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Appendix – SAS and R Code for Project

Analysis 1

```
FILENAME REFFILE '/folders/myfolders/sasuser.v94/test.csv';

PROC IMPORT DATAFILE=REFFILE
	DBMS=CSV
	OUT=test;
	GETNAMES=YES;
RUN;

FILENAME REFFILE '/folders/myfolders/sasuser.v94/train.csv';

PROC IMPORT DATAFILE=REFFILE
	DBMS=CSV
	OUT=train;
	GETNAMES=YES;
RUN;

/*Filter only relevant Neighborhoods for Q1.  NAmes, Edwards, BrkSide*/
data neighborhoodSS;
	set train;
	where Neighborhood = 'NAmes' or Neighborhood = 'Edwards' or Neighborhood='BrkSide';
run;

/* Create GrLivAreaper100 variable, log Transform the SalesPrice and GrLivAreaper100 to re-run model */
data logneighborhoodSS;
	set neighborhoodSS;
	GrLivAreaper100 = GrLivArea/100;
	logSalePrice = log(SalePrice);
	logGrLivAreaper100 = log(GrLivArea/100);
run;

/*proc print data = logneighborhoodSS;
run;*/

/*Scatterplot the Saleprice to GrLivArea for the three requested neighborhoods*/
proc sgplot data=logneighborhoodSS;
scatter x=GrLivAreaper100 y=SalePrice / group=Neighborhood;
run;

/* Model for Salesprice to GrLivArea*/
proc glm data = logneighborhoodSS plots=all;
class Neighborhood;
model SalePrice = GrLivAreaper100 | Neighborhood / cli clm clparm;
run;

/*Filter out all homes greater than 40 100 sq.ft.*/
data logneighborhoodSSsmall;
	set logneighborhoodSS;
	where GrLivAreaper100 <= 40;
run;
```

```
/* Model for Salesprice to GrLivArea*/
proc glm data = logneighborhoodSSsmall plots=all;
class Neighborhood;
model SalePrice = GrLivAreaper100 | Neighborhood / cli clm clparm;
run;

/*Filter out all homes that costs more than $300,000*/
data logneighborhoodSScheap;
        set logneighborhoodSS;
        where SalePrice <= 300000;
run;

/* Model for Salesprice to GrLivArea*/
proc glm data = logneighborhoodSScheap plots=all;
class Neighborhood;
model SalePrice = GrLivAreaper100 | Neighborhood / cli clm clparm;
run;

/*Filter out all homes that costs more than $300,000 and smaller than 40 100 sq. ft.*/
data logneighborhoodSScheapsmall;
        set logneighborhoodSS;
        where SalePrice <= 300000 and GrLivAreaper100 <= 40;
run;

/* Model for Salesprice to GrLivArea*/
proc glm data = logneighborhoodSScheapsmall plots=all;
class Neighborhood;
model SalePrice = GrLivAreaper100 | Neighborhood / cli clm clparm solution;
run;

/* Model with log transformed SalePrice*/
proc glm data = logneighborhoodSS plots=all;
class Neighborhood;
model logSalePrice = GrLivAreaper100 | Neighborhood / cli clm clparm;
run;

/* Model with log transformed GrLivAreaper100*/
proc glm data = logneighborhoodSS plots=all;
class Neighborhood;
model SalePrice = logGrLivAreaper100 | Neighborhood / cli clm clparm;
run;

/* Model with log-log transformed SalePrice-GrLivAreaper100*/
proc glm data = logneighborhoodSS plots=all;
class Neighborhood;
model logSalePrice = logGrLivAreaper100 | Neighborhood / cli clm clparm;
run;

/* Model with log-log transformed SalePrice-GrLivAreaper100 on homes that are less than $300,000 and 40 100 sq. ft.*/
proc glm data = logneighborhoodSScheapsmall plots=all;
class Neighborhood;
model logSalePrice = logGrLivAreaper100 | Neighborhood / cli clm clparm; run;
```

Analysis 2

#R code for EDA

```
#masterAN.csv is combination of train.csv and test.csv

        trainDF <- read.csv("masterAN.csv", header = T, stringsAsFactors = F)
        trainDF <- subset(trainDF[1:1470,])
        trainDF$SalePrice <- as.integer(trainDF$SalePrice)
        titles <- names(trainDF)

        for (i in 1:length(trainDF)){
          if (is.character(trainDF[[i]])){
            boxplot(trainDF$SalePrice ~ trainDF[[i]], main = paste("Sale price vs ", titles[i], sep=""), ylab = titles[i], xlab = "Sale price", horizontal = T,
        las = 1)
          }
            else if (is.integer(trainDF[[i]])){
            plot(x = trainDF[[i]], y = trainDF$SalePrice, main = paste("Sale price vs ", titles[i], sep=""), xlab = titles[i], ylab = "Sale price")
            }
        }

/*SAS code for model selection (Forward, Backward, Stepwise, and custom user defined);*/

        data train;
        infile '/folders/myfolders/sasuser.v94/masterAN.csv' dlm=',' firstobs=2;
        input Id MSSubClass MSZoning $ LotFrontage LotArea Street $ Alley $ LotShape $ LandContour $
                Utilities $ LotConfig $ LandSlope $ Neighborhood $ Condition1 $ Condition2 $ BldgType $
                HouseStyle $ OverallQual OverallCond YearBuilt YearRemodAdd RoofStyle $ RoofMatl $
                Exterior1st $ Exterior2nd $ MasVnrType $ MasVnrArea ExterQual $ ExterCond $ Foundation $
                BsmtQual $ BsmtCond $ BsmtExposure $ BsmtFinType1 $ BsmtFinSF1 BsmtFinType2 $ BsmtFinSF2 BsmtUnfSF TotalBsmtSF
                Heating $ HeatingQC $ CentralAir $ Electrical $ _1stFlrSF _2ndFlrSF LowQualFinSF GrLivArea BsmtFullBath BsmtHalfBath
                FullBath HalfBath BedroomAbvGr KitchenAbvGr KitchenQual $ TotRmsAbvGrd Functional $ Fireplaces FireplaceQu $
                GarageType $ GarageYrBlt GarageFinish $ GarageCars GarageArea GarageQual $ GarageCond $ PavedDrive $ WoodDeckSF
                OpenPorchSF EnclosedPorch _3SsnPorch ScreenPorch PoolArea PoolQC $ Fence $ MiscFeature $ MiscVal MoSold YrSold
                SaleType $ SaleCondition $ SalePrice;


        /*Forward selection*/
        proc glmselect data=train seed=1;
                class MSZoning Street Alley LotShape LandContour Utilities LotConfig LandSlope
                        Neighborhood Condition1 Condition2 BldgType HouseStyle RoofStyle RoofMatl
                        Exterior1st Exterior2nd MasVnrType ExterQual ExterCond Foundation BsmtQual
                        BsmtCond BsmtExposure BsmtFinType1 BsmtFinType2 Heating HeatingQC CentralAir
                        Electrical KitchenQual Functional FireplaceQu GarageType GarageFinish
                        GarageQual GarageCond PavedDrive Fence MiscFeature SaleType SaleCondition PoolQC;
                model SalePrice=MSSubClass--SaleCondition / selection=forward (choose=CV
                        stop=CV) cvmethod=split(10) CVdetails;
                output out=forward_results p=Predict;
        run;

        /* Subset only Test data with salesprice prediction*/
        data forward_results2;
                set forward_results;

                if Predict > 0 then
                        SalePrice=Predict;

                if Predict < 0 then
                        SalePrice=10000;
                keep id SalePrice;
                where id > 1460;
        run;

        /* Export Kaggle Submission csv file*/
        proc export data=forward_results2
```

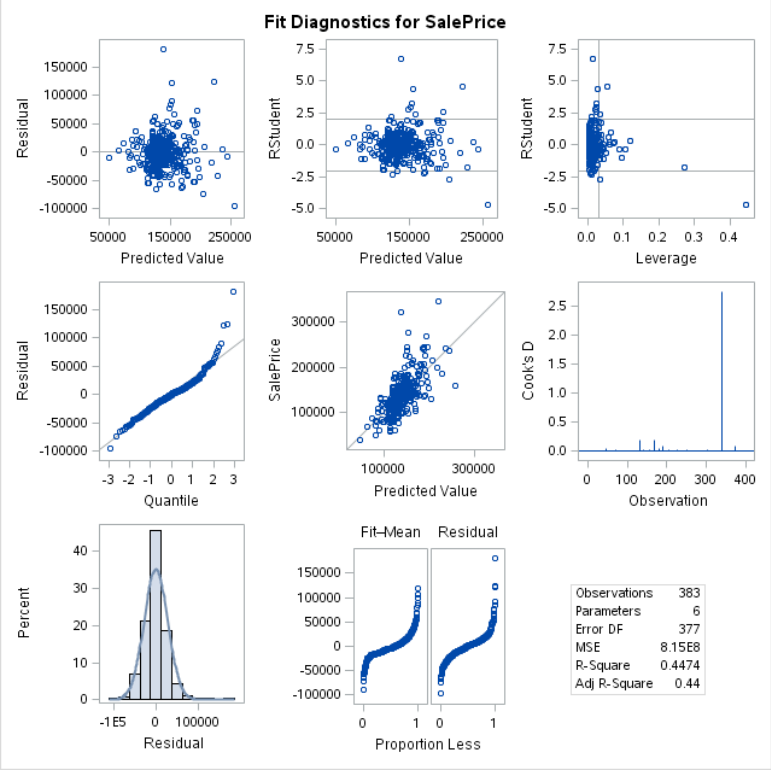
```
		outfile='/folders/myfolders/sasuser.v94/submit_forward2.csv' dbms=csv replace;
run;

proc print data=forward_results2;
run;


/*Backward elimination*/
proc glmselect data=train seed=1;
	class MSZoning Street Alley LotShape LandContour Utilities LotConfig LandSlope
		Neighborhood Condition1 Condition2 BldgType HouseStyle RoofStyle RoofMatl
		Exterior1st Exterior2nd MasVnrType ExterQual ExterCond Foundation BsmtQual
		BsmtCond BsmtExposure BsmtFinType1 BsmtFinType2 Heating HeatingQC CentralAir
		Electrical KitchenQual Functional FireplaceQu GarageType GarageFinish
		GarageQual GarageCond PavedDrive Fence MiscFeature SaleType SaleCondition PoolQC;
	model SalePrice=MSSubClass--SaleCondition / selection=backward(choose=CV
		stop=CV) cvmethod=split(10) CVdetails;
	output out=backward_results p=Predict;
run;

/* Subset only Test data with salesprice prediction*/
data backward_results2;
	set backward_results;

	if Predict > 0 then
		SalePrice=Predict;

	if Predict < 0 then
		SalePrice=10000;
	keep id SalePrice;
	where id > 1460;
run;

/* Export Kaggle Submission csv file*/
proc export data=backward_results2
		outfile='/folders/myfolders/sasuser.v94/submit_backwards.csv' dbms=csv replace;
run;

proc print data=backward_results2;
run;

/*Stepwise selection*/
proc glmselect data=train seed=1;
	class MSZoning Street Alley LotShape LandContour Utilities LotConfig LandSlope
		Neighborhood Condition1 Condition2 BldgType HouseStyle RoofStyle RoofMatl
		Exterior1st Exterior2nd MasVnrType ExterQual ExterCond Foundation BsmtQual
		BsmtCond BsmtExposure BsmtFinType1 BsmtFinType2 Heating HeatingQC CentralAir
		Electrical KitchenQual Functional FireplaceQu GarageType GarageFinish
		GarageQual GarageCond PavedDrive Fence MiscFeature SaleType SaleCondition PoolQC;
	model SalePrice=MSSubClass--SaleCondition / selection=stepwise(choose=CV
		stop=CV) cvmethod=split(10) CVdetails;
	output out=stepwise_results p=Predict;
run;

/* Subset only Test data with salesprice prediction*/
data stepwise_results2;
	set stepwise_results;

	if Predict > 0 then
		SalePrice=Predict;
```

