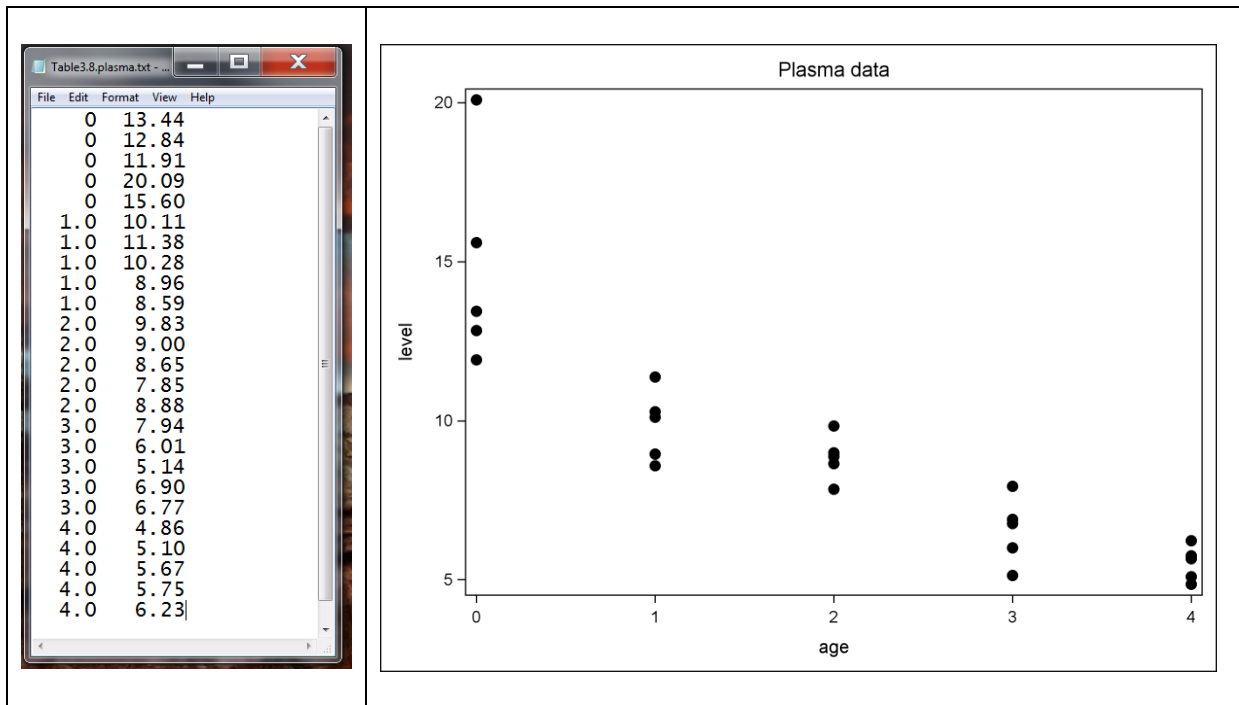


## 2.2.2: SAS - Linear Regression Remedial Measures

Dr. Bean – Stat 5100

Example: Age and plasma level for 25 healthy children in a study are reported. Of interest is how plasma level depends on age. (Text Table 3.8 – first column is age; second column is plasma level)



```

/*
data plasma;
    infile "[File Path]/Table3.8.plasma.txt";
    input age level;
run;
*/
data plasma; input age level @@; cards;
    0 13.44    0 12.84    0 11.91    0 20.09    0 15.60
    1.0 10.11  1.0 11.38  1.0 10.28  1.0 8.96    1.0 8.59
    2.0 9.83   2.0 9.00   2.0 8.65   2.0 7.85   2.0 8.88
    3.0 7.94   3.0 6.01   3.0 5.14   3.0 6.90   3.0 6.77
    4.0 4.86   4.0 5.10   4.0 5.67   4.0 5.75   4.0 6.23
;

/* Fit regression model and check assumptions */
proc reg data=plasma;
    model level = age;
    output out=out1 r=resid p=pred;
    title1 'Simple model for plasma data';
run;

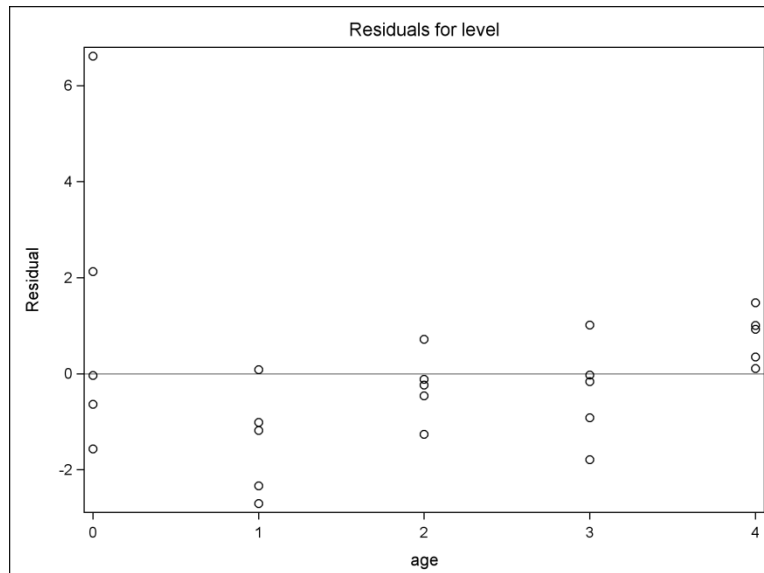
```

