

The Shortcut of Diagnosis and Correction of Heteroscedastic Model Studies Based on The Software of Eviews

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Abstracts

Because the perplexing of real economy phenomenon, the homoscedasticity assumption of econometric model does not accord with actual, if the model exists heteroskedasticity and directly applied the OLS method, will cause serious adverse consequences, therefore, the diagnosis and correction of model heteroscedasticity is particularly important. Usually think of the “Glejse test “ for econometric model heteroscedasticity, not only can judge the heteroscedasticity is present, and can determine the form of heteroscedastic model, for the basis of elimination of heteroscedasticity. But this research through comparative analysis and examples show that, the most significant heteroscedastic form may not be able to completely eliminate the heteroscedasticity. In view of the complexity of commonly used methods, this study explored a more practical shortcut of diagnosis and correction of heteroscedastic model based on the software of Eviews.

Keywords: Glejser test, White test, output results, weight

1. Brief introduction of diagnostic method of heteroscedastic models

There are many diagnostic methods of heteroscedastic models, such as graphic method, Goldfeld-Quandt method, Glejser method, White method, ARCH method, Spielman rank correlation method. To summarize the shortcut of diagnosis and correction of heteroscedastic model, we only introduce Glejser method and White method.

(1) Glejser Test

This method not only can be used for the test of heteroscedasticity exists, but more important is to find out the form of heteroskedasticity, that is very important for the heteroskedasticity correction.

The basic idea of Glejser test is: to identified one of the most significant function form, In the power-law relationship between absolute error $|Resid_i|$ and explanatory variables. IT not only can explain the variance exists, but also determines the form of heteroskedasticity. The specific steps are as follows:

First, using least squares regression to model, computing the resides: $Resid_i$ ($i = 1, 2, \dots, n$)

Second, using regression model to analyze the relationship between error $|Resid_i|$ and each form of x_i , and then estimated by the least square method. We can the following form:

$$|Resid_i| = \beta_0 + \beta_1 x_i + v_i ; \quad |Resid_i| = \beta_0 + \beta_1 x_i^2 + v_i ; \quad |Resid_i| = \beta_0 + \beta_1 \frac{1}{x_i} + v_i ;$$

$$|Resid_i| = \beta_0 + \beta_1 \sqrt{x_i} + v_i ; \quad |Resid_i| = \beta_0 + \beta_1 \frac{1}{\sqrt{x_i}} + v_i ; \quad \dots\dots$$

Third, test significance of parameters in each regression equation. Make statistical test of each regression equation, if the level of goodness of fit is high, and the T test of parameters is significant, which prove the existence of the relationship between $Resid_i$ and explanatory variables, thus judging the existence of heteroskedasticity.

There are huge calculation workload in Glejser test, so we generally first make sure the existence of heteroskedasticity by other test methods, and then use this method to determine the form of heteroskedasticity.

[Example 1] There are observations of savings and income values, please try to analyze the heteroscedasticity and establish econometric model about savings (y) and income(x).

Table 1 Personal savings and income data Unit of measure: the dollar

Serial number	y	x	Serial number	y	x
1	264	8777	17	1578	24127
2	105	9210	18	1654	25604
3	90	9954	19	1400	26500
4	131	10508	20	1829	27670
5	122	10979	21	2200	28300
6	107	11912	22	2017	27430
7	406	12747	23	2105	29560
8	503	13499	24	1600	28150
9	431	14269	25	2250	32100
10	588	15522	26	2420	32500
11	898	16730	27	2570	32500
12	950	17663	28	1720	33500
13	779	18575	29	1900	36000
14	819	19635	30	2100	36200
15	1222	21163	31	2300	38200
16	1702	22880			

For the datas of table 1, the steps of Glejser test with the software of Eviews are as follows:

(1) Using OLS($ls\ y\ c\ x$) can obtain the regression equation:

$$Y = -655.9599555 + 0.08535215381 * X \quad (\text{details shown in the output results 1})$$

Output results 1: parameters estimation results without considering whether exist the heteroscedasticity