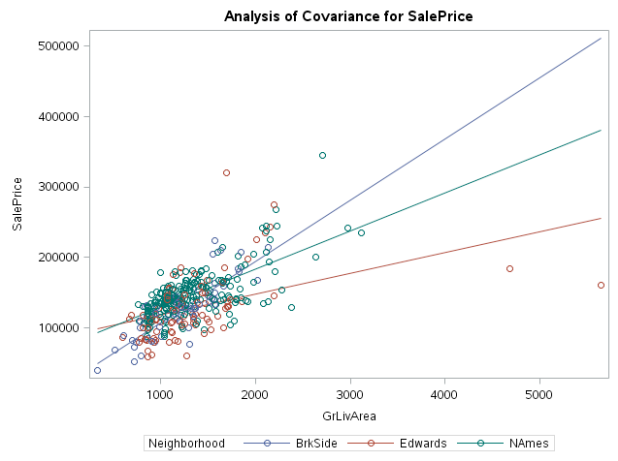
```
	if Predict < 0 then
		SalePrice=10000;
	keep id SalePrice;
	where id > 1460;
run;

/* Export Kaggle Submission csv file*/
proc export data=stepwise_results2
		outfile='/folders/myfolders/sasuser.v94/submit_stepwise.csv' dbms=csv replace;
run;

proc print data=stepwise_results2;
run;

/*Custom model*/
proc glmselect data=train2 plots=all;
	class KitchenQual GarageFinish BsmtQual ExterQual MasVnrType Neighborhood;
	model SalePrice=LotFrontage LotArea OverallQual OverallCond YearBuilt
		BsmtFinSF1 TotalBsmtSF _1stFlrSF _2ndFlrSF GrLivArea FullBath TotRmsAbvGrd
		GarageYrBlt GarageCars GarageArea WoodDeckSF OpenPorchSF KitchenQual
		GarageFinish BsmtQual ExterQual MasVnrType Neighborhood / selection=none;
	output out=results p=Predict; run;

/* Subset only Test data with salesprice prediction*/
data results3;
	set results;

	if Predict > 0 then
		SalePrice=Predict;

	if Predict < 0 then
		SalePrice=10000;
	keep id SalePrice;
	where id > 1460;
run;

/* Export Kaggle Submission csv file*/
proc export data=results3 outfile='/folders/myfolders/sasuser.v94/submit_custom2.csv'
		dbms=csv replace;run;

/*Custom model, use for obtaining Cook's D, Leverate, and Studentized residuals;*/
proc glm data=train plots=all;
	class KitchenQual GarageFinish BsmtQual ExterQual MasVnrType Neighborhood;
	model SalePrice=LotFrontage LotArea OverallQual OverallCond YearBuilt
		BsmtFinSF1 TotalBsmtSF _1stFlrSF _2ndFlrSF GrLivArea FullBath TotRmsAbvGrd
		GarageYrBlt GarageCars GarageArea WoodDeckSF OpenPorchSF KitchenQual
		GarageFinish BsmtQual ExterQual MasVnrType Neighborhood / solution;
	output out=results student=res cookd = cookd h = lev;run;

/*Display individuals with high Cook's D, large absolute studentized residuals or high leverage;*/
data results2;
	set results;
	where id <= 1460 and (cookd > 1 or res > 10 or res < -10 or lev > 1);
run;
proc print data = results2;run;
```

Appendix 1: Vanilla Regression – Raw Data | Model Original

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	74676.40154	B	6337.89399	11.78	<.0001
GrLivArea	54.31586	B	4.61364	11.77	<.0001
Neighborhood BrkSide	-54704.88774	B	13882.33364	-3.94	<.0001
Neighborhood Edwards	13676.70324	B	9097.57465	1.50	0.1336
Neighborhood NAmes	0.00000	B	.	.	.
GrLivArea*Neighborho BrkSide	32.84667	B	10.81538	3.04	0.0026
GrLivArea*Neighborho Edwards	-24.56556	B	6.36139	-3.86	0.0001
GrLivArea*Neighborho NAmes	0.00000	B	.	.	.

R-Square	Coeff Var	Root MSE	SalePrice Mean
0.447376	20.68070	28552.30	138062.5

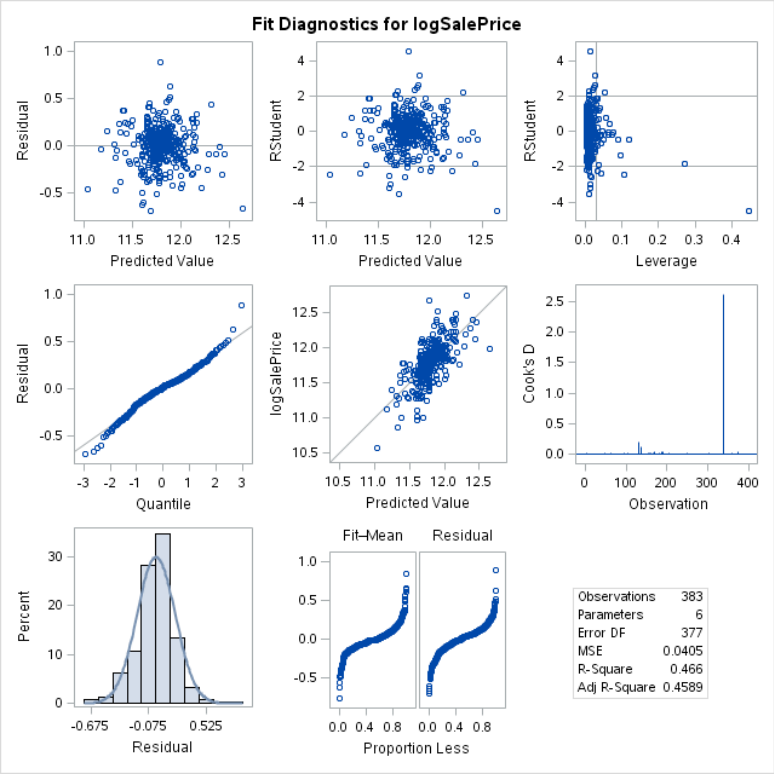


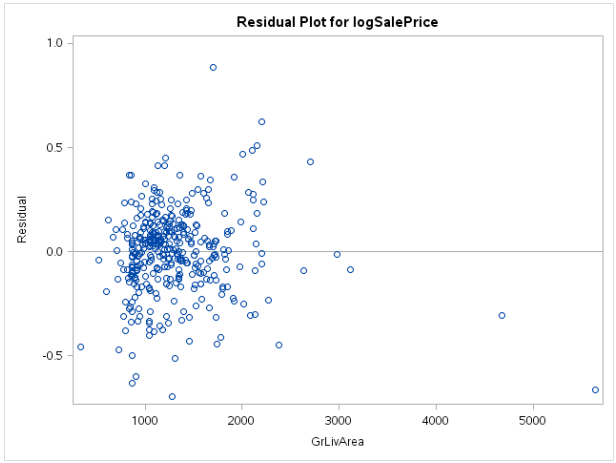


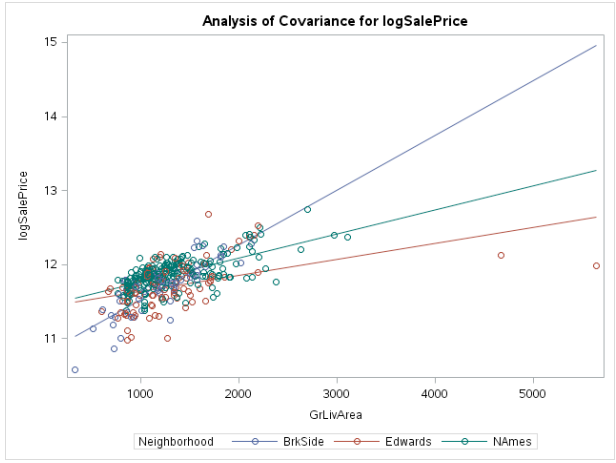
Appendix 2: Vanilla Regression | Model: Log-Linear

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	11.44334070	B	0.04465161	256.28	<.0001
GrLivArea	0.00032412	B	0.00003250	9.97	<.0001
Neighborhood BrkSide	-0.65174673	B	0.09780355	-6.66	<.0001
Neighborhood Edwards	-0.02139976	B	0.06409406	-0.33	0.7387
Neighborhood NAmes	0.00000000	B	.	.	.
GrLivArea*Neighborho BrkSide	0.00041410	B	0.00007620	5.43	<.0001
GrLivArea*Neighborho Edwards	-0.00010744	B	0.00004482	-2.40	0.0170
GrLivArea*Neighborho NAmes	0.00000000	B	.	.	.