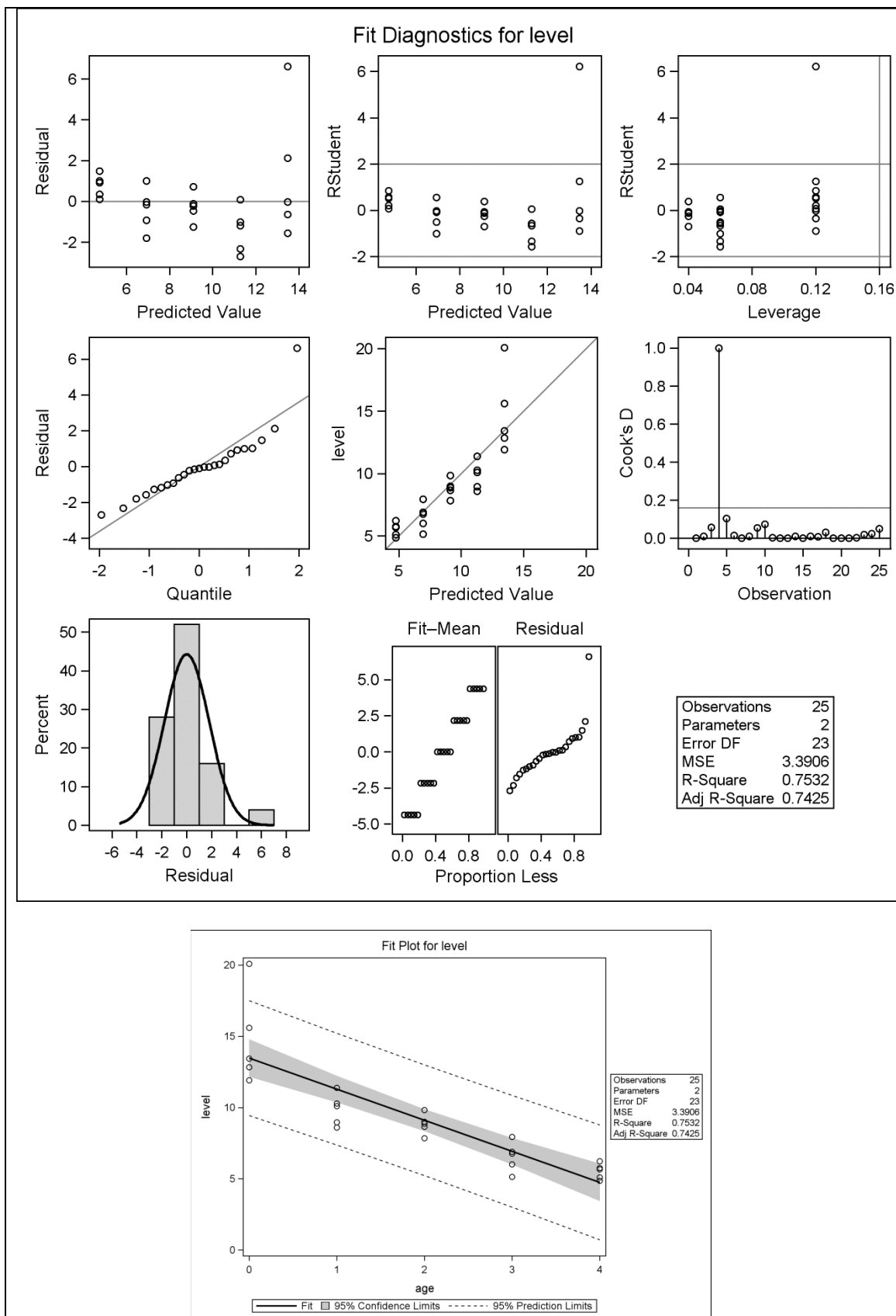
**Simple model for plasma data**

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	238.05620	238.05620	70.21	<.0001
Error	23	77.98306	3.39057		
Corrected Total	24	316.03926			

Root MSE	1.84135	R-Square	0.7532
Dependent Mean	9.11120	Adj R-Sq	0.7425
Coeff Var	20.20974		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	1	13.47520	0.63786	21.13	<.0001
age	1	-2.18200	0.26041	-8.38	<.0001





```

/* Define shortcut macro, using line copied from
   [File Path]/resid_num_diag_1line.sas
*/
%macro resid_num_diag(dataset,...
/* Call shortcut macro */
%resid_num_diag(dataset=out1, datavar=resid, label='Residual',
  predvar=pred, predlabel='Predicted Value');

```

*P-value for Brown-Forsythe test of constant variance  
in Residual vs. Predicted Value*

Obs	t_BF	BF_pvalue
1	1.50583	0.14572

*Output for correlation test of normality of Residual  
(Check text Table B.6 for threshold)*

Pearson Correlation Coefficients, N = 25 Prob >  r  under H0: Rho=0		
