

### Stepwise Selection

The REG Procedure  
Model: MODEL1  
Dependent Variable: quality

Adjusted R-Square Selection Method

Number of Observations Read	1599
Number of Observations Used	1599

Number in Model	Adjusted R-Square	R-Square	AIC	Variables in Model
7	0.3572	0.3600	-1382.2341	vol_acidity chlorides free_sulfur total_sulfur pH sulphates alcohol
6	0.3554	0.3578	-1378.5568	vol_acidity chlorides total_sulfur pH sulphates alcohol
6	0.3507	0.3532	-1367.1591	vol_acidity chlorides free_sulfur total_sulfur sulphates alcohol
5	0.3500	0.3520	-1366.2685	vol_acidity chlorides total_sulfur sulphates alcohol

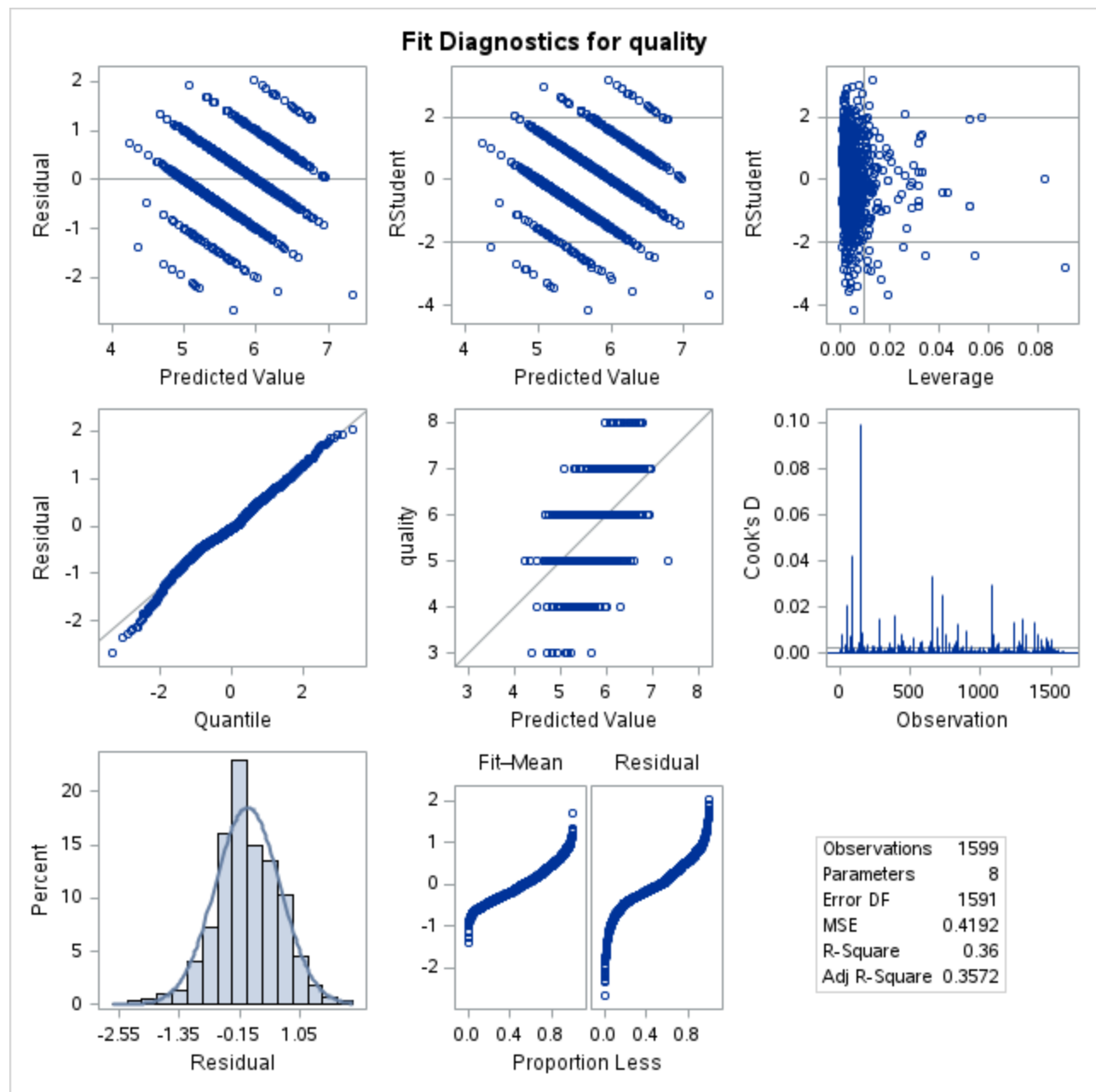
Number in Model	Adjusted R-Square	R-Square	AIC	Variables in Model
6	0.3472	0.3497	-1358.4932	vol_acidity chlorides free_sulfur pH sulphates alcohol
5	0.3468	0.3488	-1358.4479	vol_acidity chlorides pH sulphates alcohol
6	0.3467	0.3491	-1357.1258	vol_acidity free_sulfur total_sulfur pH sulphates alcohol
5	0.3449	0.3470	-1353.8915	vol_acidity total_sulfur pH sulphates alcohol
5	0.3430	0.3451	-1349.2612	vol_acidity free_sulfur total_sulfur sulphates alcohol
5	0.3428	0.3448	-1348.6744	vol_acidity chlorides free_sulfur sulphates alcohol
4	0.3421	0.3438	-1348.1049	vol_acidity total_sulfur sulphates alcohol
4	0.3419	0.3435	-1347.4780	vol_acidity chlorides sulphates alcohol
5	0.3375	0.3396	-1335.8198	vol_acidity free_sulfur pH sulphates alcohol
4	0.3372	0.3388	-1336.0432	vol_acidity pH sulphates alcohol
4	0.3353	0.3370	-1331.5566	vol_acidity free_sulfur sulphates alcohol
3	0.3346	0.3359	-1330.9611	vol_acidity sulphates alcohol
6	0.3312	0.3338	-1319.8471	vol_acidity chlorides free_sulfur total_sulfur pH alcohol
5	0.3297	0.3318	-1317.2506	vol_acidity free_sulfur total_sulfur pH alcohol
5	0.3290	0.3311	-1315.4782	vol_acidity chlorides total_sulfur pH alcohol
4	0.3276	0.3293	-1313.1734	vol_acidity total_sulfur pH alcohol
5	0.3228	0.3249	-1300.7357	vol_acidity chlorides free_sulfur total_sulfur alcohol
4	0.3227	0.3244	-1301.6547	vol_acidity free_sulfur total_sulfur alcohol
4	0.3227	0.3244	-1301.6296	vol_acidity chlorides pH alcohol
5	0.3226	0.3247	-1300.3548	vol_acidity chlorides free_sulfur pH alcohol
4	0.3219	0.3236	-1299.6167	vol_acidity chlorides total_sulfur alcohol
3	0.3218	0.3231	-1300.4790	vol_acidity total_sulfur alcohol
3	0.3214	0.3227	-1299.5345	vol_acidity pH alcohol
4	0.3213	0.3230	-1298.3000	vol_acidity free_sulfur pH alcohol
6	0.3171	0.3197	-1286.3578	chlorides free_sulfur total_sulfur pH sulphates alcohol
4	0.3164	0.3181	-1286.7162	vol_acidity chlorides free_sulfur alcohol
3	0.3163	0.3176	-1287.5629	vol_acidity free_sulfur alcohol
3	0.3162	0.3174	-1287.1765	vol_acidity chlorides alcohol
2	0.3161	0.3170	-1288.0566	vol_acidity alcohol
5	0.3127	0.3148	-1277.1042	chlorides total_sulfur pH sulphates alcohol
5	0.3014	0.3036	-1251.0644	chlorides free_sulfur pH sulphates alcohol
4	0.3014	0.3031	-1252.0049	chlorides pH sulphates alcohol
5	0.2968	0.2990	-1240.5742	free_sulfur total_sulfur pH sulphates alcohol
5	0.2959	0.2981	-1238.4988	chlorides free_sulfur total_sulfur sulphates alcohol
4	0.2940	0.2958	-1235.1502	chlorides total_sulfur sulphates alcohol
4	0.2923	0.2941	-1231.4306	total_sulfur pH sulphates alcohol
4	0.2839	0.2857	-1212.5257	chlorides free_sulfur sulphates alcohol
3	0.2832	0.2845	-1211.8348	chlorides sulphates alcohol
3	0.2820	0.2833	-1209.1681	pH sulphates alcohol
4	0.2819	0.2836	-1207.8988	free_sulfur pH sulphates alcohol
4	0.2813	0.2831	-1206.6831	free_sulfur total_sulfur sulphates alcohol
3	0.2791	0.2804	-1202.6789	total_sulfur sulphates alcohol
3	0.2694	0.2708	-1181.4323	free_sulfur sulphates alcohol
5	0.2693	0.2716	-1179.2671	chlorides free_sulfur total_sulfur pH alcohol
2	0.2690	0.2699	-1181.4774	sulphates alcohol
4	0.2652	0.2671	-1171.3068	free_sulfur total_sulfur pH alcohol
4	0.2632	0.2651	-1166.9959	chlorides total_sulfur pH alcohol
3	0.2593	0.2607	-1159.4823	total_sulfur pH alcohol
3	0.2549	0.2563	-1150.0701	chlorides pH alcohol