R-Square	Coeff Var	Root MSE	logSalePrice Mean
0.465985	1.704877	0.201156	11.79887



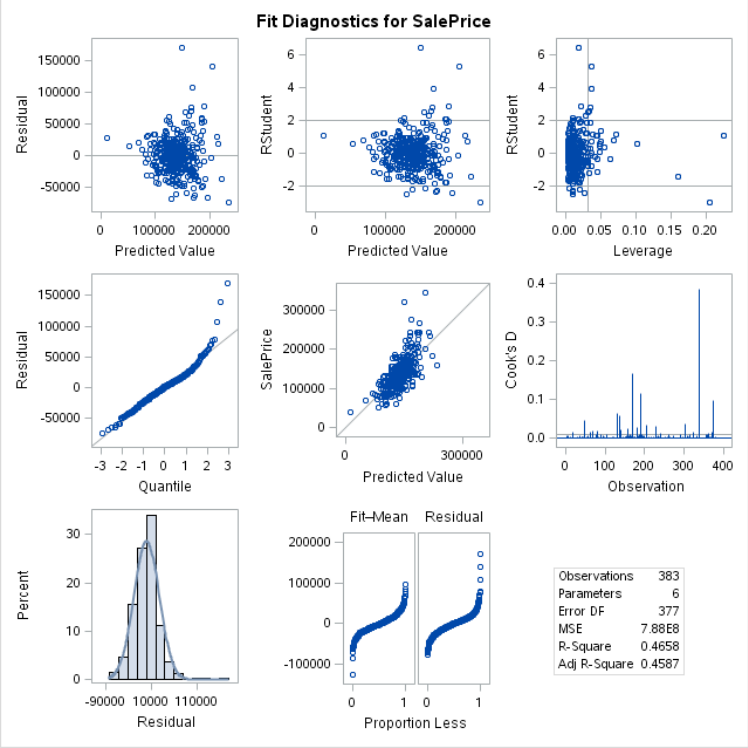


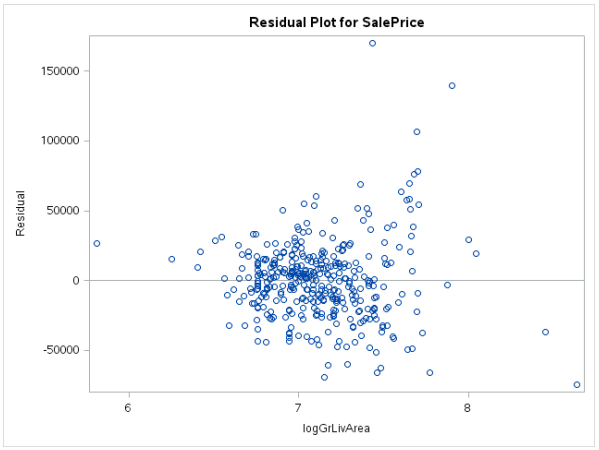


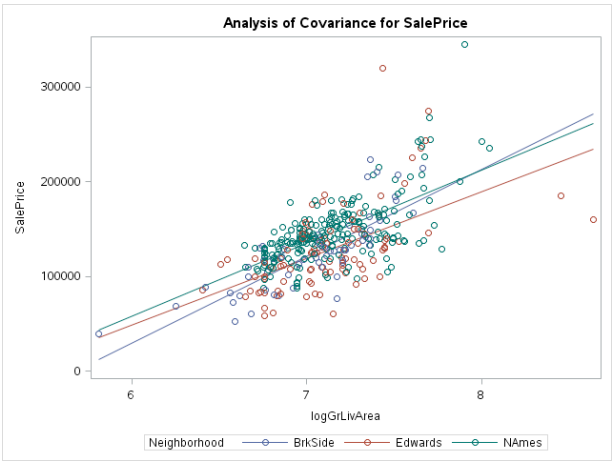
Appendix 3: Vanilla Regression | Model: Linear - Log

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	-405474.3769	B	47364.43769	-8.56	<.0001
logGrLivArea	77263.2789	B	6632.56245	11.65	<.0001
Neighborhood BrkSide	-115363.9795	B	87581.82712	-1.32	0.1886
Neighborhood Edwards	29405.8761	B	75555.48597	0.39	0.6974
Neighborhood NAmes	0.0000	B	.	.	.
logGrLivA*Neighborho BrkSide	14507.4723	B	12383.61185	1.17	0.2421
logGrLivA*Neighborho Edwards	-6546.6413	B	10581.99330	-0.62	0.5365
logGrLivA*Neighborho NAmes	0.0000	B	.	.	.

R-Square	Coeff Var	Root MSE	SalePrice Mean
0.465809	20.33287	28072.06	138062.5



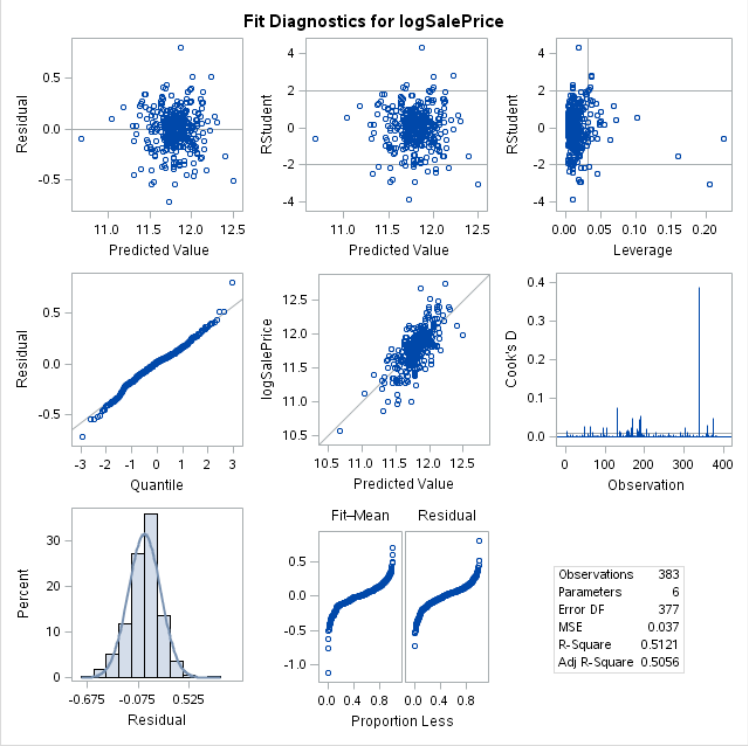


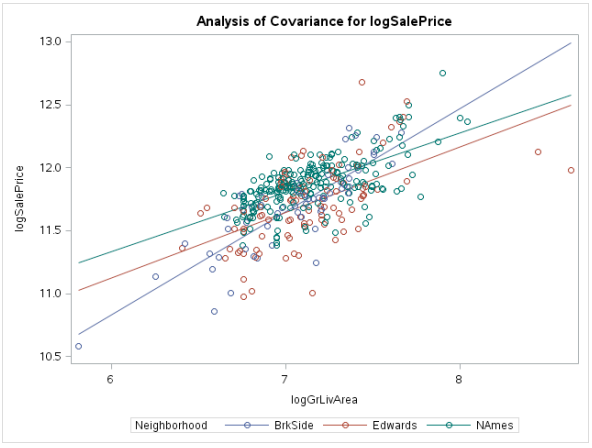


Appendix 4: Vanilla Regression | Model: Log-Log

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	8.492727641	B	0.32441709	26.18	<.0001
logGrLivArea	0.473023602	B	0.04542895	10.41	<.0001
Neighborhood BrkSide	-2.579806905	B	0.59988132	-4.30	<.0001
Neighborhood Edwards	-0.486220461	B	0.51750833	-0.94	0.3481
Neighborhood NAmes	0.000000000	B	.	.	.
logGrLivA*Neighborho BrkSide	0.346624454	B	0.08482008	4.09	<.0001
logGrLivA*Neighborho Edwards	0.046643642	B	0.07248011	0.64	0.5203
logGrLivA*Neighborho NAmes	0.000000000	B	.	.	.

