Assumptions of classical linear regression model pdf sheet pdf

the residuals of those fitted values. Assumption 4: Independent and Identically Distributed Error Terms Assumption 4 requires error terms to be independent and identically distributed with expected value to be zero and variance to be constant. A more detailed elaboration of assumption 2 can be found here. This means that in case matrix X is a matrix . A extensive discussion of Assumption 1 can be found here. For example, instead of using the population size to predict the number of flower shops in a city, we may instead use population size to predict the number of flower shops per capita. This is why it’s often easier to just use graphical methods like a Q-Q plot to check this assumption. Given the Gauss-Markov Theorem we know that the least squares estimator and are unbiased and have minimum variance among all unbiased linear estimators. time. This type of regression assigns a weight to each data point based on the variance of its fitted value. Linear relationship: There exists a linear relationship between the independent variable, x, and the dependent variable, y. What to do if this assumption is violated Depending on the nature of the way this assumption is violated, you have a few options: For positive serial correlation, consider adding lags of the dependent and/or independent variable to the model. If there are outliers present, make sure that they are real values and that they aren’t data entry errors. y. The following post will give a short introduction about the underlying assumptions of the classical linear regression model (OLS assumptions), which we derived in the following post. When the proper weights are used, this can eliminate the problem of heteroscedasticity. Notice how the residuals become much more spread out as the fitted values get larger. In this post, we provide an explanation for each assumption, how to determine if the assumption is met, and what to do if the assumption is violated. You can find more information on this assumption and its meaning for the OLS estimator here. Assumption 2: Full Rank of Matrix X Assumption 2 requires the matrix of explanatory variables X to have full rank. Assumption 4: Normality Explanation The next assumption of linear regression is that the residuals are normally distributed. How to determine if this assumption is met There are two common ways to check if this assumption is met: 1. However, assumption 5 is not a Gauss-Markov assumption in that sense that the OLS estimator will still be BLUE even if the assumption is not fulfilled. How to determine if this assumption is met The simplest way to detect heteroscedasticity is by creating a fitted value vs. If it looks like the points in the plot could fall along a straight line, then there exists some type of linear relationship between the two variables and this assumption is met. Use weighted regression. Another way to fix heteroscedasticity is to use weighted regression. If one or more of these assumptions are violated, then the results of our linear regression may be unreliable or even misleading. 4. Normality: The residuals of the model are normally distributed. What to do if this assumption is violated If the normality assumption is violated, you have a few options: First, verify that any outliers aren’t having a huge impact on the distribution. For example, residuals shouldn’t steadily grow larger as time goes on. However, keep in mind that these tests are sensitive to large sample sizes – that is, they often conclude that the residuals are not normal when your sample size is large. In order for a least squares estimator to be BLUE (best linear unbiased estimator) the first four of the following five assumptions have to be satisfied: Assumption 1: Linear Parameter and correct model specification Assumption 1 requires that the dependent variable is a linear combination of the explanatory variables and the error terms . Specifically, heteroscedasticity increases the variance of the regression coefficient estimates, but the regression model doesn’t pick up on this. Assumption 1: Linear Relationship Explanation The first assumption of linear regression is that there is a linear relationship between the independent variable, x, and the independent variable, y. In most cases, this reduces the variability that naturally occurs among larger populations since we’re measuring the number of flower shops per person, rather than the sheer amount of flower shops. The Gauss-Markov Theorem is telling us that in a regression model, where the expected value of our error terms is zero, and variance of the error terms is constant and finite and and are uncorrelated for all and the least squares estimator and are unbiased and have minimum variance among all unbiased linear estimators. Assumption 2: Independence Explanation The next assumption of linear regression is that the residuals are independent. residual plot in which heteroscedasticity is present. Next, you can apply a nonlinear transformation to the independent and/or dependent variable. How to determine if this assumption is met The easiest way to detect if this assumption is met is to create a scatter plot of x vs. Using the log of the dependent variable, rather than the original dependent variable, often causes heteroskedasticity to go away. A Q-Q plot, short for quantile-quantile plot, is a type of plot that we can use to determine whether or not the residuals of a model follow a normal distribution. Assumption 3: Explanatory Variables must be exogenous