ERCP Single Series Interrupted Time Series (ITS) with Segmented Regression Supplemental File June 2024

STATISITCAL ANALYSIS

Monthly counts of avoidable stent were also extracted between January 2020 to June 2022. To estimate the intervention effect, an interrupted time series (ITS) with segmented regression analysis was performed to determine if the change was statistically significant. 'A time series is a continuous sequence of observations (values) on a population, taken repeatedly over time'[1]. When an intervention is introduced in a defined time period, it interrupts the time series, allowing for the identification of change in level (the value at the beginning of the segment in series) and trend (slope of the line) before and after an intervention[1-4]. Statistical analysis was performed using SAS Enterprise Guide 8.3 and AUTOREG procedures for ITS analysis. The approach used was to estimate the shifts in avoidable stent counts before and after the intervention.

RESULTS

Test statistics for the regression model suggested that the data had positive autocorrelation (Durbin-Waston (DW)=1.623, P-value<DW=0.0472 & P-value>DW=0.95), and data was stationary (p-value (Dickey-Fuller test) =0.0127). Autocorrelation function (ACFs) and Partial autocorrelation function (PACF) were used to identify the number of significant lags, where a lag is the number of time points between an observation and its previous values. As a result, AR (1) model was employed for this analysis. Table 7 shows the parameter estimates from ITS regression. Before the beginning of the observation/intervention period, the number of avoidable stents was 6.3. During pre-intervention period, the regression slope was -0.03 and showed no significant month-to-month change (p-value=0.825). The post intervention timeframe showed that immediately following the intervention, counts of avoidable stents significantly dropped by 6.1 (p-value=0.0088). The post-intervention timeframe indicated no significant change in the month-to-month trend/slope after intervention (p-value=0.3051) suggestive of sustained reduction.

Table 1. ITS Regression Estimate

Variable	Estimate	SE	t Value	P-value
Intercept (Level)	6.29	1.49	4.22	0.0003
Pre-Intervention (Slope)	-0.03	0.15	-0.22	0.8250
Intervention (Level)	-6.13	2.16	-2.84	0.0088
Post-Intervention (Slope)	0.26	0.24	1.05	0.3051

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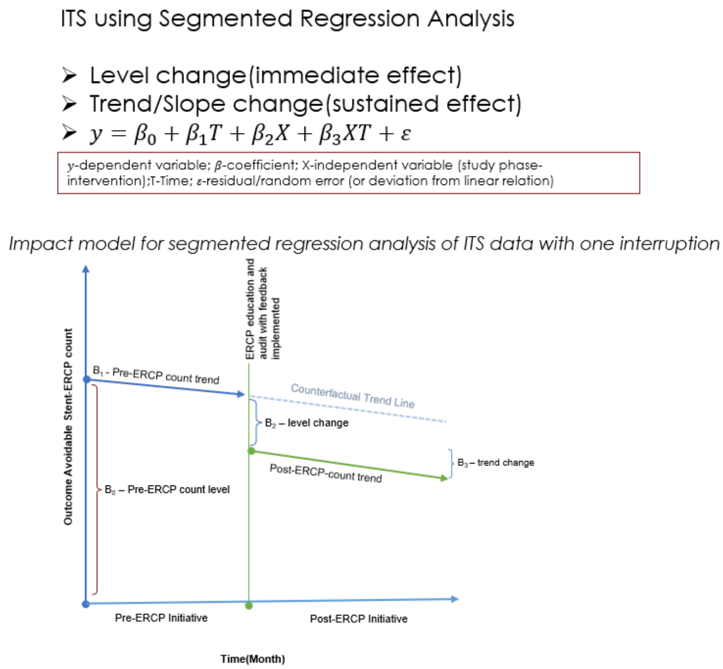