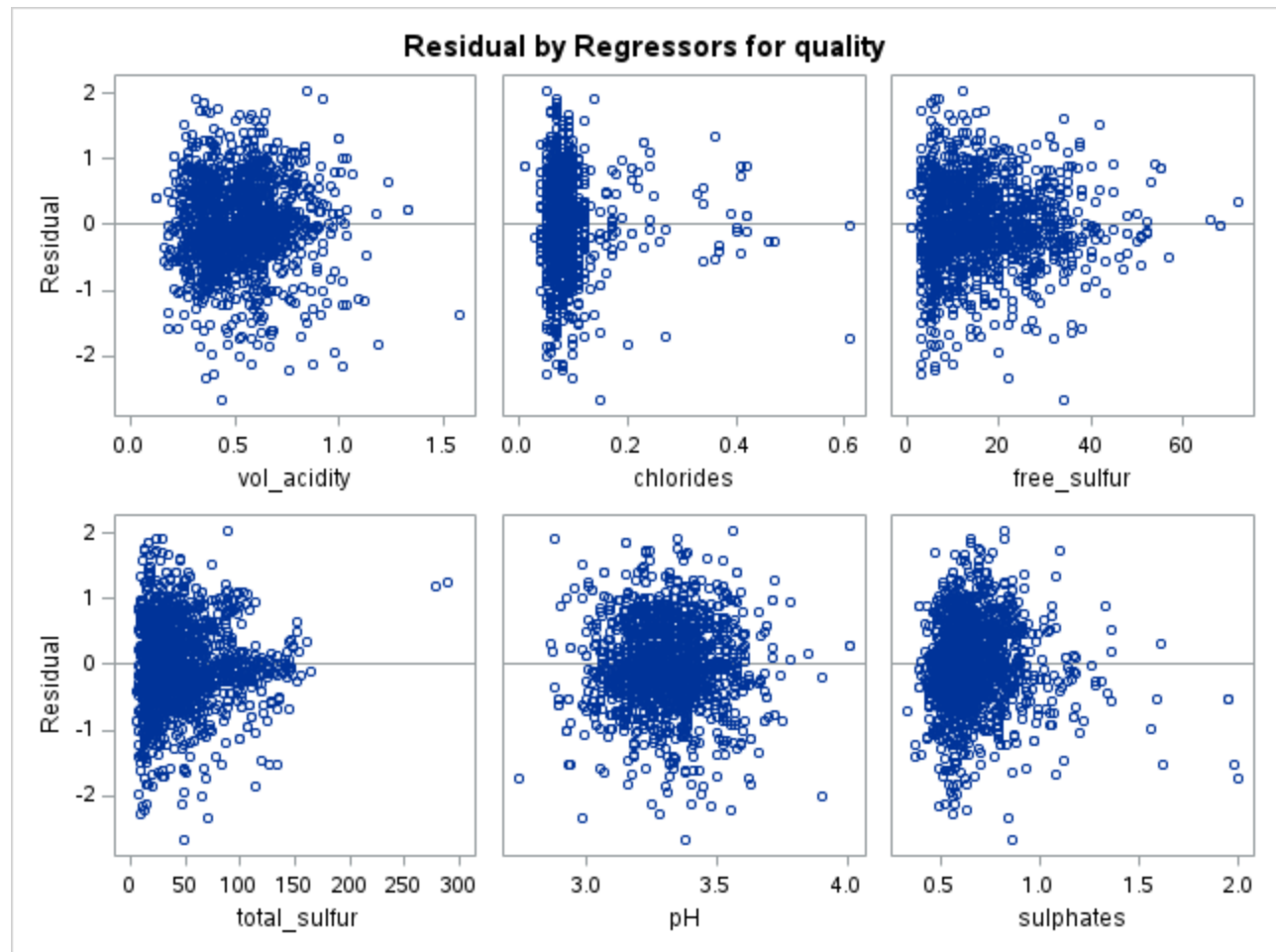
Number in Model	Adjusted R-Square	R-Square	AIC	Variables in Model
4	0.2545	0.2563	-1148.0950	chlorides free_sulfur pH alcohol
2	0.2511	0.2520	-1142.8308	pH alcohol
3	0.2506	0.2520	-1140.8630	free_sulfur pH alcohol
5	0.2383	0.2407	-1112.7962	vol_acidity chlorides free_sulfur total_sulfur sulphates
6	0.2380	0.2408	-1111.0843	vol_acidity chlorides free_sulfur total_sulfur pH sulphates
4	0.2367	0.2386	-1110.3158	chlorides free_sulfur total_sulfur alcohol
3	0.2364	0.2379	-1110.8238	free_sulfur total_sulfur alcohol
4	0.2354	0.2373	-1107.6702	vol_acidity chlorides total_sulfur sulphates
5	0.2349	0.2373	-1105.6724	vol_acidity chlorides total_sulfur pH sulphates
3	0.2340	0.2354	-1105.7378	chlorides total_sulfur alcohol
2	0.2337	0.2347	-1106.1436	total_sulfur alcohol
2	0.2265	0.2275	-1091.2236	chlorides alcohol
3	0.2264	0.2278	-1089.8948	chlorides free_sulfur alcohol
1	0.2262	0.2267	-1091.6482	alcohol
2	0.2261	0.2270	-1090.2927	free_sulfur alcohol
4	0.2130	0.2150	-1061.5644	vol_acidity chlorides free_sulfur sulphates
5	0.2128	0.2153	-1060.1542	vol_acidity chlorides free_sulfur pH sulphates
3	0.2091	0.2106	-1054.6534	vol_acidity chlorides sulphates
4	0.2088	0.2107	-1052.9245	vol_acidity chlorides pH sulphates
5	0.2070	0.2095	-1048.4508	vol_acidity free_sulfur total_sulfur pH sulphates
4	0.2064	0.2084	-1048.1889	vol_acidity free_sulfur total_sulfur sulphates
4	0.2042	0.2062	-1043.6641	vol_acidity total_sulfur pH sulphates
3	0.2027	0.2041	-1041.6161	vol_acidity total_sulfur sulphates
4	0.1890	0.1911	-1013.5477	vol_acidity chlorides free_sulfur total_sulfur
5	0.1889	0.1914	-1012.2958	vol_acidity chlorides free_sulfur total_sulfur pH
3	0.1855	0.1870	-1007.5819	vol_acidity chlorides total_sulfur
4	0.1850	0.1871	-1005.7005	vol_acidity chlorides total_sulfur pH
4	0.1824	0.1844	-1000.5201	vol_acidity free_sulfur pH sulphates
3	0.1797	0.1812	-996.2278	vol_acidity free_sulfur total_sulfur
4	0.1793	0.1813	-994.4020	vol_acidity free_sulfur total_sulfur pH
3	0.1789	0.1804	-994.6967	vol_acidity free_sulfur sulphates
3	0.1783	0.1798	-993.5018	vol_acidity pH sulphates
2	0.1757	0.1768	-989.5499	vol_acidity total_sulfur
3	0.1757	0.1772	-988.4344	vol_acidity total_sulfur pH
2	0.1755	0.1765	-989.0045	vol_acidity sulphates
5	0.1675	0.1701	-970.6644	chlorides free_sulfur total_sulfur pH sulphates
3	0.1655	0.1670	-968.7129	vol_acidity chlorides free_sulfur
4	0.1650	0.1671	-966.8536	vol_acidity chlorides free_sulfur pH
2	0.1630	0.1640	-965.0056	vol_acidity chlorides
3	0.1625	0.1641	-963.0394	vol_acidity chlorides pH
4	0.1610	0.1631	-959.1814	chlorides free_sulfur total_sulfur sulphates
4	0.1599	0.1620	-957.0932	chlorides total_sulfur pH sulphates
3	0.1555	0.1570	-949.6675	vol_acidity free_sulfur pH
3	0.1554	0.1570	-949.6145	chlorides total_sulfur sulphates
2	0.1545	0.1555	-948.7776	vol_acidity free_sulfur
2	0.1526	0.1537	-945.3579	vol_acidity pH
1	0.1520	0.1525	-945.0694	vol_acidity
4	0.1269	0.1291	-895.5201	chlorides free_sulfur pH sulphates
3	0.1244	0.1261	-891.9686	chlorides free_sulfur sulphates

