**Time Series Multivariate Regression – What is a standard error?**

After a recent discussion and a couple of years away from academia I came to realise there’s things I’m forgetting or frankly never questioned enough, which is where this all started. For me this is an exercise in writing things down, remembering what I’m reading and building on it towards a better understanding of statistics. I can’t say I’m an expert in this either, but it’s important to form your own interpretations which is what I intend to do here.

So, this one particularly thread of articles stemmed from a want to better understand Bayesian statistics and the R package INLA. In this attempt, it seemed a good opportunity to step back and check in on my fundamentals around OLS, and multivariate modelling so here we go…

**What is a parameter standard error??**

Two key outputs after estimating our ordinary least squares (OLS) model are the parameter coefficients and standard errors.

**What’s a coefficient?**

From the coefficients, we can begin to infer the relationship between our dependent and independent variables within the model. The coefficient tells us about our prediction of how the dependent variable will change in correspondence to a unitary change in an independent variable. But how certain can we be about the estimation of parameter coefficient our model has produced? That’s where the standard error comes in…

**What’s a standard error?**

The standard error in essence describes the level of precision in estimating the parameter coefficient. It helps us understand the spread of the sampling distribution i.e. the distribution of all possible values if we repeatedly take samples from the population. The standard error, is the standard deviation of that sampling distribution. Here is a great article with visuals on sampling distributions <https://towardsdatascience.com/central-limit-theorem-clearly-explained-4fe60def52d6>

**Standard Error Formula – (setting up Gauss-Markov Assumptions to come)**

Looking at what how our population variance formula we have the below.

**–** given that error variance is an unknown feature of the population we make the assumption that . Our ability to make that assumption is dependent on assuming the residuals to be homoscedastic – we’ll come to that in a later article.

This leaves us here:

With the standard error being the square root of the variance.

**–** *the sum of the squared residuals* – from the formula we see that when there is a lot of variation in the residuals then standard error of the parameter will likely be larger which makes sense as it will be harder to determine what coefficient value should be when there is excess ‘noise’ in the model.

**SST** – - *total sample variation in X* - We also see that when we have greater variation in our independent variables our parameter variance should fall. We should see our variances fall as we increase our sample size as by increasing sample size we should be increasing the sample variation of the independent variables.

– comes from regressing the other independent variables in the regression on – i.e. how much of the variation do the other variables in the regression explain – (getting into multicollinearity). here) – thus a high R squared produced by this regression essentially penalises our parameter variance estimation.