	resid	expectNorm
resid	1.00000	0.90360
Residual		<.0001
expectNorm	0.90360	1.00000
	<.0001	

```

/* F-test for lack of fit
Options:
Covar=1 - specifies the first variable on the right
          Hand side of the equation is linear
          (default is quadratic)
Noopt    - suppresses rsreg output not associated
           with the F-test for lack of fit */
proc rsreg data=plasma;
  model level = age / lackfit covar=1 noopt;
  title1 'F-test for lack of fit';
run;

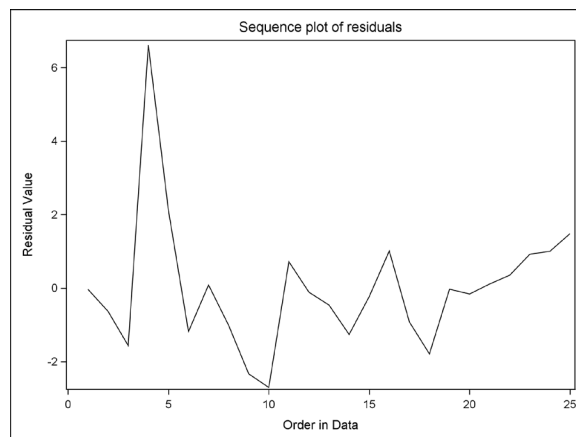
```

Residual	DF	Sum of Squares	Mean Square	F Value	Pr > F
Lack of Fit	3	22.748784	7.582928	2.75	0.0699
Pure Error	20	55.234280	2.761714		
Total Error	23	77.983064	3.390568		

```

/* Look at sequence plot */
data temp; set out1;
  order = _n_;
proc sgplot data=temp;
  series x=order y=resid / lineattrs=(pattern=solid) ;
  xaxis label='Order in Data';
  yaxis label='Residual Value';
  title1 'Sequence plot of residuals';
run;