Figure 1: Impact model for single series segmented regression analysis

Reference

1. Bernal L, Cummins S, Gasparrini A. Interrupted time series regression for the evaluation of public health interventions: a Tutorial. Intl J Epidemiol 2017;46:348–55.
2. Chatfield, C. (2003). The Analysis of Time Series: An Introduction, Sixth Edition (6th ed.). Chapman and Hall/CRC. https://doi.org/10.4324/9780203491683
3. Linden A. Conducting interrupted time-series analysis for Single- and multiple-group comparisons. The Stata Journal 2015;15:480–500.
4. Ramsay CR, Matowe L, Grilli R, et al. Interrupted time series designs in health technology assessment: lessons from two systematic reviews of behavior change strategies. Int J Technol Assess Health Care 2003;19:613:613–23.:.
5. Wagner AK, Soumerai SB, Zhang F, et al. Segmented regression analysis of interrupted time series studies in medication use research. J Clin Pharm Ther 2002;27:299–309.

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Appendix SAS Output:

Dependent Variable	counts
	counts

Ordinary Least Squares Estimates			
SSE	172.600372	**DFE**	26
MSE	6.63848	**Root MSE**	2.57652
SBC	151.234548	**AIC**	145.629759
MAE	1.82709976	**AICC**	147.229759
MAPE	50.6682563	**HQC**	147.422779
Durbin-Watson	1.6234	**Total R-Square**	0.5133

Durbin-Watson Statistics			
Order	**DW**	**Pr < DW**	**Pr > DW**
1	1.6234	0.0472	0.9528

NOTE: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation.

Estimates of Autocorrelations

Lag	Covariance	Correlation	-1.0 -0.5 0.0 0.5 1.0
0	5.7533	1.0000	
1	0.3585	0.0623	

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Preliminary MSE	5.7310

Estimates of Autoregressive Parameters			
Lag	**Coefficient**	**Standard Error**	**t Value**
1	-0.062311	0.199611	-0.31

Algorithm converged.

AR(1) Model

Maximum Likelihood Estimates			
SSE	171.523487	**DFE**	25
MSE	6.86094	**Root MSE**	2.61934
SBC	154.457021	**AIC**	147.451034
MAE	1.84597371	**AICC**	149.951034
MAPE	50.8629907	**HQC**	149.69231
Log Likelihood	-68.725517	**Transformed Regression R-Square**	0.4699
Durbin-Watson	1.7785	**Total R-Square**	0.5164
		Observations	30

Durbin-Watson Statistics			
Order	**DW**	**Pr < DW**	**Pr > DW**
1	1.7785	0.1119	0.8881

NOTE: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation.