R-Square	Coeff Var	Root MSE	logSalePrice Mean
0.512092	1.629617	0.192276	11.79887

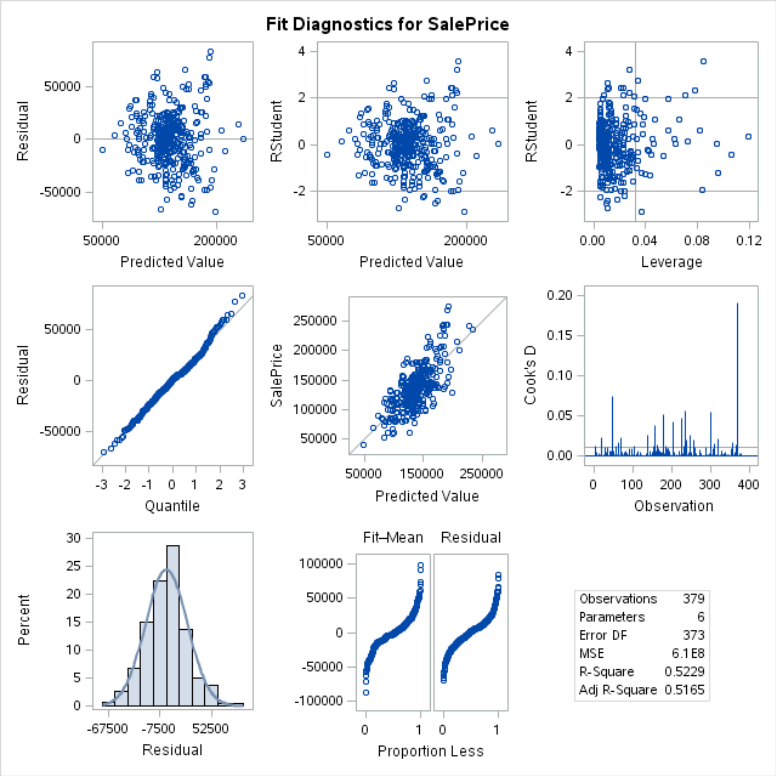


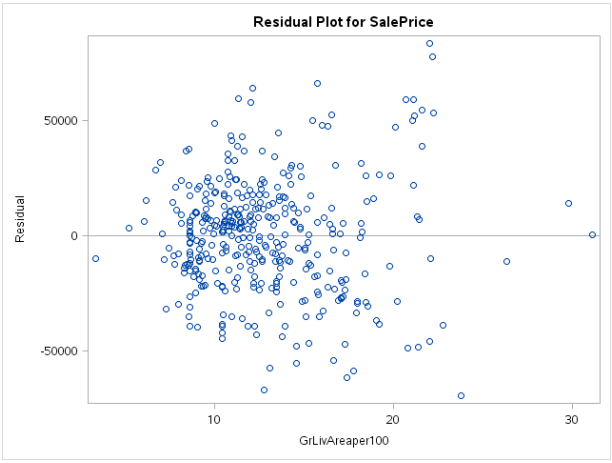


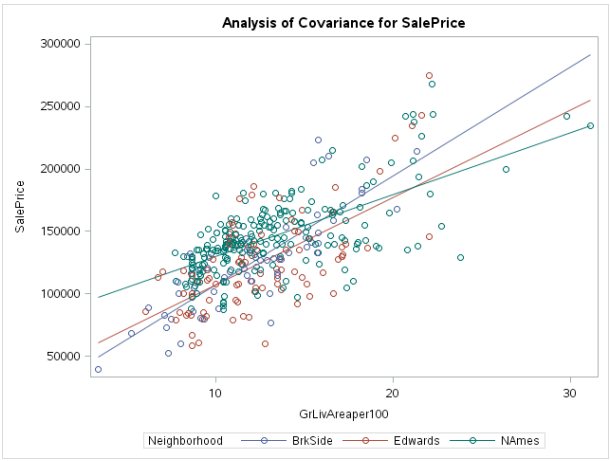
Appendix 5: Vanilla Regression | Model: Outliers Addressed*

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	80325.71230	B	5592.03832	14.36	<.0001
GrLivAreaper100	4956.12477	B	409.70671	12.10	<.0001
Neighborhood BrkSide	-60354.19850	B	12060.03479	-5.00	<.0001
Neighborhood Edwards	-43225.29073	B	10837.81644	-3.99	<.0001
Neighborhood NAmes	0.00000	B	.	.	.
GrLivArea*Neighborho BrkSide	3760.12849	B	940.21789	4.00	<.0001
GrLivArea*Neighborho Edwards	2059.71212	B	820.38610	2.51	0.0125
GrLivArea*Neighborho NAmes	0.00000	B	.	.	.

R-Square	Coeff Var	Root MSE	SalePrice Mean
0.522897	18.04909	24701.16	136855.4



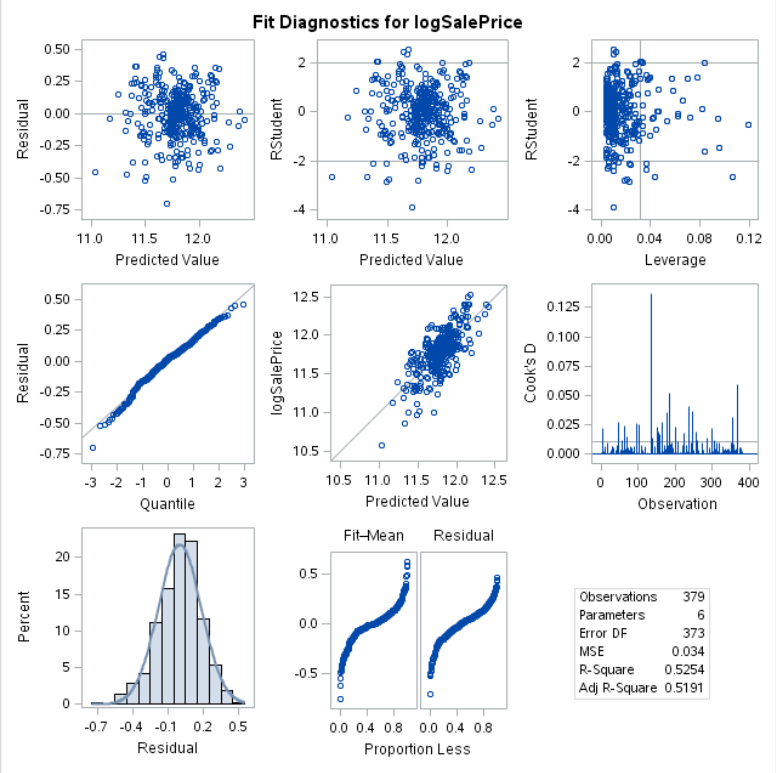


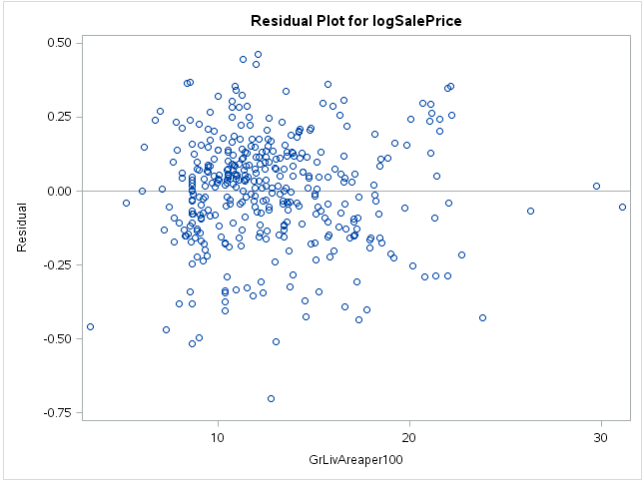


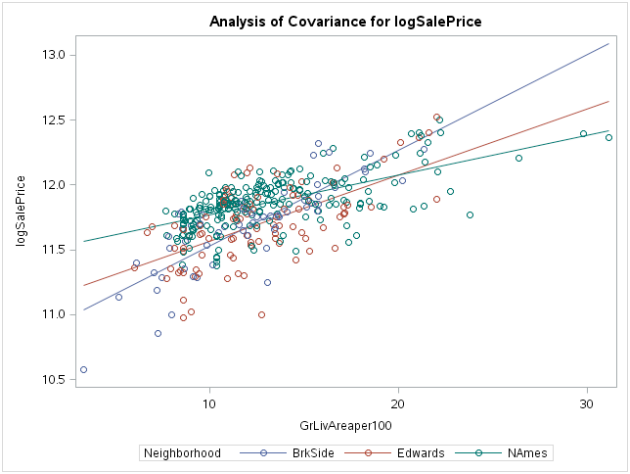
Appendix 6: Vanilla Regression | Model: Log-Linear (Outliers Addressed)

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	11.46308762	B	0.04175292	274.55	<.0001
GrLivAreaper100	0.03075050	B	0.00305907	10.05	<.0001
Neighborhood BrkSide	-0.67149365	B	0.09004618	-7.46	<.0001
Neighborhood Edwards	-0.41144266	B	0.08092049	-5.08	<.0001
Neighborhood NAmes	0.00000000	B	.	.	.
GrLivArea*Neighborho BrkSide	0.04307178	B	0.00702013	6.14	<.0001
GrLivArea*Neighborho Edwards	0.02043149	B	0.00612541	3.34	0.0009
GrLivArea*Neighborho NAmes	0.00000000	B	.	.	.

R-Square	Coeff Var	Root MSE	logSalePrice Mean
0.525413	1.563944	0.184431	11.79269