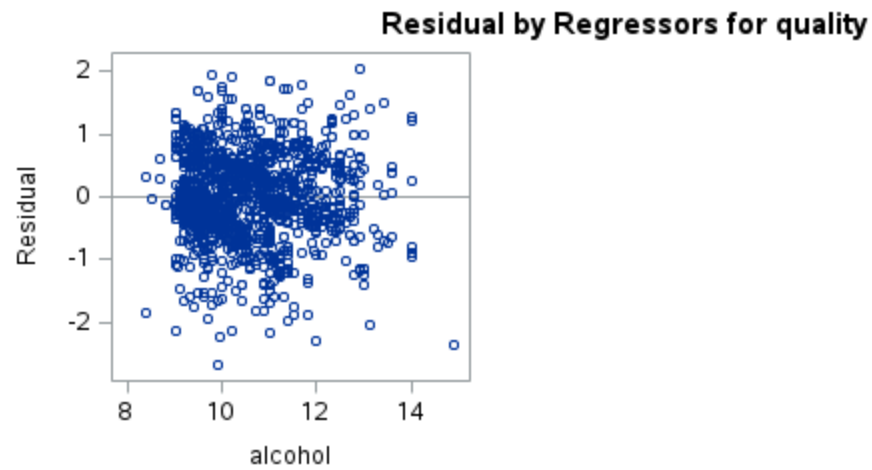
Number in Model	Adjusted R-Square	R-Square	AIC	Variables in Model
3	0.1234	0.1251	-890.1796	chlorides pH sulphates
2	0.1204	0.1215	-885.5437	chlorides sulphates
4	0.1088	0.1110	-862.6175	free_sulfur total_sulfur pH sulphates
3	0.1081	0.1097	-862.3748	free_sulfur total_sulfur sulphates
2	0.1005	0.1016	-849.8972	total_sulfur sulphates
3	0.1004	0.1021	-848.6175	total_sulfur pH sulphates
4	0.0707	0.0730	-795.7828	chlorides free_sulfur total_sulfur pH
2	0.0661	0.0673	-789.8362	free_sulfur sulphates
3	0.0655	0.0673	-787.8541	free_sulfur pH sulphates
1	0.0626	0.0632	-784.8891	sulphates
2	0.0621	0.0633	-783.0113	pH sulphates
3	0.0590	0.0608	-776.7798	chlorides total_sulfur pH
3	0.0565	0.0583	-772.4918	chlorides free_sulfur total_sulfur
3	0.0495	0.0513	-760.7352	free_sulfur total_sulfur pH
2	0.0483	0.0495	-759.7160	chlorides total_sulfur
2	0.0427	0.0439	-750.2114	free_sulfur total_sulfur
2	0.0380	0.0392	-742.4217	total_sulfur pH
1	0.0337	0.0343	-736.2425	total_sulfur
3	0.0266	0.0284	-722.5899	chlorides free_sulfur pH
2	0.0253	0.0265	-721.5020	chlorides pH
2	0.0187	0.0199	-710.6181	chlorides free_sulfur
1	0.0167	0.0174	-708.4987	chlorides
2	0.0043	0.0055	-687.3391	free_sulfur pH
1	0.0027	0.0033	-685.8350	pH
1	0.0019	0.0026	-684.6052	free_sulfur

