Exploring the performance of Test Statistics of Time Series Outlier Detection: Evidence from Robust Estimation Methods

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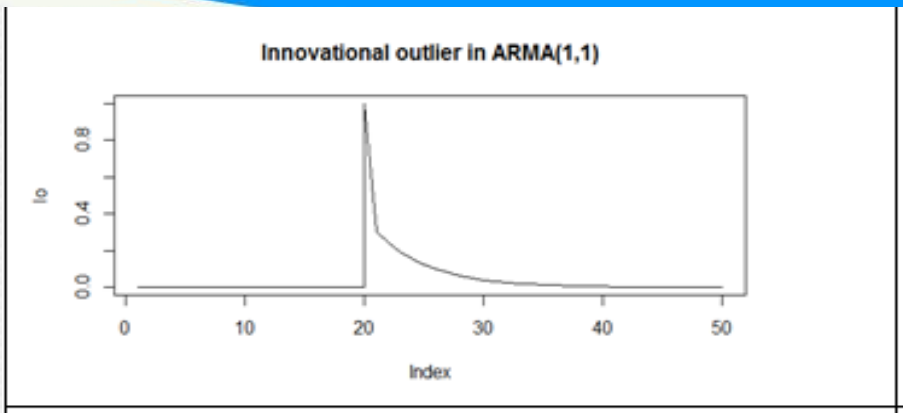
Introduction about outliers

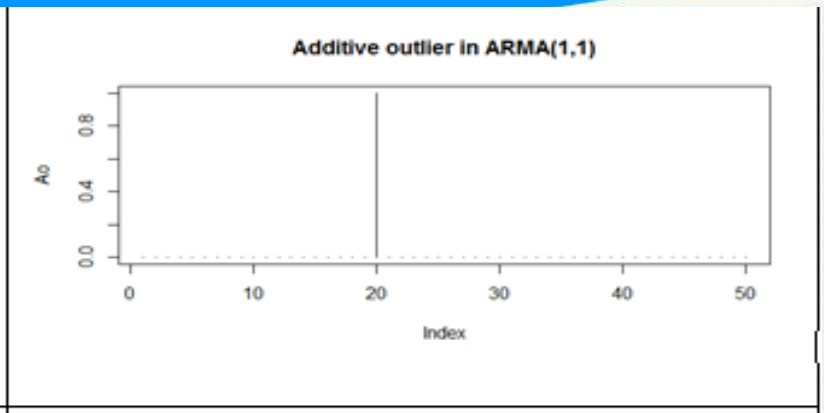
- An outlier is an observation which behaves differently from the remaining data set(Grubbs.1969)
- The abrupt changes and sudden variations that occur all over the globe in the financial markets is one of the reason of becoming an outlier in the series