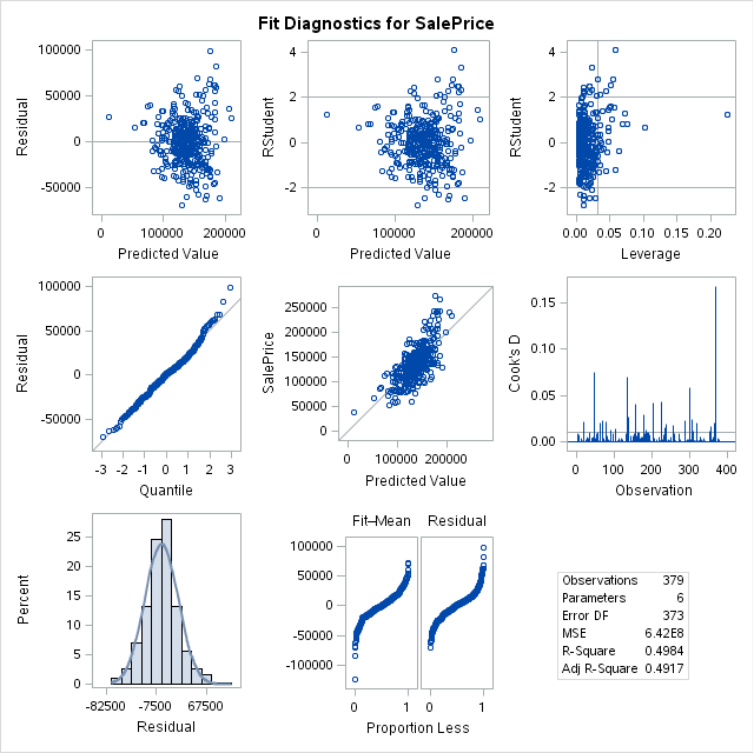


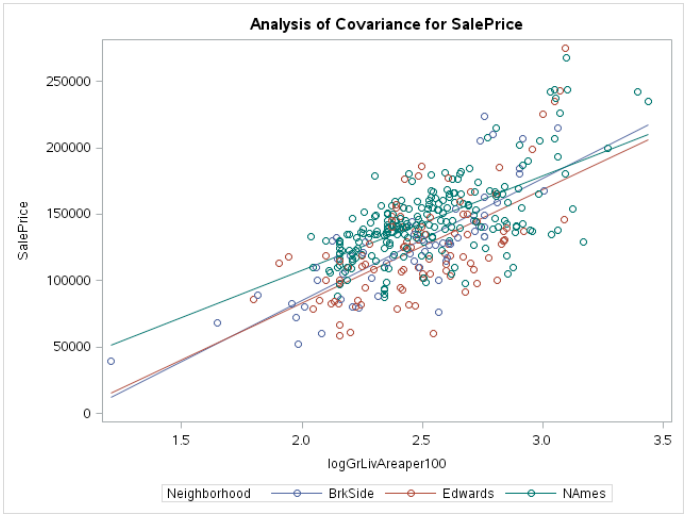


Appendix 7: Vanilla Regression | Model: Linear-Log (Outliers Addressed)

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	-34567.92221	B	15470.76545	-2.23	0.0260
logGrLivAreaper100	71042.34430	B	6085.38391	11.67	<.0001
Neighborhood BrkSide	-63650.50684	B	27862.76048	-2.28	0.0229
Neighborhood Edwards	-52636.52333	B	28037.21033	-1.88	0.0612
Neighborhood NAmes	0.00000	B	.	.	.
logGrLivA*Neighborho BrkSide	20728.40689	B	11227.58949	1.85	0.0657
logGrLivA*Neighborho Edwards	14188.73230	B	11130.71521	1.27	0.2032
logGrLivA*Neighborho NAmes	0.00000	B	.	.	.

R-Square	Coeff Var	Root MSE	SalePrice Mean
0.498378	18.50708	25327.93	136855.4

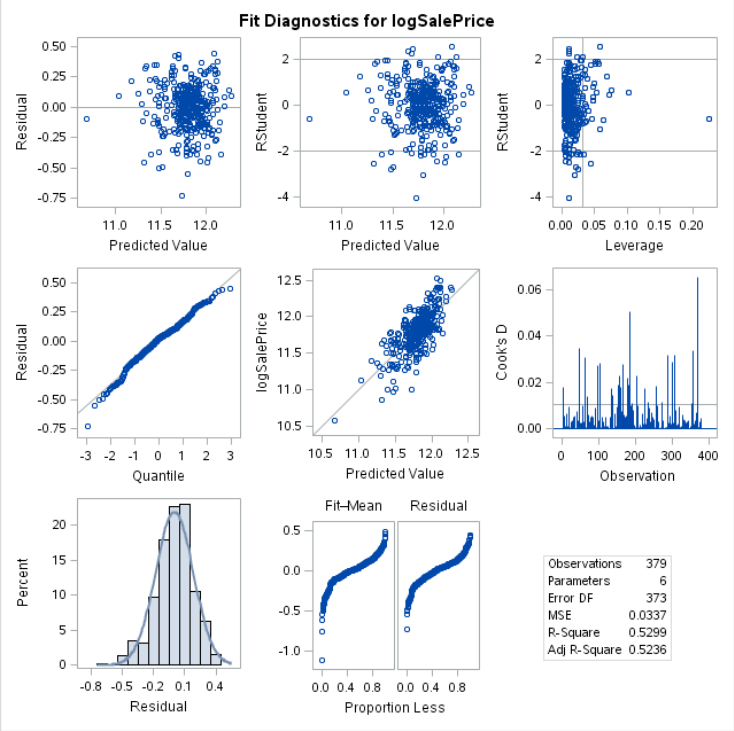


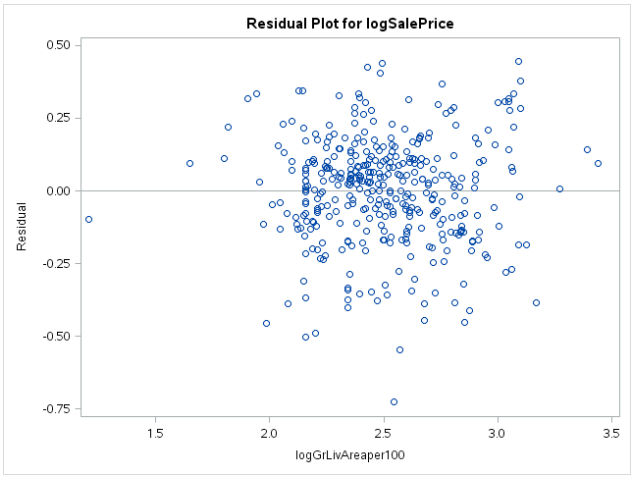


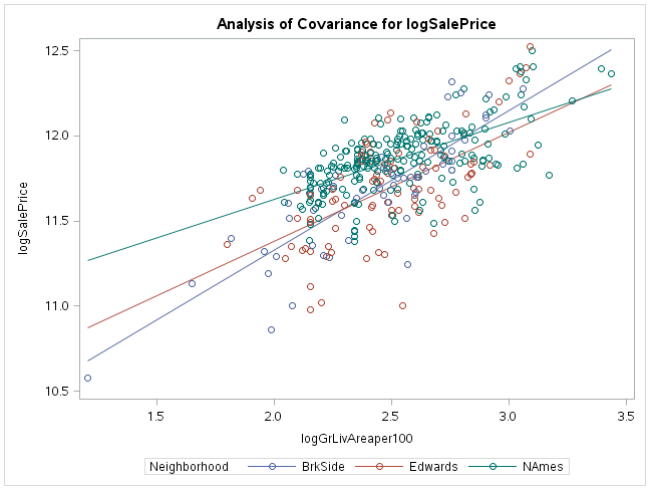
Appendix 8: Vanilla Regression | Model: Log-Log (Outliers Addressed)

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	10.72724642	B	0.11211841	95.68	<.0001
logGrLivAreaper100	0.44987850	B	0.04410147	10.20	<.0001
Neighborhood BrkSide	-1.03970690	B	0.20192461	-5.15	<.0001
Neighborhood Edwards	-0.62585626	B	0.20318887	-3.08	0.0022
Neighborhood NAmes	0.00000000	B	.	.	.
logGrLivA*Neighborho BrkSide	0.36976955	B	0.08136763	4.54	<.0001
logGrLivA*Neighborho Edwards	0.18931410	B	0.08066557	2.35	0.0195
logGrLivA*Neighborho NAmes	0.00000000	B	.	.	.

R-Square	Coeff Var	Root MSE	logSalePrice Mean
0.529914	1.556511	0.183554	11.79269



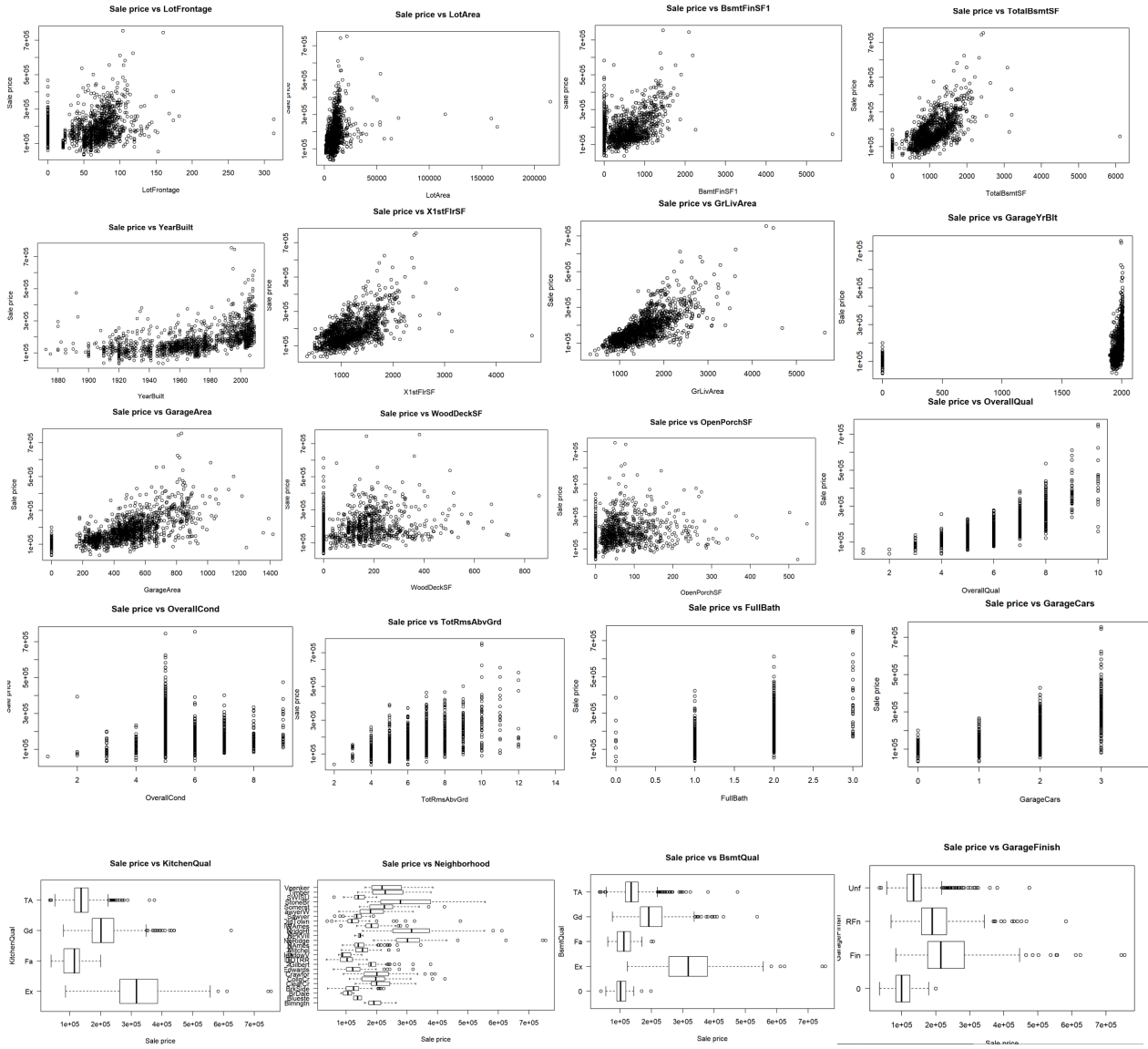




Appendix 9: Analysis 2 | Checking Assumptions

(Pairwise Variables with Linearity)

We disregarded the values of '0' as it was originally 'NA'. For a few of the plots, if '0' was not included in judging the plots, there would be sufficient evidence of correlation between the pairwise variables.