```

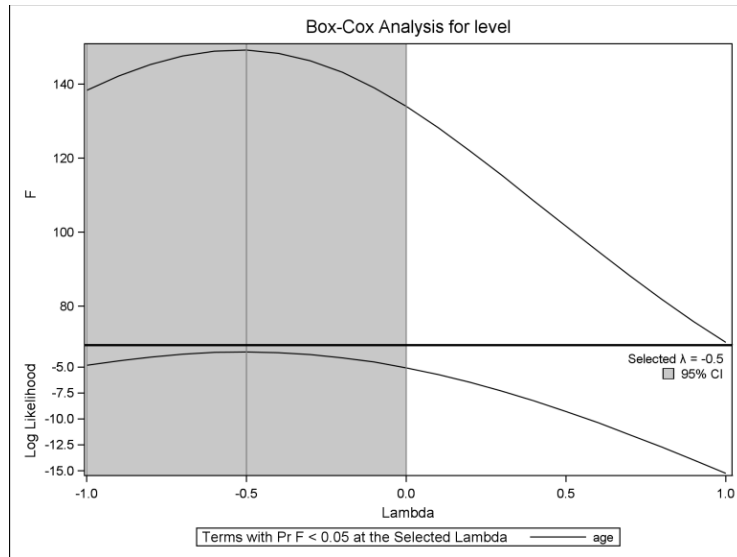


```

/***** Consider Transformations *****/

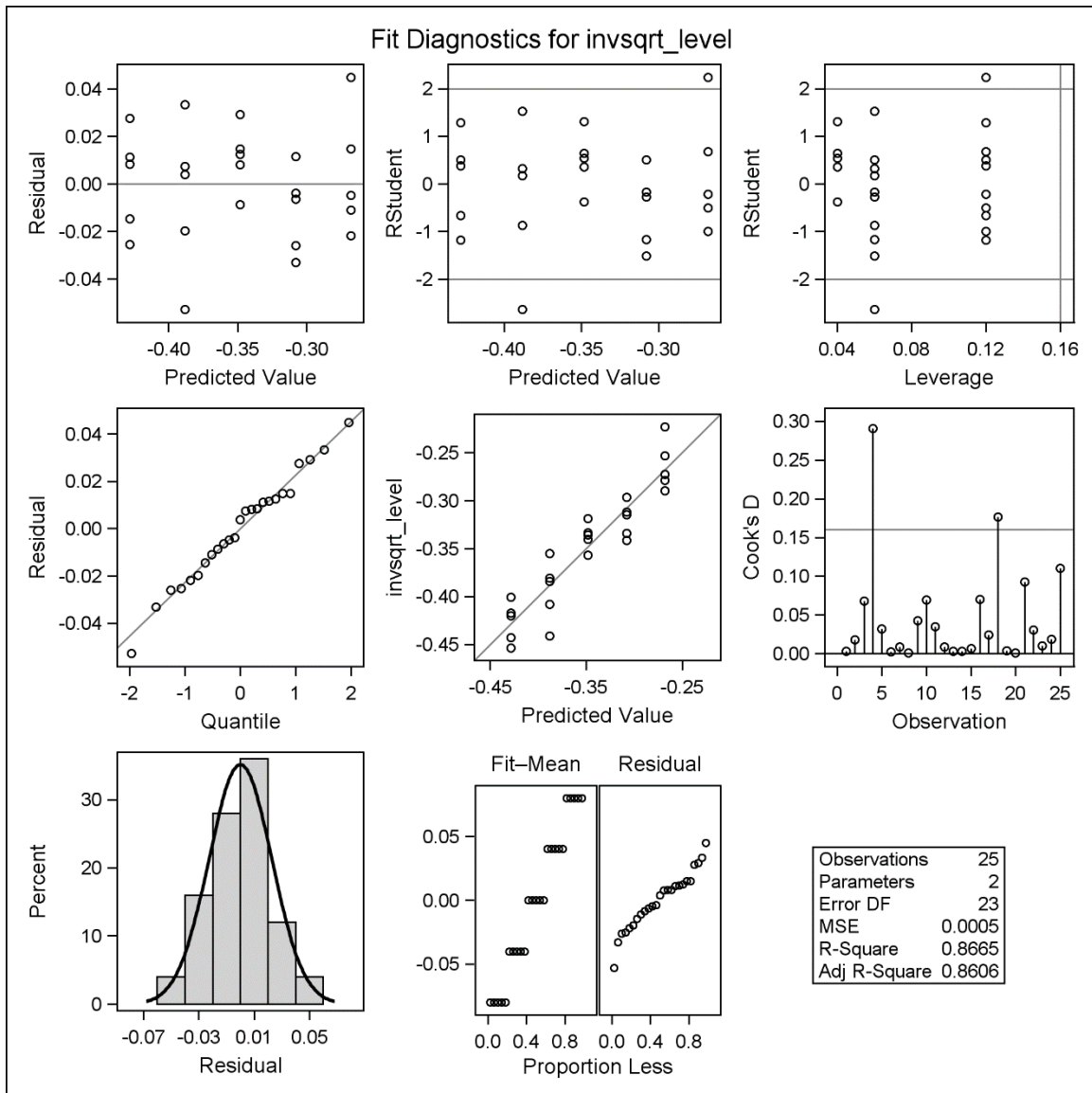
proc transreg data=plasma;
  model boxcox(level / lambda=-1 to 1 by 0.1)
    = identity(age);
  title1 'Box-Cox Transformation: Regressing Level on Age';
run;