## Stepwise Selection

The REG Procedure  
Model: MODEL1  
Dependent Variable: quality







### Forward Selection

The REG Procedure  
Model: MODEL1  
Dependent Variable: quality

Number of Observations Read	1599
Number of Observations Used	1599

#### Forward Selection: Step 1

Variable alcohol Entered: R-Square = 0.2267 and C(p) = 327.4438

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	236.29279	236.29279	468.26	<.0001
Error	1597	805.87231	0.50462		
Corrected Total	1598	1042.16510			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	1.87502	0.17471	58.12245	115.18	<.0001
alcohol	0.36084	0.01668	236.29279	468.26	<.0001

Bounds on condition number: 1, 1

## Forward Selection: Step 2

Variable vol\_acidity Entered: R-Square = 0.3170 and C(p) = 105.1076

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	330.33266	165.16633	370.32	<.0001
Error	1596	711.83245	0.44601		
Corrected Total	1598	1042.16510			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	3.09370	0.18445	125.47003	281.32	<.0001
vol_acidity	-1.37875	0.09495	94.03987	210.85	<.0001
alcohol	0.31381	0.01601	171.40529	384.31	<.0001

Bounds on condition number: 1.0427, 4.1707

## Forward Selection: Step 3

Variable sulphates Entered: R-Square = 0.3359 and C(p) = 60.0833

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	350.04487	116.68162	268.89	<.0001
Error	1595	692.12024	0.43393		
Corrected Total	1598	1042.16510			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	2.60914	0.19563	77.19066	177.89	<.0001
vol_acidity	-1.21712	0.09668	68.77538	158.49	<.0001
sulphates	0.67935	0.10079	19.71221	45.43	<.0001
alcohol	0.30921	0.01580	166.10533	382.79	<.0001

Bounds on condition number: 1.111, 9.6919

## Forward Selection: Step 4

Variable total\_sulfur Entered: R-Square = 0.3438 and C(p) = 42.4337

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	358.28179	89.57045	208.77	<.0001
Error	1594	683.88331	0.42904		
Corrected Total	1598	1042.16510			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	2.82456	0.20064	85.03112	198.19	<.0001
vol_acidity	-1.19449	0.09627	66.05144	153.95	<.0001
total_sulfur	-0.00224	0.00051076	8.23693	19.20	<.0001
sulphates	0.71245	0.10051	21.55750	50.25	<.0001



Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
alcohol	0.29529	0.01603	145.52567	339.19	<.0001

Bounds on condition number: 1.1142, 17.337

Forward Selection: Step 5

Variable chlorides Entered: R-Square = 0.3520 and C(p) = 23.9903

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	366.85151	73.37030	173.07	<.0001
Error	1593	675.31359	0.42393		
Corrected Total	1598	1042.16510			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	3.00981	0.20365	92.59849	218.43	<.0001
vol_acidity	-1.13579	0.09658	58.62706	138.30	<.0001
chlorides	-1.75580	0.39051	8.56972	20.22	<.0001
total_sulfur	-0.00232	0.00050804	8.83789	20.85	<.0001
sulphates	0.92016	0.11007	29.62549	69.88	<.0001
alcohol	0.27659	0.01647	119.53606	281.97	<.0001

Bounds on condition number: 1.3123, 29.688

Forward Selection: Step 6

Variable pH Entered: R-Square = 0.3578 and C(p) = 11.6590

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	372.85906	62.14318	147.81	<.0001
Error	1592	669.30605	0.42042		
Corrected Total	1598	1042.16510			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	4.30995	0.39928	48.98620	116.52	<.0001
vol_acidity	-1.03187	0.10003	44.73448	106.40	<.0001
chlorides	-2.05284	0.39675	11.25507	26.77	<.0001
total_sulfur	-0.00238	0.00050621	9.31856	22.16	<.0001
pH	-0.43827	0.11594	6.00755	14.29	0.0002
sulphates	0.89328	0.10985	27.80237	66.13	<.0001
alcohol	0.29029	0.01680	125.54249	298.61	<.0001

Bounds on condition number: 1.3282, 44.182

Forward Selection: Step 7

Variable free\_sulfur Entered: R-Square = 0.3600 and C(p) = 8.0000

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	375.23126	53.60447	127.88	<.0001

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Error	1591	666.93384	0.41919		
Corrected Total	1598	1042.16510			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	4.44319	0.40261	51.05423	121.79	<.0001
vol_acidity	-1.00664	0.10045	42.09899	100.43	<.0001
chlorides	-2.06652	0.39622	11.40313	27.20	<.0001
free_sulfur	0.00505	0.00212	2.37220	5.66	0.0175
total_sulfur	-0.00349	0.00068647	10.82327	25.82	<.0001
pH	-0.48543	0.11746	7.16007	17.08	<.0001
sulphates	0.88709	0.10972	27.40348	65.37	<.0001
alcohol	0.28894	0.01678	124.23885	296.38	<.0001