Appendix 10 : Forward Selection SAS Results

The GLMSELECT Procedure

Data Set	WORK.TRAIN4
Dependent Variable	SalePrice
Selection Method	Forward
Select Criterion	SBC
Stop Criterion	Cross Validation
Choose Criterion	Cross Validation
Cross Validation Method	Split
Cross Validation Fold	10
Effect Hierarchy Enforced	None

Number of Observations Read	2919
Number of Observations Used	1453

The GLMSELECT Procedure
Selected Model

The selected model, based on Cross Validation, is the model at Step 7.

Effects:	Intercept MSSubClass Neighborhood OverallQual ExterQual BsmtExposure BsmtFinSF1 GrLivArea

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value
Model	35	7.706526E12	2.201865E11	267.65
Error	1417	1.165735E12	822677995	
Corrected Total	1452	8.872261E12		

Root MSE	28682
Dependent Mean	180405
R-Square	0.8686
Adj R-Sq	0.8654
AIC	31318
AICC	31320
SBC	30053
CV PRESS	1.284085E12

Cross Validation Details

Index	Observations Fitted	Observations Left Out	CV PRESS
1	1307	146	9.66431E10
2	1307	146	9.4771E10
3	1307	146	2.47223E11
4	1308	145	1.12533E11
5	1308	145	1.37267E11
6	1308	145	1.8053E11
7	1308	145	1.35943E11
8	1308	145	9.83451E10
9	1308	145	1.02255E11
10	1308	145	7.85748E10
Total			1.28409E12

Parameter Estimates

Parameter	DF	Estimate	Standard Error	t Value
Intercept	1	23083	10518	2.19
MSSubClass	1	-275.366217	21.280080	-12.94
Neighborhood Blmngtn	1	-7602.992318	11296	-0.67
Neighborhood Blueste	1	-13329	22296	-0.60
Neighborhood BrDale	1	-28498	11717	-2.43
Neighborhood BrkSide	1	-34635	9732.085281	-3.56
Neighborhood ClearCr	1	-22912	10333	-2.22
Neighborhood CollgCr	1	-20846	9085.523663	-2.29
Neighborhood Crawfor	1	-11832	9735.585870	-1.22
Neighborhood Edwards	1	-44564	9384.758640	-4.75
Neighborhood Gilbert	1	-20714	9389.515096	-2.21
Neighborhood IDOTRR	1	-49267	10218	-4.82
Neighborhood MeadowV	1	-21426	11605	-1.85
Neighborhood Mitchel	1	-31967	9776.667107	-3.27
Neighborhood NAmes	1	-37252	9109.777197	-4.09
Neighborhood NPkVill	1	-10921	13243	-0.82
Neighborhood NWAmes	1	-30911	9542.657568	-3.24
Neighborhood NoRidge	1	18607	9985.134713	1.86
Neighborhood NridgHt	1	24169	9538.973472	2.53
Neighborhood OldTown	1	-47004	9380.734580	-5.01
Neighborhood SWISU	1	-52040	10704	-4.86
Neighborhood Sawyer	1	-33888	9558.483583	-3.55
Neighborhood SawyerW	1	-27646	9529.227186	-2.90
Neighborhood Somerst	1	1083.589725	9375.122303	0.12
Neighborhood StoneBr	1	33689	10549	3.19
Neighborhood Timber	1	-17183	9873.938952	-1.74
Neighborhood Veenker	0	0	.	.
OverallQual	1	13747	1010.396593	13.61
ExterQual Ex	1	61646	5435.303177	11.34
ExterQual Fa	1	-4045.246585	8079.321547	-0.50
ExterQual Gd	1	9922.462958	2536.197499	3.91
ExterQual TA	0	0	.	.
BsmtExposure 0	1	-789.054205	4985.392953	-0.16
BsmtExposure Av	1	11100	2363.318582	4.70
BsmtExposure Gd	1	33250	3062.316378	10.86
BsmtExposure Mn	1	8970.798814	2889.601355	3.10
BsmtExposure No	0	0	.	.
BsmtFinSF1	1	24.467273	2.048623	11.94
GrLivArea	1	60.931671	2.057459	29.62

Appendix 11 : Analysis 2 | Backwards Elimination

The GLMSELECT Procedure

Data Set	WORK.TRAIN4
Dependent Variable	SalePrice
Selection Method	Backward
Select Criterion	SBC
Stop Criterion	Cross Validation
Choose Criterion	Cross Validation
Cross Validation Method	Split
Cross Validation Fold	10
Effect Hierarchy Enforced	None

Number of Observations Read	2919
Number of Observations Used	1453

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value
Model	231	8.273593E12	35816421120	73.05
Error	1221	5.986678E11	490309403	
Corrected Total	1452	8.872261E12		

Root MSE	22143
Dependent Mean	180405
R-Square	0.9325
Adj R-Sq	0.9198
AIC	30742
AICC	30831
SBC	30512
CV PRESS	1.2082E12

Cross Validation Details

Index	Observations Fitted	Observations Left Out	CV PRESS
1	1307	146	6.29604E10
2	1307	146	7.0841E10
3	1307	146	2.43882E11
4	1308	145	8.98807E10
5	1308	145	1.03041E11
6	1308	145	1.38758E11
7	1308	145	9.06685E10
8	1308	145	7.13204E10
9	1308	145	8.98909E10
10	1308	145	2.46959E11
Total			1.2082E12

