ETS(A,Ad,A)	-166.25	32312	2.532%	0.357
Technical prem.	SARIMA(3,1,1)(0,1,1,12)	-426.78	24616.4	2.432%	0.343
	ETS(A,Ad,A)	-154.71	24411.5	2.672%	0.366
Claims	SARIMA(3,1,0)(2,0,0,12)	-390.64	18957.8	3.847%	0.368
	ETS(A,N,A)	-22.3	24128	3.971%	0.380
Contracts	SARIMA(1,0,1)(0,1,1,12)	-288.08	8967.1	3.123%	0.248
	ETS(A,Ad,A)	-26.7	8715.6	3.411%	0.267

Conclusion

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The SARIMA and ETS exponential smoothing models offer a robust framework for predicting non-life insurance segments in North Macedonia.

The SARIMA models offer more accurate predictions compared to the ETS models, both on in-sample and out-of-sample forecasting.

The exponential smoothing predictions offer larger prediction intervals, thus containing higher proportion of GWP, technical premiums, claims and contracts dynamics into the 80-95% area.

THANK YOU FOR YOUR ATTENTION