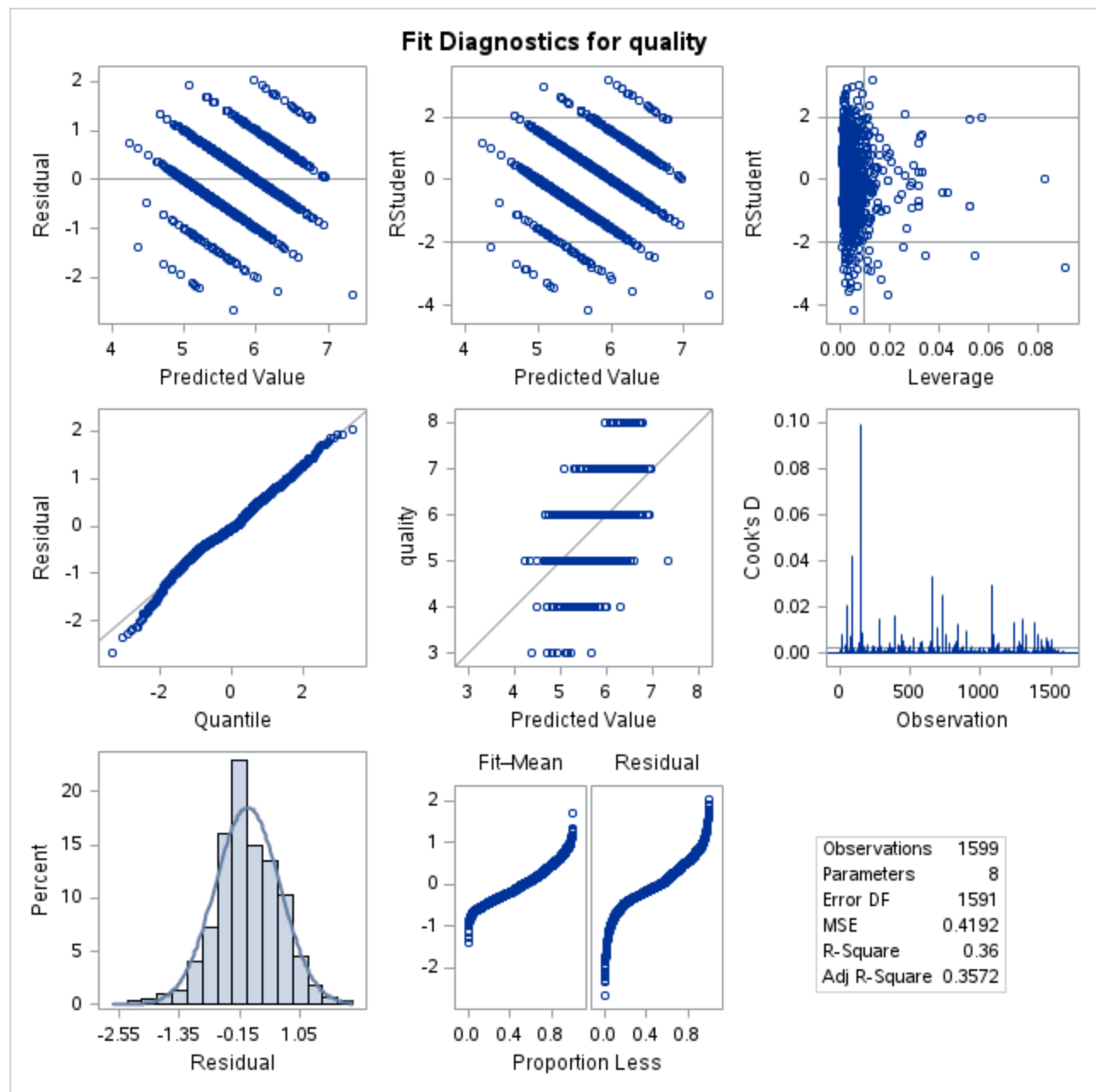
Bounds on condition number: 1.9439, 71.318

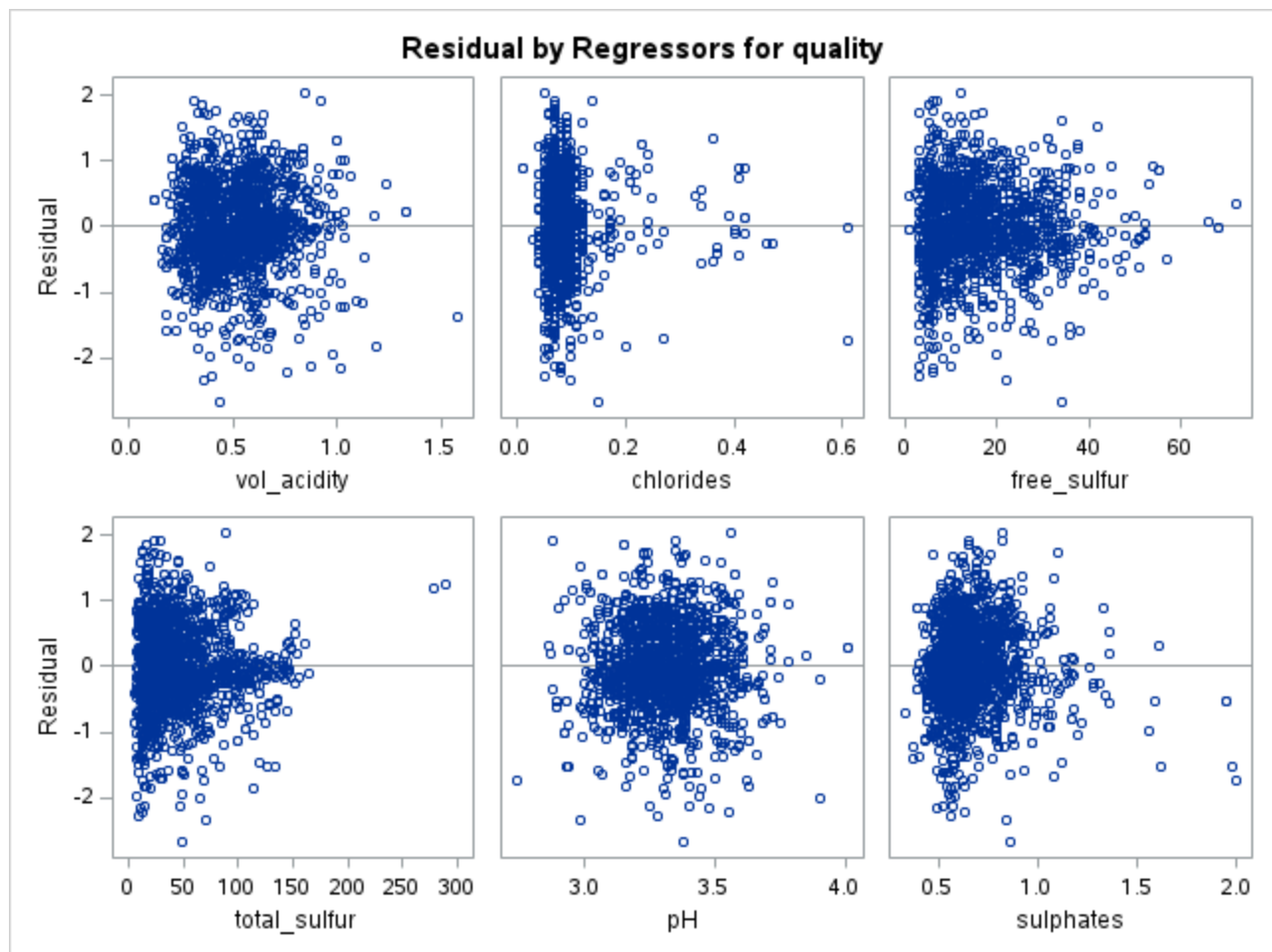
All variables have been entered into the model.