Parameter Estimates

Parameter	DF	Estimate	Standard Error	t Value
Intercept	1	455801	1019977	0.45
MSSubClass	1	-47.661185	80.414936	-0.59
MSZoning C (all)	1	-21515	9341.518072	-2.30
MSZoning FV	1	11452	7418.640168	1.54
MSZoning RH	1	585.002446	7373.814431	0.08
MSZoning RL	1	3693.746453	3661.999781	0.99
MSZoning RM	0	0	.	.
LotFrontage	1	11.804637	22.370992	0.53
L rea	1	0.750481	0.104492	0.99
St et Grvl	1	-32557	11902	-2.74
St et Pave	0	0	.	.
Alley 0	1	529.020919	4612.754680	0.11
Alley Grvl	1	832.339977	5868.060953	0.14
Alley Pave	0	0	.	.
LotShape IR1	1	2005.359904	1588.572325	1.26
LotShape IR2	1	1984.673074	4221.582566	0.47
LotShape IR3	1	3717.705375	8637.540302	0.43
LotShape Reg	0	0	.	.
LandContour Bnk	1	-5012.242098	3589.675608	-1.40
LandContour HLS	1	2831.838534	3972.579777	0.71
LandContour Low	1	-15611	5518.446937	-2.83
LandContour Lvl	0	0	.	.
Utilities AllPub	1	39760	25792	1.54
Utilities NoSeWa	0	0	.	.
LotConfig Corner	1	1463.381584	1711.234849	0.86
LotConfig CulDSa	1	10029	2936.803256	3.42
LotConfig FR2	1	-5660.332208	3672.918171	-1.54
LotConfig FR3	1	-14168	12199	-1.16
LotConfig Inside	0	0	.	.
LandSlope Gtl	1	43224	11116	3.89
LandSlope Mod	1	50495	11048	4.57
LandSlope Sev	0	0	.	.
Neighborhood Blmngtn	1	578.779303	10214	0.06
Neighborhood Blueste	1	7496.030490	19000	0.39
Neighborhood BrDale	1	-1303.307897	11245	-0.12
Neighborhood BrkSide	1	-5699.351008	9189.583066	-0.62
Neighborhood ClearCr	1	-14707	9246.047859	-1.59
Neighborhood CollgCr	1	-9906.376941	8037.091543	-1.23
Neighborhood Crawfor	1	9583.684201	8662.312413	1.11
Neighborhood Edwards	1	-20526	8318.071740	-2.47
Neighborhood Gilbert	1	-10245	8402.251023	-1.22
Neighborhood IDOTRR	1	-13648	10378	-1.32
Neighborhood MeadowV	1	-6840.749053	11375	-0.60
Neighborhood Mitchel	1	-20826	8499.582839	-2.45
Neighborhood NAmes	1	-16562	7950.338677	-2.08
Neighborhood NPkVill	1	13214	11373	1.16
Neighborhood NWAmes	1	-16994	8182.603346	-2.08
Neighborhood NoRidge	1	22769	8825.154154	2.58
Neighborhood NridgHt	1	17620	8572.122664	2.06
Neighborhood OldTown	1	-15622	9343.086167	-1.67
Neighborhood SWISU	1	-10675	9871.034455	-1.08
Neighborhood Sawyer	1	-10370	8254.090541	-1.26
Neighborhood SawyerW	1	-3398.198855	8263.887725	-0.40
Neighborhood Somerst	1	-2959.142333	9572.621799	-0.31
Neighborhood StoneBr	1	36704	9190.754496	3.99
Neighborhood Timber	1	-9994.277509	8830.439128	-1.13
Neighborhood Veenker	0	0	.	.
Condition1 Arter	1	-11959	12316	-0.97
Condition1 Feedr	1	-7370.706354	11920	-0.62
Condition1 Norm	1	1734.118922	11631	0.15
Condition1 PosA	1	-4834.036921	14577	-0.33
Condition1 PosN	1	-1093.918382	13026	-0.08
Condition1 RRAe	1	-29795	14101	-2.11
Condition1 RRAn	1	-1370.463981	12236	-0.11
Condition1 RRNe	1	-17656	20135	-0.88
Condition1 RRNn	0	0	.	.
Condition2 Arter	1	1427.552024	26445	0.05
Condition2 Feedr	1	-4885.224225	20600	-0.24
Condition2 Norm	1	-6278.701688	17299	-0.36
Condition2 PosA	1	40450	36178	1.12
Condition2 PosN	1	-233580	25246	-9.25
Condition2 RRAe	1	-117890	63175	-1.87
Condition2 RRAn	1	-17351	28866	-0.60
Condition2 RRNn	0	0	.	.
BldgType 1Fam	1	15581	8742.768486	1.78
BldgType 2fmCon	1	12821	7383.062076	1.74
BldgType Duplex	1	8418.536751	8491.364783	0.99
BldgType Twnhs	1	-4763.643432	4803.273042	-0.99
BldgType TwnhsE	0	0	.	.
HouseStyle 105Fin	1	-3958.447514	5434.998208	-0.73
HouseStyle 105Unf	1	8677.255532	8635.834236	1.00
HouseStyle 1Story	1	2147.503108	5983.017492	0.37
HouseStyle 205Fin	1	-29241	13303	-2.20
HouseStyle 205Unf	1	-13427	9736.291789	-1.38
HouseStyle 2Story	1	-8753.513870	5181.853335	-1.69
HouseStyle SFoyer	1	-2380.377156	5384.209776	-0.44
HouseStyle SLvl	0	0	.	.
OverallQual	1	6804.476213	985.285364	6.91
OverallCond	1	5486.264727	849.804231	6.46
YearBuilt	1	299.197264	74.323153	4.03
YearRemodAdd	1	118.998282	54.367681	2.19
RoofStyle Flat	1	-59641	33577	-2.79
RoofStyle Gable	1	-89142	29129	-3.06
RoofStyle Gambrel	1	-85564	30981	-2.84
RoofStyle Hip	1	-89402	29157	-3.07
RoofStyle Mansard	1	-79003	28867	-2.74
RoofStyle Shed	0	0	.	.
RoofMatl CompShg	1	-54207	11057	-4.90
RoofMatl Membran	1	35702	33963	1.05
RoofMatl Metal	1	6662.328806	33003	0.20
RoofMatl Roll	1	-68297	27218	-2.51
RoofMatl Tar&Grv	1	-54162	20796	-2.60
RoofMatl WdShake	1	-60139	17839	-3.37
RoofMatl WdShngl	0	0	.	.
Exterior1st AsbShng	1	6100.049267	7851.526579	0.78
Exterior1st AsphShn	1	-4987.949758	24740	-0.20
Exterior1st BrkComm	1	3312.177857	18942	0.17
Exterior1st BrkFace	1	17966	6066.708599	2.96
Exterior1st CBlock	1	-12389	26309	-0.47
Exterior1st CemntBd	1	5013.425301	6347.241189	0.79
Exterior1st HdBoard	1	-1041.228705	5279.512800	-0.20
Exterior1st ImStucc	1	-3536.469817	24201	-0.15
Exterior1st MetalSd	1	3260.308700	5124.593809	0.64
Exterior1st Plywood	1	-3040.923820	5631.892835	-0.54
Exterior1st Stone	1	-1357.092871	19058	-0.07
Exterior1st Stucco	1	6761.844773	7118.470764	0.95
Exterior1st VinylSd	1	2524.268367	5170.980167	0.49
Exterior1st Wd Sdng	1	53.264056	5096.300373	0.01
Exterior1st WdShing	0	0	.	.
MasVnrType 0	1	-8764.851594	8547.222067	-1.03
MasVnrType BrkCm	1	-10394	7055.660922	-1.47
MasVnrType BrkFa	1	-5028.349186	2808.745293	-1.79
MasVnrType None	1	-2198.935374	3058.571806	-0.72
MasVnrType Stone	0	0	.	.
MasVnrArea	1	22.479543	5.658221	3.97
ExterQual Ex	1	23014	5206.536432	4.42
ExterQual Fa	1	11948	9435.239124	1.27
ExterQual Gd	1	535.792299	2397.200372	0.22
ExterQual TA	0	0	.	.
ExterCond Ex	1	2832.038076	16804	0.17
ExterCond Fa	1	-264.852697	5594.939143	-0.05
ExterCond Gd	1	-1907.991800	2328.520292	-0.82
ExterCond Po	1	5626.576929	25364	0.22
ExterCond TA	0	0	.	.
Foundation BrkTil	1	23051	14432	1.60
Foundation CBlock	1	26363	14211	1.86
Foundation PConc	1	28236	14113	2.00
Foundation Slab	1	16817	16826	1.12
Foundation Stone	1	30801	17874	1.72
Foundation Wood	0	0	.	.
BsmtQual 0	1	40926	35066	1.17
BsmtQual Ex	1	14189	4024.210426	3.53
BsmtQual Fa	1	2138.427037	4748.397502	0.45
BsmtQual Gd	1	-2862.865864	2477.067201	-1.16
BsmtQual TA	0	0	.	.
BsmtCond 0	0	0	.	.
BsmtCond Fa	1	-3231.985232	4132.307362	-0.78
BsmtCond Gd	1	-3177.262960	3171.340280	-1.00
BsmtCond Po	1	72796	29028	2.51
BsmtCond TA	0	0	.	.
BsmtExposure 0	1	-6243.459554	22480	-0.28
BsmtExposure Av	1	4900.025199	2129.387256	2.30
BsmtExposure Gd	1	19382	2897.942328	6.69
BsmtExposure Mn	1	1418.849766	2456.641154	0.58
BsmtExposure No	0	0	.	.
BsmtFinType1 0	0	0	.	.
BsmtFinType1 ALQ	1	-2737.478979	2832.743013	-0.97
BsmtFinType1 BLQ	1	-227.379663	3035.373339	-0.07
BsmtFinType1 GLQ	1	3275.584175	2646.285029	1.24
BsmtFinType1 LwQ	1	-5793.857420	3644.072557	-1.59
BsmtFinType1 Rec	1	-2745.080595	3085.563373	-0.89
BsmtFinType1 Unf	0	0	.	.
BsmtFinSF1	1	36.415188	5.173747	7.04
BsmtFinType2 0	1	-18004	24089	-0.75
BsmtFinType2 ALQ	1	8291.756428	7386.126840	1.12
BsmtFinType2 BLQ	1	-4236.939712	4970.933202	-0.85
BsmtFinType2 GLQ	1	5966.414679	8070.493999	0.69
BsmtFinType2 LwQ	1	-2462.341131	4500.949358	-0.55
BsmtFinType2 Rec	1	-1234.668209	4676.981038	-0.26
BsmtFinType2 Unf	0	0	.	.
BsmtFinSF2	1	28.707654	8.815251	3.26
BsmtUnfSF	1	19.544998	4.734109	4.13
Heating Floo	1	-9167.340822	28759	-0.32
Heating GasA	1	-5921.954456	13793	-0.43
Heating GasW	1	-9798.974734	14863	-0.66
Heating Grav	1	-11122	16901	-0.66
Heating OthW	1	-28793	22723	-1.27
Heating Wall	0	0	.	.
HeatingQC Ex	1	3029.300818	2013.989125	1.50
HeatingQC Fa	1	4364.228857	4392.626582	0.99
HeatingQC Gd	1	-636.612877	2102.823900	-0.30
HeatingQC Po	1	6061.782721	25988	0.23
HeatingQC TA	0	0	.	.
CentralAir N	1	-560.747923	3753.312070	-0.15
CentralAir Y	0	0	.	.
Electrical 0	1	13970	23362	0.60
Electrical FuseA	1	2696.431433	2861.122451	0.94
Electrical FuseF	1	1188.287942	5343.537515	0.22
Electrical FuseP	1	-2847.900137	17734	-0.16
Electrical Mix	1	-43972	41637	-1.06
Electrical SBrkr	0	0	.	.
A1stFlrSF	1	44.321615	5.490132	8.07
A2ndFlrSF	1	60.971619	5.550750	10.98
LowQualFinSF	1	25.015558	18.958772	1.32
BsmtFullBath	1	1720.024480	1926.620555	0.89
BsmtHalfBath	1	801.885105	2923.795455	0.27
FullBath	1	3697.729967	2138.813106	1.73
HalfBath	1	1733.927607	2029.680834	0.85
BedroomAbvGr	1	-3387.471228	1319.941030	-2.57
KitchenAbvGr	1	-14485	5508.261594	-2.63
KitchenQual Ex	1	20740	3831.324413	5.41
KitchenQual Fa	1	3266.230145	4720.097108	0.70
KitchenQual Gd	1	-725.042008	2082.906846	-0.35
KitchenQual TA	0	0	.	.
TotRmsAbvGrd	1	1729.918503	929.125504	1.86
Functional Maj	1	-20999	6262.465087	-3.35
Functional Min	1	-9842.364451	3320.987389	-2.96
Functional Mod	1	-21589	7383.777413	-2.92
Functional Sev	1	-60914	28127	-2.17
Functional Typ	0	0	.	.