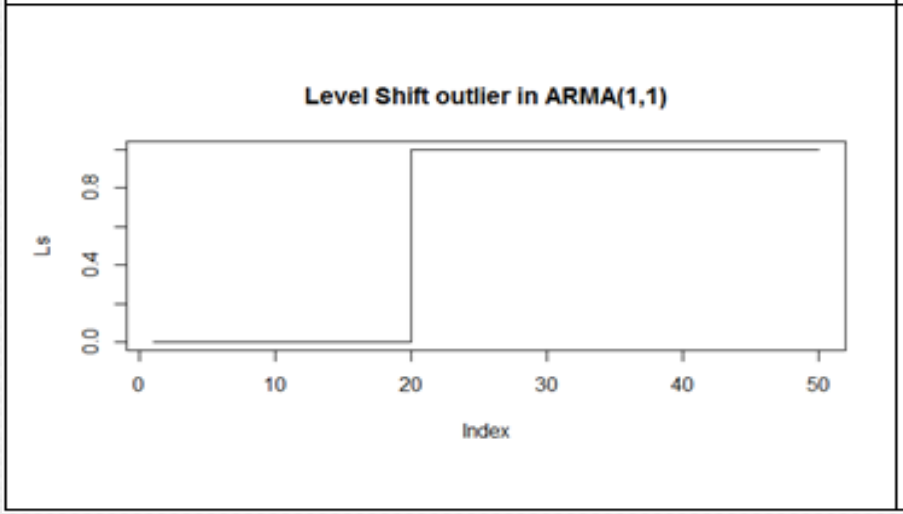
Types of Outlier

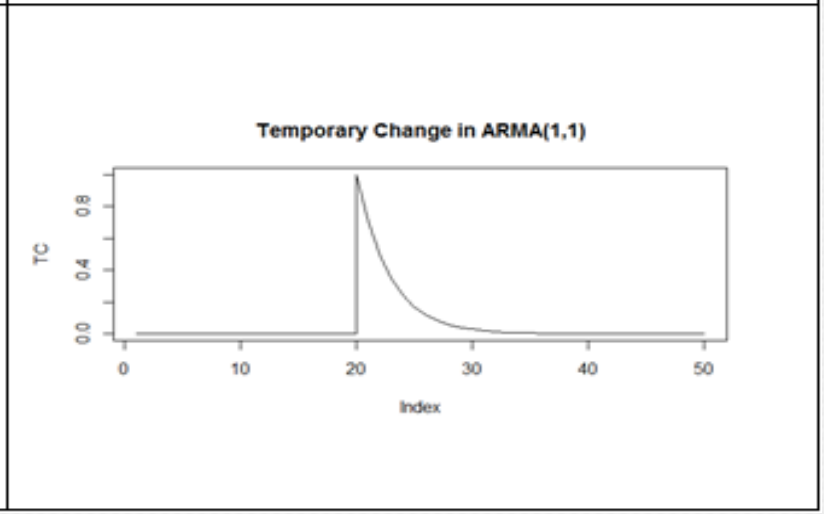
- Fox (1972) enhanced this concept to the time series outlier in time-dependent series and classified them into two types; one affecting only a single observation and another type of outlier affecting the succeeding observation as well.
- Tsay (1988) explores two types of outliers, considering the sensitivities of the unexpected changes in the series.
- In time-series literature, three types of outliers need to be widely discussed named as Additive outlier (AO), Innovational Outlier (IO), and Level Shift outlier (LS).

Graphically









Earlier Studies

- Balke and Fomby (1991 and 1994)
- Chen and Liu (1993)
- Fischer and Planas (1998)
- Tolvi (2001)
- Urooj and Asghar (2017)
- Urooj and Asghar (2020)

Objectives of Study

- The foremost objective is to investigate the robust scale measure for the estimation of residual standard deviation, unlike the seminal studies of Chen and Liu (1993), Tsay (1986) and recent studies of Urooj and Asghar (2017; 2020) and Urooj (2016).
- To obtain the residuals of the data generating process, the parameter will not be estimated by classical Maximum Likelihood estimation (MLE) as these estimates are biased toward the asymmetric distribution; thus robust filter proposed by Bianco (2001) has been employed to analyze the sampling behavior and probability of diagnosis the type of outlier.

Methodology

- 1) **Scale Estimators**
- $MAD = c\,median\,\left|\mu_j - median(\mu_j)\right|$
- $Q_n = c\{\left|\mu_j - \mu_k\right|\}; j < k\}(p)$
- $S_n = c\,median\,\{median\left|\mu_j - \mu_k\right|\}$

Robust REGARIMA Model

- $Q_t(\beta, \lambda) = \sum_{T=t^*+1}^{T} \log^{f()}(a^2_t(\lambda)) + (T-t^*)\log(s^2(\frac{u_{t_{2+}1}(\beta,\lambda)}{a_{t_*+1}(\lambda)} \ldots\ldots \frac{u_t(\beta,\lambda)}{aT(\lambda)}))$ ----(1)
- Where s is a τ –estimates of a scale

Iterative Algorithm

- Estimate a filtered τ-estimators the parameter β, λ and σ_u the estimates of these parameters are represented by βcap, λcap and σ_u cap respectively.
- Compute the residuals of the regression. Using the estimate λcap , spread over the robust filter to δ_t.This produce the weight w_t, scale measure s_t and filtered residual u_t.
- For making the method affordable ,a initial set of outliers position should be determined in the following manner:
- $|u_{t0}| > M_t s_{t0}$ =

Where M_t is constant.

Simulation Results

Methods	Classical	Robust	Classical	Robust	Classical	Robust	Classical	Robust
C/Type	IO		AO		LS		TC	
2.0	55%	80%	13%	68%	67%	96%	73%	70%
2.5	36%	95%	48%	96%	46%	73%	30%	93%
3.0	21%	94%	12%	73%	44%	71%	34%	80%
3.5	34%	98%	60%	80%	65%	78%	87%	96%

Conclusion

- The proposed robust estimation with MAD residuals are performing better than traditional MLE method.
- It has been revealed that sample size is the key element while selecting the critical value for selection of particular outlier.
- The percentage of correct detection of outlier and its type with the location is also sensitive to the method of estimation.

Continued

- Out of the three scale estimators of estimating the residual standard deviation, the efficiency of MAD is more obvious for the ARMA process.