Summary of Forward Selection							
Step	Variable Entered	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	alcohol	1	0.2267	0.2267	327.444	468.26	<.0001
2	vol_acidity	2	0.0902	0.3170	105.108	210.85	<.0001
3	sulphates	3	0.0189	0.3359	60.0833	45.43	<.0001
4	total_sulfur	4	0.0079	0.3438	42.4337	19.20	<.0001
5	chlorides	5	0.0082	0.3520	23.9903	20.22	<.0001
6	pH	6	0.0058	0.3578	11.6590	14.29	0.0002
7	free_sulfur	7	0.0023	0.3600	8.0000	5.66	0.0175

## Forward Selection

The REG Procedure  
Model: MODEL1  
Dependent Variable: quality







### Backward Selection

The REG Procedure  
Model: MODEL1  
Dependent Variable: quality

Number of Observations Read	1599
Number of Observations Used	1599

#### Backward Elimination: Step 0

All Variables Entered: R-Square = 0.3600 and C(p) = 8.0000

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	375.23126	53.60447	127.88	<.0001
Error	1591	666.93384	0.41919		
Corrected Total	1598	1042.16510			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	4.44319	0.40261	51.05423	121.79	<.0001
vol_acidity	-1.00664	0.10045	42.09899	100.43	<.0001
chlorides	-2.06652	0.39622	11.40313	27.20	<.0001
free_sulfur	0.00505	0.00212	2.37220	5.66	0.0175

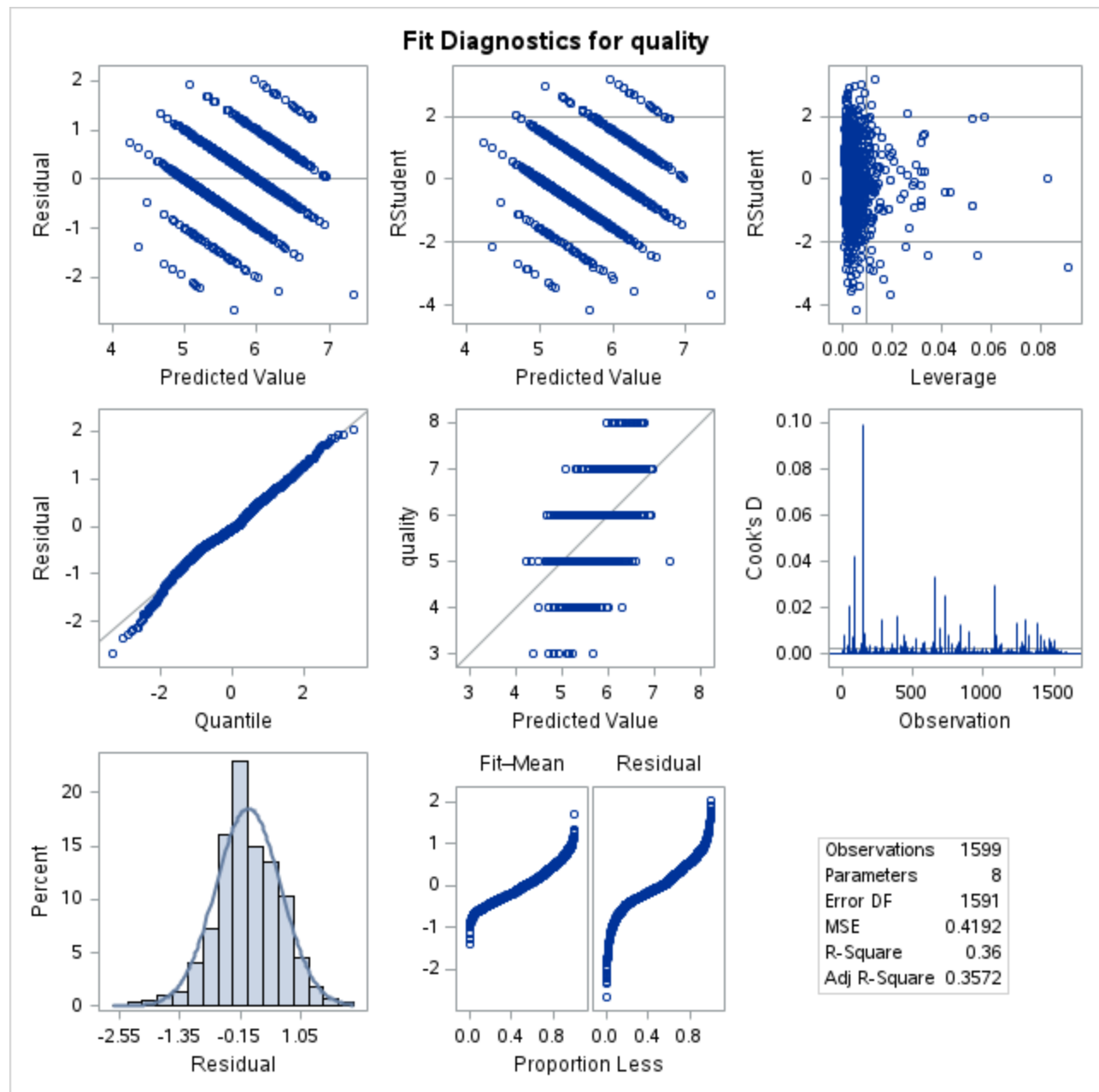
Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
total_sulfur	-0.00349	0.00068647	10.82327	25.82	<.0001
pH	-0.48543	0.11746	7.16007	17.08	<.0001
sulphates	0.88709	0.10972	27.40348	65.37	<.0001
alcohol	0.28894	0.01678	124.23885	296.38	<.0001