Appendix 12 : Analysis 2 | Stepwise Selection

The GLMSELECT Procedure

Data Set	WORK.TRAIN4
Dependent Variable	SalePrice
Selection Method	Stepwise
Select Criterion	SBC
Stop Criterion	Cross Validation
Choose Criterion	Cross Validation
Cross Validation Method	Split
Cross Validation Fold	10
Effect Hierarchy Enforced	None

Number of Observations Read	2919
Number of Observations Used	1453

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value
Model	35	7.706526E12	2.201865E11	267.65
Error	1417	1.165735E12	822677995	
Corrected Total	1452	8.872261E12		

Root MSE	28682
Dependent Mean	180405
R-Square	0.8686
Adj R-Sq	0.8654
AIC	31318
AICC	31320
SBC	30053
CV PRESS	1.284085E12

Cross Validation Details

Index	Observations		CV PRESS
	Fitted	Left Out	
1	1307	146	9.66431E10
2	1307	146	9.4771E10
3	1307	146	2.47223E11
4	1308	145	1.12533E11
5	1308	145	1.37267E11
6	1308	145	1.8053E11
7	1308	145	1.35943E11
8	1308	145	9.83451E10
9	1308	145	1.02255E11
10	1308	145	7.85748E10
Total			1.28409E12

Parameter Estimates

Parameter	DF	Estimate	Standard Error	t Value
Intercept	1	23083	10518	2.19
MSSubClass	1	-275.366217	21.280080	-12.94
Neighborhood Blmngtn	1	-7602.992318	11296	-0.67
Neighborhood Blueste	1	-13329	22296	-0.60
Neighborhood BrDale	1	-28498	11717	-2.43
Neighborhood BrkSide	1	-34635	9732.085281	-3.56
Neighborhood ClearCr	1	-22912	10333	-2.22
Neighborhood CollgCr	1	-20846	9085.523663	-2.29
Neighborhood Crawfor	1	-11832	9735.585870	-1.22
Neighborhood Edwards	1	-44564	9384.758640	-4.75
Neighborhood Gilbert	1	-20714	9389.515096	-2.21
Neighborhood IDOTRR	1	-49267	10218	-4.82
Neighborhood MeadowV	1	-21426	11605	-1.85
Neighborhood Mitchel	1	-31967	9776.667107	-3.27
Neighborhood NAmes	1	-37252	9109.777197	-4.09
Neighborhood NPkVill	1	-10921	13243	-0.82
Neighborhood NWAmes	1	-30911	9542.657568	-3.24
Neighborhood NoRidge	1	18607	9985.134713	1.86
Neighborhood NridgHt	1	24169	9538.973472	2.53
Neighborhood OldTown	1	-47004	9380.734580	-5.01
Neighborhood SWISU	1	-52040	10704	-4.86
Neighborhood Sawyer	1	-33888	9558.483583	-3.55
Neighborhood SawyerW	1	-27646	9529.227186	-2.90
Neighborhood Somerst	1	1083.589725	9375.122303	0.12
Neighborhood StoneBr	1	33689	10549	3.19
Neighborhood Timber	1	-17183	9873.938952	-1.74
Neighborhood Veenker	0	0	.	.
OverallQual	1	13747	1010.396593	13.61
ExterQual Ex	1	61646	5435.303177	11.34
ExterQual Fa	1	-4045.246585	8079.321547	-0.50
ExterQual Gd	1	9922.462958	2536.197499	3.91
ExterQual TA	0	0	.	.
BsmtExposure 0	1	-789.054205	4985.392953	-0.16
BsmtExposure Av	1	11100	2363.318582	4.70
BsmtExposure Gd	1	33250	3062.316378	10.86
BsmtExposure Mn	1	8970.798814	2889.601355	3.10
BsmtExposure No	0	0	.	.
BsmtFinSF1	1	24.467273	2.048623	11.94
GrLivArea	1	60.931671	2.057459	29.62

Appendix 13 : Analysis 2 | Custom Selection

The GLMSELECT Procedure

Data Set	WORK.TRAIN4
Dependent Variable	SalePrice
Selection Method	None

Number of Observations Read	2919
Number of Observations Used	1460

The GLMSELECT Procedure
Least Squares Model (No Selection)

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	58	7.879044E12	1.358456E11	143.22	<.0001
Error	1401	1.328867E12	948513132		
Corrected Total	1459	9.207911E12			

Root MSE	30798
Dependent Mean	180921
R-Square	0.8557
Adj R-Sq	0.8497
AIC	31699
AICC	31704
SBC	30548

Parameter Estimates

Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-427134	165878	-2.57	0.0101
LotFrontage	1	-20.289697	25.933358	-0.78	0.4341
LotArea	1	0.545618	0.096061	5.68	<.0001
OverallQual	1	10486	1163.841790	9.01	<.0001
OverallCond	1	6775.936796	881.410022	7.69	<.0001
YearBuilt	1	298.450330	76.443384	3.90	<.0001
BsmtFinSF1	1	11.857029	2.310627	5.13	<.0001
TotalBsmtSF	1	3.199482	4.882422	0.66	0.5124
A1stFlrSF	1	27.624703	18.947882	1.46	0.1451
A2ndFlrSF	1	18.648615	18.375416	1.01	0.3103
GrLivArea	1	19.129055	18.322085	1.04	0.2966
FullBath	1	2430.130029	2385.894354	1.02	0.3086
TotRmsAbvGrd	1	1163.576980	973.104965	1.20	0.2320
GarageYrBlt	1	-95.689282	68.537013	-1.40	0.1629
GarageCars	1	14015	2772.172788	5.06	<.0001
GarageArea	1	1.331760	9.463098	0.14	0.8881
WoodDeckSF	1	23.713846	7.144184	3.32	0.0009
OpenPorchSF	1	5.858968	13.737009	0.43	0.6698
KitchenQual Ex	1	30562	4820.201639	6.34	<.0001
KitchenQual Fa	1	673.600459	5631.775551	0.12	0.9048
KitchenQual Gd	1	4211.597007	2560.005327	1.65	0.1002
KitchenQual TA	0	0	.	.	.
GarageFinish 0	1	-172383	133386	-1.29	0.1964
GarageFinish Fin	1	6447.686766	2862.799050	2.25	0.0245
GarageFinish RFn	1	2305.719977	2470.049925	0.93	0.3507
GarageFinish Unf	0	0	.	.	.
BsmtQual 0	1	-9626.708062	7309.116629	-1.32	0.1880
BsmtQual Ex	1	30387	5025.225166	6.05	<.0001
BsmtQual Fa	1	-1825.588841	5688.341768	-0.32	0.7483
BsmtQual Gd	1	-2523.238208	2957.712595	-0.85	0.3937
BsmtQual TA	0	0	.	.	.
ExterQual Ex	1	19183	6503.615057	2.95	0.0032
ExterQual Fa	1	2890.634534	9229.274923	0.31	0.7542
ExterQual Gd	1	1655.229412	3047.200080	0.54	0.5871
BsmtQual TA	0	0	.	.	.
ExterQual Ex	1	19183	6503.615057	2.95	0.0032
ExterQual Fa	1	2890.634534	9229.274923	0.31	0.7542
ExterQual Gd	1	1655.229412	3047.200080	0.54	0.5871
ExterQual TA	0	0	.	.	.
MasVnrType 0	1	-727.980970	11377	-0.06	0.9490
MasVnrType BrkCm	1	-13212	8855.522649	-1.49	0.1359
MasVnrType BrkFa	1	-1912.709008	3508.983949	-0.55	0.5858
MasVnrType None	1	470.556562	3628.403230	0.13	0.8968
MasVnrType Stone	0	0	.	.	.
Neighborhood Blmngtn	1	-30558	12415	-2.46	0.0140
Neighborhood Blueste	1	-50121	24004	-2.09	0.0370
Neighborhood BrDale	1	-45077	12846	-3.51	0.0005
Neighborhood BrkSide	1	-24276	10848	-2.24	0.0254
Neighborhood ClearCr	1	-13600	11278	-1.21	0.2281
Neighborhood CollgCr	1	-15807	9902.689966	-1.60	0.1107
Neighborhood Crawfor	1	-1818.648751	10774	-0.17	0.8660
Neighborhood Edwards	1	-39691	10274	-3.86	0.0001
Neighborhood Gilbert	1	-22840	10355	-2.21	0.0276
Neighborhood IDOTRR	1	-35346	11470	-3.08	0.0021
Neighborhood MeadowV	1	-44209	12376	-3.57	0.0004
Neighborhood Mitchel	1	-36508	10566	-3.46	0.0006
Neighborhood NAmes	1	-28200	9988.832172	-2.82	0.0048
Neighborhood NPkVill	1	-38212	14239	-2.68	0.0074
Neighborhood NWAmes	1	-31493	10326	-3.05	0.0023
Neighborhood NoRidge	1	38068	10852	3.51	0.0005
Neighborhood NridgHt	1	8794.347363	10577	0.83	0.4059
Neighborhood OldTown	1	-40255	10637	-3.78	0.0002
Neighborhood SWISU	1	-33778	12118	-2.79	0.0054
Neighborhood Sawyer	1	-29777	10361	-2.87	0.0041
Neighborhood SawyerW	1	-22278	10356	-2.15	0.0316
Neighborhood Somerst	1	-8774.462064	10342	-0.85	0.3963
Neighborhood StoneBr	1	25030	11373	2.20	0.0279
Neighborhood Timber	1	-18263	10808	-1.69	0.0913
Neighborhood Veenker	0	0	.	.	.

APPENDIX 14 : Kaggle Submission Score

Submission and Description	Public Score	Use for Final Score
submit_stepwise3.csv 11 minutes ago by Andy H add submission details	0.15937	☑
submit_forward2.csv a day ago by Andy H add submission details	0.15937	☑
submit_custom2.csv a day ago by Andy H add submission details	0.18171	☑
submit_backwards.csv a day ago by Andy H add submission details	0.17309	☑