Assumption 3 requires data of matrix x to be deterministic or at least stochastically independent of for all . For negative serial correlation, check to make sure that none of your variables are overdifferenced. Assumption 5: Normal Distributed Error Terms in Population Assumption 5 is often listed as a Gauss-Markov assumption and refers to normally distributed error terms in population. You can also check the normality assumption using formal statistical tests like Shapiro-Wilk, Kolmogorov-Smironov, Jarque-Barre, or D’Agostino-Pearson. Apply a nonlinear transformation to the independent and/or dependent variable. The following Q-Q plot shows an example of residuals that roughly follow a normal distribution: However, the Q-Q plot below shows an example of when the residuals clearly depart from a straight diagonal line, which indicates that they do not follow normal distribution: 2. Mathematically is assumption 4 expressed as The exact implications of Assumption 4 can be found here. Homoscedasticity: The residuals have constant variance at every level of x. If the points on the plot roughly form a straight diagonal line, then the normality assumption is met. For example, if the plot of x vs. Essentially, this gives small weights to data points that have higher variances, which shrinks their squared residuals. The scatterplot below shows a typical fitted value vs. y has a parabolic shape then it might make sense to add X2 as an additional independent variable in the model. This is known as homoscedasticity. When this is not the case, the residuals are said to suffer from heteroscedasticity. Ideally, we don’t want there to be a pattern among consecutive residuals. For seasonal correlation, consider adding seasonal dummy variables to the model. This allows you to visually see if there is a linear relationship between the two variables. When heteroscedasticity is present in a regression analysis, the results of the analysis become hard to trust. In other words, explanatory variables x are not allowed to contain any information on the error terms , i.e. it must not be possible to explain through X. 3. Further Reading: Introduction to Simple Linear Regression Understanding Heteroscedasticity in Regression Analysis How to Create & Interpret a Q-Q Plot in R This makes it much more likely for a regression model to declare that a term in the model is statistically significant, when in fact it is not. 2. Add another independent variable to the model. This is mostly relevant when working with time series data. Assumptions of Classical Linear Regression Models (CLRM) Overview of all CLRM Assumptions Assumption 1 Assumption 2 Assumption 3 Assumption 4 Assumption 5 Linear regression is a useful statistical method we can use to understand the relationship between two variables, x and y. This “cone” shape is a classic sign of heteroscedasticity: What to do if this assumption is violated There are three common ways to fix heteroscedasticity: 1. Transform the dependent variable. One common transformation is to simply take the log of the dependent variable. Redefine the dependent variable. One common way to redefine the dependent variable is to use a rate, rather than the raw value. In particular, there is no correlation between consecutive residuals in time series data. Assumption 3: Homoscedasticity Explanation The next assumption of linear regression is that the residuals have constant variance at every level of x. Independence: The residuals are independent. Common examples include taking the log, the square root, or the reciprocal of the independent and/or dependent variable. Check the assumption visually using Q-Q plots. Ideally, most of the residual autocorrelations should fall within the 95% confidence bands around zero, which are located at about +/- 2-over the square root of n, where n is the sample size. residual plot. Once you fit a regression line to a set of data, you can then create a scatterplot that shows the fitted values of the model vs. For example, if we are using population size (independent variable) to predict the number of flower shops in a city (dependent variable), we may instead try to use population size to predict the log of the number of flower shops in a city. However, before we conduct linear regression, we must first make sure that four assumptions are met: 1. 2. (A detailed proof of the Gauss-Markov Theorem can be found here) In the following we will summarize the assumptions underlying the Gauss-Markov Theorem in greater depth. Additionally we need the model to be fully specified. For example, the points in the plot below look like they fall on roughly a straight line, which indicates that there is a linear relationship between x and y: However, there doesn’t appear to be a linear relationship between x and y in the plot below: And in this plot there appears to be a clear relationship between x and y, but not a linear relationship: What to do if this assumption is violated If you create a scatter plot of values for x and y and see that there is not a linear relationship between the two variables, then you have a couple options: 1. Mathematically is assumption 3 expressed as The following post contains a more detailed description of assumption 3. You can also formally test if this assumption is met using the Durbin-Watson test. How to determine if this assumption is met The simplest way to test if this assumption is met is to look at a residual time series plot, which is a plot of residuals vs.

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