```



```
data plasma; set plasma;
  log_level = log(level);
  invsqrt_level = -1/sqrt(level);
run;

/* Inverse square root */
proc reg data=plasma;
  model invsqrt_level = age;
  output out=out2 r=resid p=pred;
  title1 'Simple model for negative inverse root plasma
data';
run;
```



```
%resid_num_diag(dataset=out2, datavar=resid,
  label='Residual (neg. inverse root)',
  predvar=pred, predlabel='Predicted Value (neg. inverse
root)');
```

***P-value for Brown-Forsythe test of constant variance  
in Residual (neg. inverse root) vs. Predicted Value (neg. inverse root)***

Obs	t_BF	BF_pvalue
1	0.16654	0.86918

***Output for correlation test of normality of Residual (neg. inverse root)  
(Check text Table B.6 for threshold)***

Pearson Correlation Coefficients, N = 25 Prob >  r  under H0: Rho=0		
	resid	expectNorm
resid Residual (neg. inverse root)	1.00000	0.99188 <.0001
expectNorm	0.99188 <.0001	1.00000

```
proc rsreg data=plasma;
  model invsqrt_level = age / lackfit covar=1 noopt;
  title1 'F-test for lack of fit (neg. inverse root)';
run;
```

***F-test for lack of fit (neg. inverse root)***

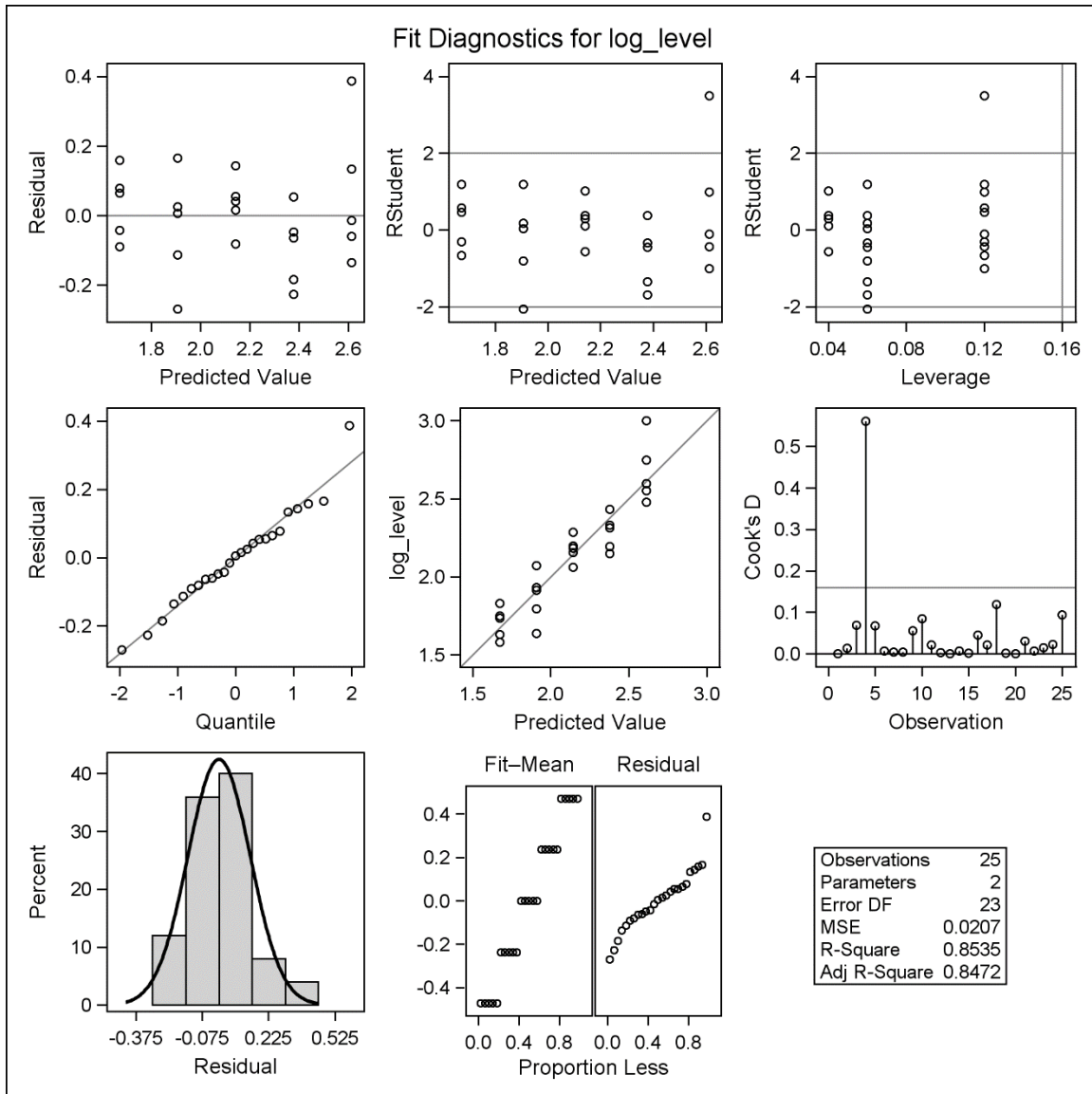
Residual	DF	Sum of Squares	Mean Square	F Value	Pr > F
Lack of Fit	3	0.001556	0.000519	0.96	0.4312
Pure Error	20	0.010813	0.000541		
Total Error	23	0.012369	0.000538		



```

/* Log */
proc reg data=plasma;
  model log_level = age;
  output out=out3 r=resid p=pred;
  title1 'Simple model for log plasma data';