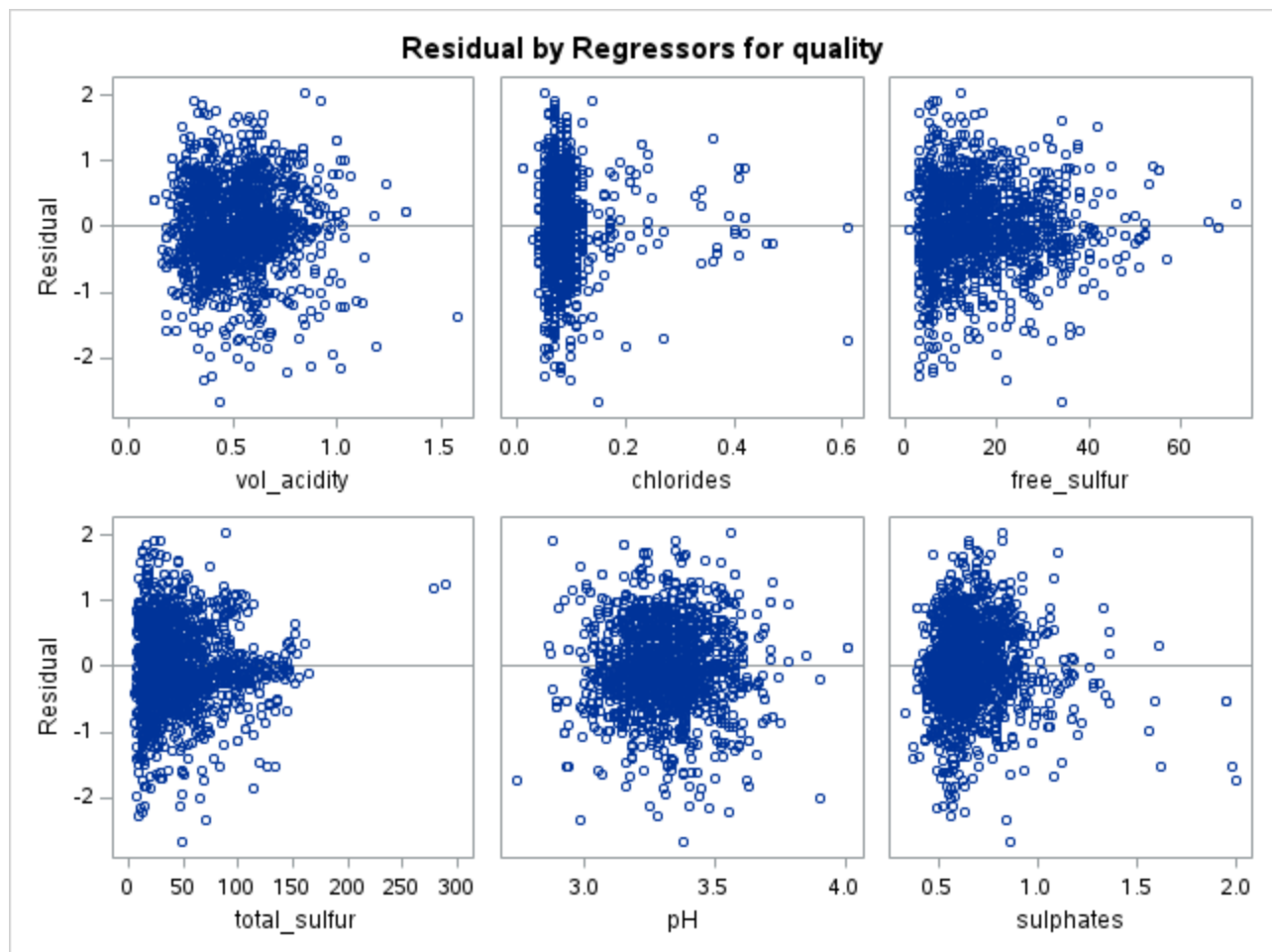
Bounds on condition number: 1.9439, 71.318

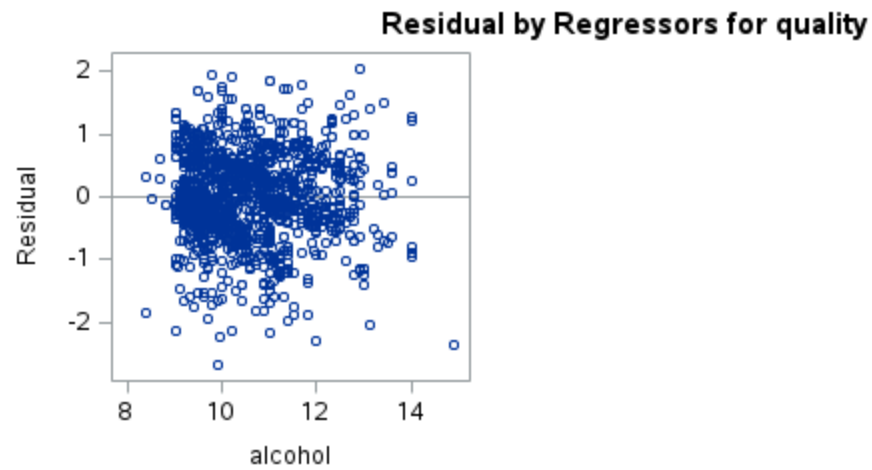
All variables left in the model are significant at the 0.1000 level.

## Backward Selection

The REG Procedure  
Model: MODEL1  
Dependent Variable: quality







### Lasso procedure

#### The GLMSELECT Procedure

<b>Data Set</b>	WORK.WINE
<b>Dependent Variable</b>	quality
<b>Selection Method</b>	LASSO
<b>Stop Criterion</b>	SBC
<b>Effect Hierarchy Enforced</b>	None

<b>Number of Observations Read</b>	1599
<b>Number of Observations Used</b>	1599

Dimensions	
<b>Number of Effects</b>	8
<b>Number of Parameters</b>	8

### Lasso procedure

#### The GLMSELECT Procedure

LASSO Selection Summary				
Step	Effect Entered	Effect Removed	Number Effects In	SBC



LASSO Selection Summary				
Step	Effect Entered	Effect Removed	Number Effects In	SBC
0	Intercept		1	-677.1197
1	alcohol		2	-821.8272
2	vol_acidity		3	-1139.7754
3	sulphates		4	-1251.2703
4	total_sulfur		5	-1283.2733
5	chlorides		6	-1292.6707
6	pH		7	-1334.7959
7	free_sulfur		8	-1339.2171*
* Optimal Value of Criterion				

Selection stopped because all effects are in the final model.