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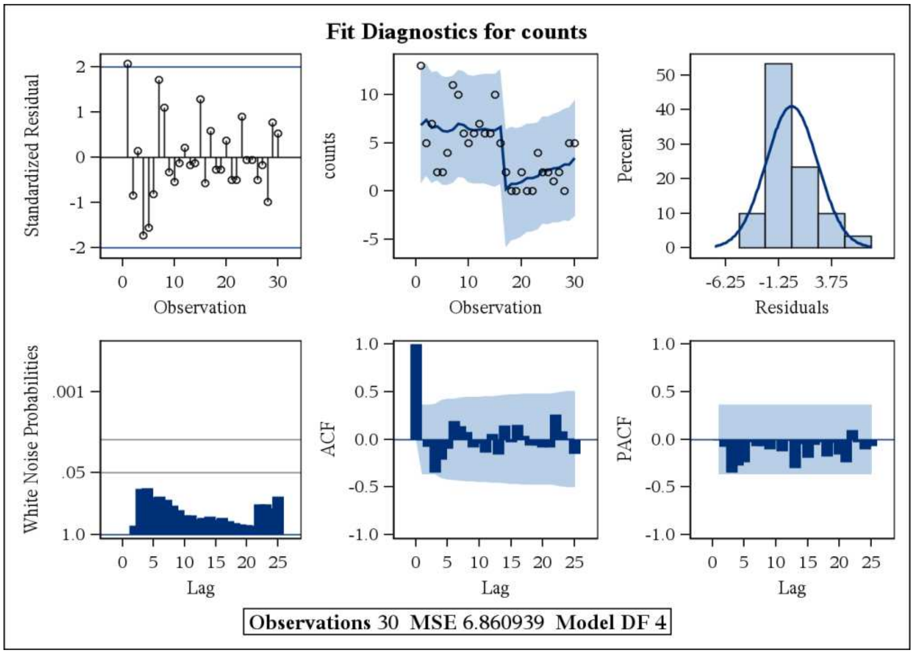
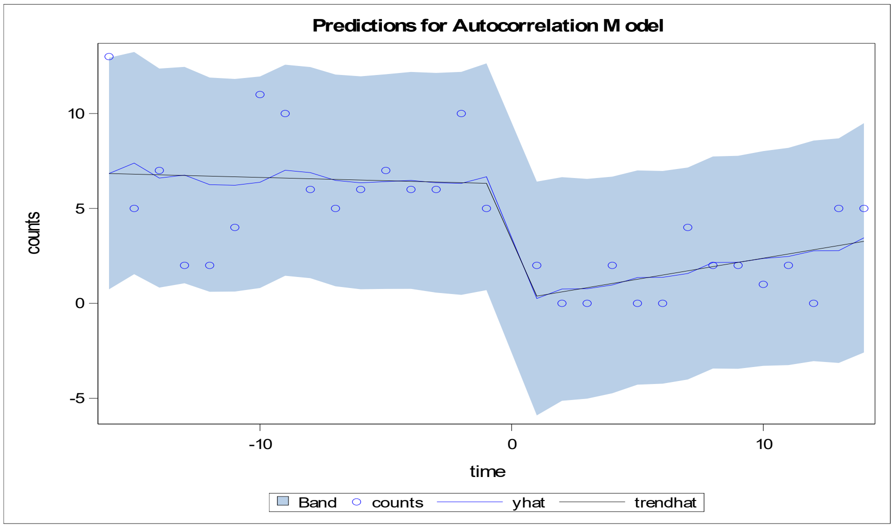
Parameter Estimates

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept (Level)	1	6.2891	1.4952	4.21	0.0003
Pre-Intervention (Slope)	1	-0.0344	0.1541	-0.22	0.8253
Intervention (Level)	1	-6.1309	2.1632	-2.83	0.0090
Post-Intervention (Slope)	1	0.2563	0.2452	1.05	0.3058
AR1	1	-0.0949	0.2019	-0.47	0.6426

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept (Level)	1	6.2891	1.4914	4.22	0.0003
Pre-Intervention (Slope)	1	-0.0344	0.1538	-0.22	0.8250
Intervention (Level)	1	-6.1309	2.1588	-2.84	0.0088
Post-Intervention (Slope)	1	0.2563	0.2448	1.05	0.3051


Fit Diagnostics for counts
Standardized Residual
Observation
counts
Percent
Residuals
White Noise Probabilities
ACF
PACF
Lag
Observations 30 MSE 6.860939 Model DF 4


Predictions for Autocorrelation Model
counts
time
Band
counts
yhat
trendhat

Name of Variable = counts	
Mean of Working Series	4.333333
Standard Deviation	3.438346
Number of Observations	30

Autocorrelation Check for White Noise									
To Lag	Chi-Square	DF	Pr > ChiSq	Autocorrelations					
6	16.02	6	0.0136	0.499	0.294	0.090	0.145	0.166	0.259

Dickey-Fuller Unit Root Tests							
Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau	F	Pr > F
Zero Mean	0	-6.8847	0.0614	-2.48	0.0150		
Single Mean	0	-14.5339	0.0256	-3.57	0.0127	6.52	0.0113
Trend	0	-17.8645	0.0501	-3.57	0.0504	7.07	0.0420