run;

```



```
%resid_num_diag(dataset=out3, datavar=resid,
label='Residual (log)',
predvar=pred, predlabel='Predicted Value (log)');
```

***P-value for Brown-Forsythe test of constant variance  
in Residual (log) vs. Predicted Value (log)***

Obs	t_BF	BF_pvalue
1	0.95179	0.35110

***Output for correlation test of normality of Residual (log)  
(Check text Table B.6 for threshold)***

Pearson Correlation Coefficients, N = 25 Prob >  r  under H0: Rho=0		
	resid	expectNorm
resid	1.00000	0.98071
Residual (log)		<.0001
expectNorm	0.98071	1.00000
	<.0001	

```
proc rsreg data=plasma;
model log_level = age / lackfit covar=1 noopt;
title1 'F-test for lack of fit (log)';
run;
```

***F-test for lack of fit (log)***

Residual	DF	Sum of Squares	Mean Square	F Value	Pr > F
Lack of Fit	3	0.081944	0.027315	1.39	0.2758
Pure Error	20	0.394004	0.019700		
Total Error	23	0.475948	0.020693		

```

/* Probably go with inverse square root */
proc reg data=plasma;
  model invsqrt_level = age;
  title1 'Negative inverse root plasma data';
run;

```

### Negative inverse root plasma data

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.08025	0.08025	149.22	<.0001
Error	23	0.01237	0.00053778		
Corrected Total	24	0.09262			

Root MSE	0.02319	R-Square	0.8665
----------	---------	----------	--------

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	1	-0.26803	0.00803	-33.36	<.0001
age	1	-0.04006	0.00328	-12.22	<.0001