## Lasso procedure

### The GLMSELECT Procedure Selected Model

The selected model is the model at the last step (Step 7).

**Effects:** Intercept vol\_acidity chlorides free\_sulfur total\_sulfur pH sulphates alcohol

Analysis of Variance				
Source	DF	Sum of Squares	Mean Square	F Value
Model	7	375.23126	53.60447	127.88
Error	1591	666.93384	0.41919	
Corrected Total	1598	1042.16510		

Root MSE	0.64745
Dependent Mean	5.63602
R-Square	0.3600
Adj R-Sq	0.3572
AIC	218.76587
AICC	218.87915
SBC	-1339.21706

Parameter Estimates		
Parameter	DF	Estimate
Intercept	1	4.443192
vol_acidity	1	-1.006636
chlorides	1	-2.066517
free_sulfur	1	0.005054
total_sulfur	1	-0.003488
pH	1	-0.485430
sulphates	1	0.887095
alcohol	1	0.288944

**Ridge procedure**

The REG Procedure  
 Model: MODEL1  
 Dependent Variable: quality

Number of Observations Read	1599
Number of Observations Used	1599

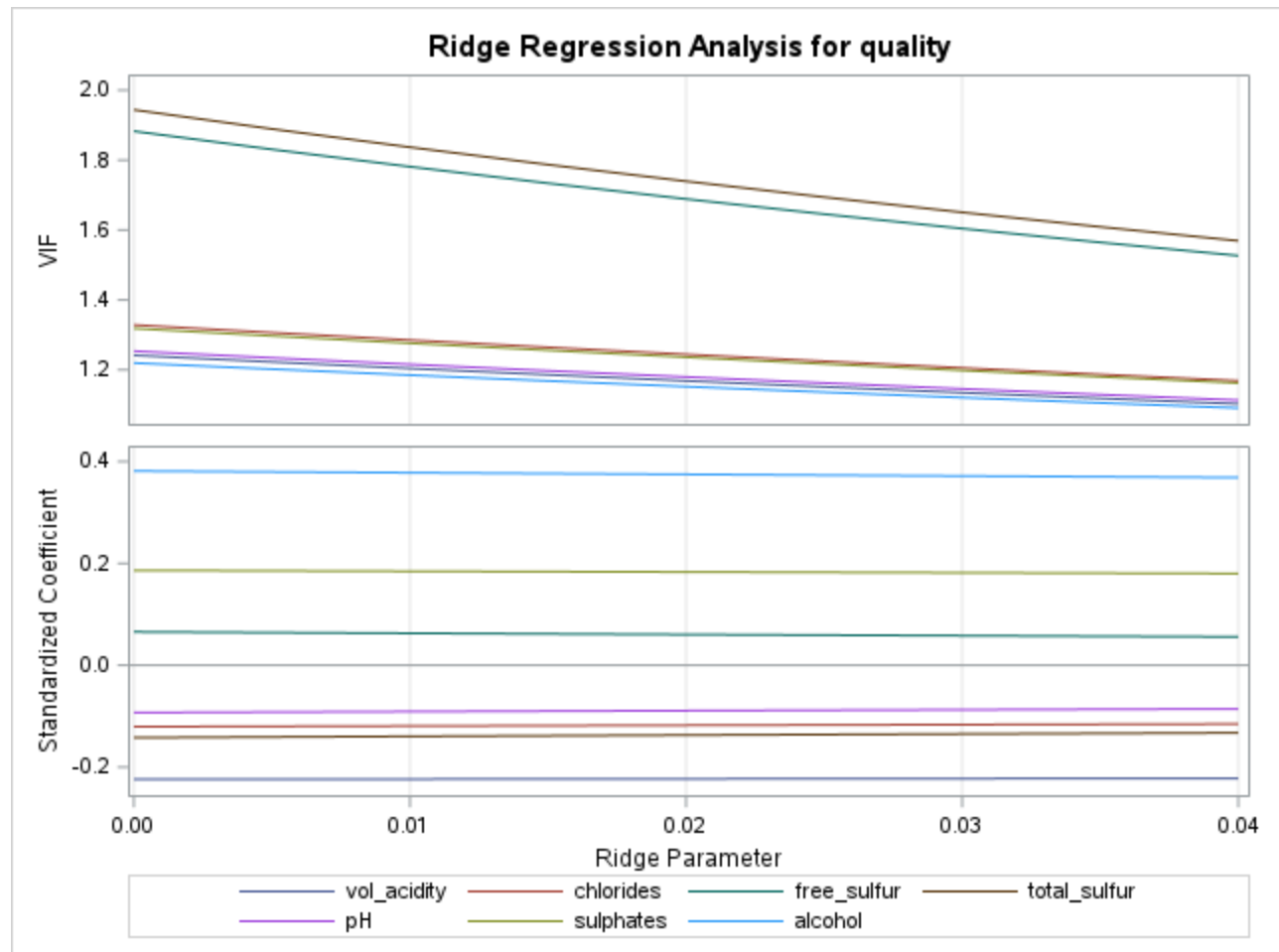
Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	375.23126	53.60447	127.88	<.0001
Error	1591	666.93384	0.41919		
Corrected Total	1598	1042.16510			

Root MSE	0.64745	R-Square	0.3600
Dependent Mean	5.63602	Adj R-Sq	0.3572
Coeff Var	11.48771		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	1	4.44319	0.40261	11.04	<.0001
vol_acidity	1	-1.00664	0.10045	-10.02	<.0001
chlorides	1	-2.06652	0.39622	-5.22	<.0001
free_sulfur	1	0.00505	0.00212	2.38	0.0175
total_sulfur	1	-0.00349	0.00068647	-5.08	<.0001
pH	1	-0.48543	0.11746	-4.13	<.0001
sulphates	1	0.88709	0.10972	8.09	<.0001
alcohol	1	0.28894	0.01678	17.22	<.0001

**Ridge procedure**

The REG Procedure  
 Model: MODEL1  
 Dependent Variable: quality



### Ridge procedure

The REG Procedure  
Model: MODEL1  
Dependent Variable: quality