Dependent Variable: Y		Method: Least Squares			
Sample: 1 31		Included observations: 31			
Variable	Coefficient	Std. Error	t-Statistic	Prob.	
C	-655.9600	124.2692	-5.278540	0.0000	
X	0.085352	0.005161	16.53779	0.0000	
R-squared	0.904132	Mean dependent var	1250.323		
Adjusted R-squared	0.900826	S.D. dependent var	820.9407		
S.E. of regression	258.5299	Akaike info criterion	14.01024		
Sum squared resid	1938294.	Schwarz criterion	14.10276		
Log likelihood	-215.1587	F-statistic	273.4984		
Durbin-Watson stat	1.039802	Prob(F-statistic)	0.000000		

$$\text{ASSIGN @ALL F: } Y = -655.9599555 + 0.08535215381 * X$$

(2) Calculating absolute value of residual sequence: $genr\ e = \text{abs}(\text{resid})$

(3) The auxiliary regression equations were established in e and X, X^2 , X^{-1} , X^{-2} , $x^{1/2}$, $x^{-1/2}$ series of variables.

Parts of the auxiliary regression equation are shown in output results 2.

Output results 2: Test results of Glejser

The auxiliary regression equation 1: $E = -28.2478826 + 0.01060001389 * X$
 Adjusted R-squared=0.45927 S.E. of regression=103.1839
 Log likelihood=-186.6853 Akaike info criterion=12.17324
 F-statistic=26.48113 Prob(F-statistic)= 0.000017
 Durbin-Watson stat=2.182659

The auxiliary regression equation 2: $E = 70.84515288 + 2.374251797e-07*(X^2)$
 Adjusted R-squared=0.484059 S.E. of regression=100.7915
 Log likelihood=-185.9580 Akaike info criterion=12.12633
 F-statistic=29.14624 Prob(F-statistic)= 0.000008
 Durbin-Watson stat=2.295165

The auxiliary regression equation 3: $E = 377.320236 - 3093171.064*(1/X)$
 Adjusted R-squared=0.316814 S.E. of regression=115.9828
 Log likelihood=-190.3101 Akaike info criterion=12.40710
 F-statistic=14.91189 Prob(F-statistic)= 0.000582
 Durbin-Watson stat= 1.337718

The auxiliary regression equation 4: $E = 282.8146372 - 2.03319706e+10*(1/X^2)$
 Adjusted R-squared=0.234999 S.E. of regression=115.9828
 Log likelihood=-192.0633 Akaike info criterion=12.52021
 F-statistic=10.21563 Prob(F-statistic)= 0.003351
 Durbin-Watson stat=1.201465

It is not difficult to see that the four auxiliary regression equations were significant, indicating the presence of heteroscedasticity, One of the most significant is the auxiliary regression equation 2, then the form of heteroskedasticity is:

$$E = 70.84515288 + 2.374251797e-07*(X^2)$$

(2) White test

The steps of White test with the software of Eviews are as follows:

First, using OLS for parameter estimation: (LS Y C X) ;

Second, in the equation window of Eviews, click “View→Residual Test→White Heteroskedasticity (no Cross terms) ”.

[Example 2] Try to illustrate the application of White Test with the data of example 1. The results are shown in output results 3.

Output results 3: Results of White Test

White Heteroskedasticity Test:			
F-statistic	11.18080	Probability	0.000270
Obs*R-squared	13.76465	Probability	0.001026

The output results 3 showed that Probability=0.001026<5%, So we should reject the null hypothesis, indicating the presence of heteroskedasticity in the model.

2.The method selection for correction of heteroskedasticity model

The basic idea is to eliminate the heteroscedasticity is to "transform" the model ,and make the "transformed" model have the same variance.

When σ_i^2 is known or can be estimated, we can use the weighted least squares method to eliminate the heteroscedasticity. When the weight $w_i = \frac{1}{\sigma_i^2}$, The essence of the weighted least squares method is to transform the original model using σ_i which is the square root of σ_i^2 .

We generally use weighted estimation method ,in which the weight is the reciprocal of heteroscedasticity, to eliminate the heteroscedasticity. In example 2 the weighting is $1/x^2$.

We can use the method of weighted least squares estimation in the Eviews software.

The steps are as follows:

First, use OLS to estimate model: $y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_kx_k + u$;

Second, use Glejser test to get concrete form of heteroscedasticity model;

Third, Generating weighted variables. We can choose a variable sequence that reverse the heteroscedasticity, for example: $1/X$, $1/X^2$, and so on;

Forth, use WLS to estimate model: $y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_kx_k + u$

In the equation window, we can click “Estimate” button, and then click “option button in the pop-up dialog box, and then select “Weighted LS” in the pop-up dialog box and input weight variables in weight variable column, and then click “Ok” button to return the dialog box, and click “Ok” button.

