Factors influencing Scots' satisfaction with public transport

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Introduction

- We **aim** to find factors related to passengers' satisfaction with public transport to help operator to improve its service.
- The **data** are from Scotland's official statistics. The theme of Transport contains seven datasets, Road Transport Expenditure, Public Transport, Road Vehicles, Concessionary Travel Cards, Road Network and Traffic, Travel to Work and Other Purposes. There are 460 observations of 24 variables in this research.

Methods

- Summarize table and density plot are illustrated to detect data patterns. The scatter and correlation plots are proposed to explore the relationship among variables. Potential factors are identified through **EDA**.
- The *Satisfaction* is the response variable, the *DateCode* is the control variable and others are independent variables. A **linear regression** model is applied as Eq.(1):

$$y = \beta_0 + \beta_1 x_1 + \cdots + \beta_p x_p + \varepsilon \tag{1}$$

- **Model diagnosis** are carried out to check model assumptions. **Stepwise regression** is applied to select variable with **AIC** as criterion. Compare the selected model with the full model in $adj\ R^2$, AIC and BIC.
- The uncertainty of the parameters is determined via **bootstrap** method. The significant variables are verified and their 95% CI are estimated.

Results

Model diagnosis

Fig.1 shows the regression diagnosis results of model1 with all variables.

- Residuals vs Fitted plot (left top) shows that there is no systematic correlation between the residual value and the fitting value.
- Normal Q-Q plot (right top) shows the points on the graph fall on a straight line with an angle of 45 degrees, which indicates the assumption of normality is not violated.
- Scale-location plot (left bottom) displays the points around the horizontal line are randomly distributed. The invariant variance assumption is satisfied.
- Residuals vs leverage (right bottom) figures out special observations.
- According to the correlation plot and VIF, there is obvious **multicollinearity** among variables.

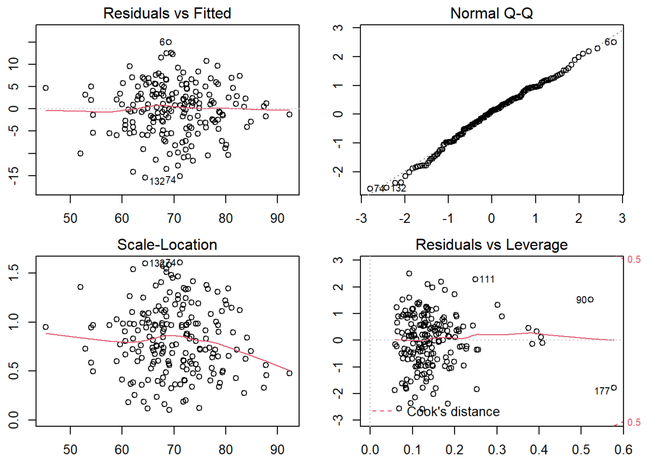

Figure 1: Regression diagnosis results

Stepwise regression

Stepwise regression technique is applied to model selection. The selected model is as Table. 1.

Table 1: Model2, selected by Stepwise regression

term	estimate	std.error	statistic	p.value
(Intercept)	49.1373307	4.0389144	12.165975	0.0000000
Cards	0.0001125	0.0000344	3.269305	0.0012981
Repair	0.2415064	0.0629651	3.835558	0.0001747
Work_Bus	0.8573720	0.1037070	8.267251	0.0000000
School	-0.1186535	0.0456380	-2.599885	0.0101222
Health	0.7652727	0.5091104	1.503157	0.1346011
Work_Train	0.8083991	0.1270588	6.362402	0.0000000
Train_Stations	-0.1437217	0.0439176	-3.272534	0.0012842
Without_Car	0.1023895	0.0713492	1.435047	0.1530586
Petrol_Diesel	-0.0309497	0.0142438	-2.172855	0.0311356

The variables with high correlation are removed by stepwise regression.

Model compare

Table 2: Compare selected model by Stepwise regression with the full model

model	adj.r.squared	AIC	BIC
model 1	0.5478475	1271.288	1365.604
model 2	0.5625876	1254.526	1309.814

The model2 has higher $adj\ R^2$ and smaller AIC and BIC compared with the model1 as Table. 2. Therefore the **model2** is better.

Bootstrap

To obtain robust results, bootstrap is developed to the estimation of parameters.

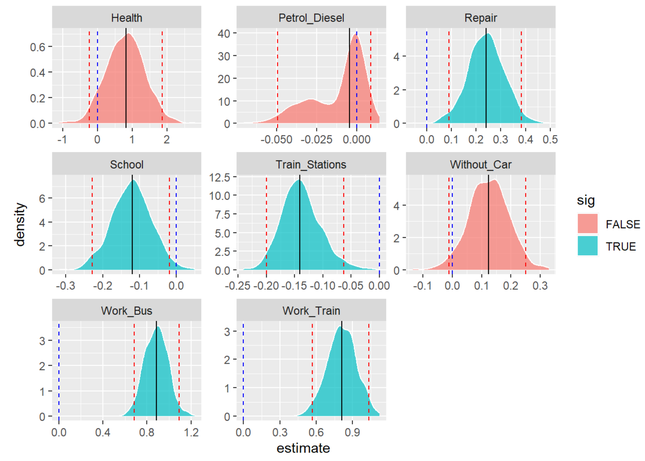

Figure 2: Density plots of parameters via bootstrap

The density plots of parameters are displayed in Fig.3. The variables with orange are not significant while the variables with blue are significant at the $\alpha = 0.05$. The blue dashed lines are zero and the orange dashed lines are 95% CI of parameters.

Conclusion

We can conclude that the **Repair** *(The Percentage Of Roads Needing Repairs)*, **School** *(Child Journeys To School By Walking/Cycling)*, **Train_Stations** *(Number Of Train Stations)*, **Work_Bus** *(Bus Journeys To Work)*, **Work_Train** *(Train Journeys To Work)* variables have great influence on satisfaction with public transport.

References

- Jim Hester and Hadley Wickham, (2020). *fs: Cross-Platform File System Operations Based on 'libuv.'* R package version 1.5.0
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