Fifth, use the White Test to determine whether the heteroscedasticity of estimated model has been eliminated.

[Example 3] Try to illustrate the correction method of heteroscedasticity model using data of example 1.

In the equation window, click Estimate/Option, input weight $1/x^2$ in weight dialog box, and then click “OK” button, and then results of using weighted estimation method can be obtained (details shown in the output results 4).

Output results 4: results when the weight is $1/X^2$

$$Y = -657.3244836 + 0.08328213888 * X \quad (\text{model 1})$$

Now, if we have completely eliminated heteroscedasticity? At this time, we can use the White Test to judge. The steps in EViews software are as follows:

In the equation window, click “View→Residual Test→White Heteroskedasticity(no Cross terms)”, and then can get the results of White Test (shown in the output results 5).

Output results 5: Results of White Test for model 1

White Heteroskedasticity Test:			
F-statistic	5.267208	Probability	0.011437
Obs*R-squared	8.474682	Probability	0.014446

The output results showed that Probability=0.014446<5%, so we judge the heteroscedasticity has not been completely eliminated.

So we will naturally think of the other three heteroscedastic forms, if we use the other three heteroscedastic forms to do weighted estimation, in which the weights are: $1/x$, x , x^2 . We can get the following parameter estimation and test results by using the White Test in Eviews software. (shown in the output results 6-10)

output results 6: Results when weight is X

$$Y = -323.281247 + 0.07327978416 * X \quad (\text{model 2})$$

output results 7: Results of White Test for model 2

White Heteroskedasticity Test:			
F-statistic	10.78316	Probability	0.000337
Obs*R-squared	13.48811	Probability	0.001178

The output results showed that Probability=0.001178<5%, so we judge the heteroscedasticity has not been completely eliminated.

output results 8: Results when weight is $1/X$

$$Y = -730.8765863 + 0.08885062757 * X \quad (\text{model 3})$$

output results 9: Results of White Test for model 3

White Heteroskedasticity Test:			
F-statistic	1.394554	Probability	0.264638
Obs*R-squared	2.808213	Probability	0.245586

The output results showed that Probability=0.245586>5%, so we judge the heteroscedasticity has been completely eliminated.

output results 10: Results when weight is X^2

$$Y = 246.33987 + 0.05495888827 * X \quad (\text{model 4})$$

output results 11: Results of White Test for model 4

White Heteroskedasticity Test:			
F-statistic	6.423668	Probability	0.005057
Obs*R-squared	9.750144	Probability	0.007635

The output results 3 showed that Probability=0.00763<5%, so we judge the heteroscedasticity has not been completely eliminated.

The results above showed that heteroscedasticity can be really eliminated when the weight is $1/x$, namely the heteroscedasticity of model 3 has been completely eliminated. So the linear regression model of savings(y) and income(x) is as follows:

$$Y = -730.8765863 + 0.08885062757 * X$$

3. The diagnosis and correction for heteroskedasticity model

To sum up, we can get the followings conclusions:

First, Glejser Test although can find out the forms of heteroscedasticity, but we may not be able to completely eliminate the heteroscedasticity for the most significant heteroskedasticity forms. As long as it is a form of significant heteroscedasticity, are likely to help us eliminate the heteroscedasticity.

Second, Since in Glejser Test, using a certain power of explanatory variables were as auxiliary regression equation, and using the variance reciprocal as the weights in weighted estimation to eliminate the heteroscedasticity. Therefore, in practice, we can directly use White Test, if the White Test showed that the heteroscedasticity exists, we can use weighted estimation method, and the weights can use x^m to test, only the weight which can eliminate the heteroscedasticity of model is the optimal weights, and then we can determines the final regression model.

Third, The steps of diagnosis and correction for heteroskedasticity model based on Eviews software are as follows:

Firstly, using OLS to do parameter estimation for the original model:(LS Y C X); Followed by White Test. In the equation window, click” View→Residual Test→White Heteroskedasticity”;

If the original model exist heteroskedasticity, using the weighted estimation. In the equation window, click”Estimate→Option”, and input weight x^m in dialog box, and click “Ok”button, when getting corrected model, then use White Test method(steps are the same as above), and try using several m until the heteroskedasticity has been completely eliminated.

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